Report
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Surat Gas Project Updated CSG WMMP Annual Report

Reporting Period: 22 October 2022 to 21 October 2023

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1. Purpose

Arrow Energy's (Arrow) Surat Gas Project (SGP) was approved by the Australian Government under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) decision 2010/5344 on 19 December 2013. The conditions attached to approval EPBC 2010/5344 require a Stage 1 Coal Seam Gas (CSG) Water Monitoring and Management Plan (WMMP) (as required under condition 13, and approved by the Australian Government on 18 December 2018) and an Updated CSG WMMP (as required under condition 17, and approved by the Australian Government on 22 November 2019) be prepared.

Section 8.2.4 of the SGP Updated WMMP requires Arrow to publish an annual report presenting a summary of progress towards Arrow's commitments and document Arrow's compliance against the approval conditions. This annual report is required to be prepared within three months of the anniversary date of the SGP commencement, which was 22 October 2020. This Report has been prepared to fulfil these obligations for the reporting period of 22 October 2022 to 21 October 2023 and provides:

- a summary of relevant monitoring results and analysis and interpretation of data, including:
    - groundwater levels (Section 3.1)
    - groundwater chemistry results (Section 3.2)
    - subsidence monitoring results (Section 3.3)
- documentation of corrective actions implemented to address exceedances of trigger thresholds, limits, or non-compliance with approval conditions (Sections 3 and 6)
- details of any updates to the Field Development Plan (FDP) and implications for water monitoring and management (Section 4)
- reporting of any relevant ongoing studies and research projects, and includes any supporting technical studies as appendices to the annual report (Section 5)
- documentation of Arrow's compliance against the approval conditions over the preceding 12 months, including monitoring obligations and implementation of the early warning monitoring system (EWMS) (Section 6)
- reporting against the performance measure criteria detailed in Section 8.3 of the SGP Updated WMMP (Sections 3, 5 and 6).

2. Surat Gas Project Status

The SGP commenced on 22 October 2020 and, in the first 12 months, production had not started from any SGP production wells during that reporting period and, as such, no water was produced from these wells during that reporting period.

During this reporting period (22 October 2022 – 21 October 2023), 138 SGP production wells have started production, whereas during the previous reporting period (22 October 2021 – 21 October 2022), 37 SGP wells had commenced production.

2.1 Well Installations

A total of 247 production wells have been installed since commencement of the SGP.

2.2 Well Production

Table 1 presents the location and start date of the SGP production wells, which commenced production during this reporting period. Figure 2-1 shows the location of these wells. The monthly water production volumes for all SGP wells are summarised in Table 2.

Table 1: SGP Production well details and start dates

Well Name	Easting (m)	Northing (m)	PL	Production Start date
Longswamp 171	316525	6980771	PL260	14-Oct-23
Longswamp 172	316540	6980769	PL260	14-Oct-23
Longswamp 173	316555	6980767	PL260	14-Oct-23
Longswamp 174	316570	6980765	PL260	14-Oct-23
Longswamp 241	315156	6981638	PL260	14-Oct-23
Longswamp 242	315154	6981623	PL260	14-Oct-23
Longswamp 243	315152	6981608	PL260	14-Oct-23
Longswamp 244	315150	6981594	PL260	14-Oct-23
Longswamp 245	314844	6980026	PL260	14-Oct-23
Longswamp 246	314842	6980012	PL260	14-Oct-23
Longswamp 247	314840	6979997	PL260	14-Oct-23
Longswamp 248	314838	6979982	PL260	14-Oct-23
Longswamp 249	316003	6979900	PL260	14-Oct-23
Longswamp 261	315993	6977710	PL260	14-Oct-23
Longswamp 262	315990	6977725	PL260	14-Oct-23
Longswamp 263	315988	6977740	PL260	14-Oct-23
Longswamp 264	315985	6977755	PL260	14-Oct-23
Longswamp 271	317414	6979177	PL260	14-Oct-23
Longswamp 272	317412	6979162	PL260	14-Oct-23
Longswamp 273	317410	6979147	PL260	14-Oct-23
Longswamp 274	317408	6979132	PL260	14-Oct-23
Longswamp 275	317406	6979117	PL260	14-Oct-23
Longswamp 278	318082	6978197	PL260	14-Oct-23
Longswamp 279	318067	6978197	PL260	14-Oct-23
Longswamp 281	317825	6981297	PL260	14-Oct-23
Longswamp 282	317823	6981282	PL260	14-Oct-23
Longswamp 283	317821	6981267	PL260	14-Oct-23
Tipton 401	319363	6981637	PL198	14-Oct-23

Tipton 402	319364	6981652	PL198	14-Oct-23
Tipton 411	319234	6980558	PL198	14-Oct-23
Tipton 412	319236	6980573	PL198	14-Oct-23
Tipton 413	319238	6980587	PL198	14-Oct-23
Tipton 421	321026	6981329	PL198	14-Oct-23
Tipton 422	321024	6981314	PL198	14-Oct-23
Tipton 423	321023	6981299	PL198	14-Oct-23
Tipton 441	318417	6977162	PL198	14-Oct-23
Tipton 442	318432	6977161	PL198	14-Oct-23
Tipton 443	318447	6977159	PL198	14-Oct-23
Longswamp 276	317432	6978276	PL260	11-Oct-23
Tipton 314	317579	6968802	PL198	3-Oct-23
Plainview 101	322133	6978345	PL238	29-Sep-23
Plainview 102	322118	6978345	PL238	29-Sep-23
Plainview 103	322103	6978344	PL238	29-Sep-23
Plainview 104	322088	6978344	PL238	29-Sep-23
Tipton 451	320428	6977280	PL198	28-Sep-23
Tipton 452	320413	6977278	PL198	28-Sep-23
Tipton 453	320398	6977277	PL198	28-Sep-23
Tipton 454	320383	6977275	PL198	28-Sep-23
Tipton 461	320238	6979083	PL198	17-Sep-23
Tipton 462	320239	6979068	PL198	17-Sep-23
Tipton 463	320239	6979053	PL198	17-Sep-23
Tipton 464	320240	6979038	PL198	17-Sep-23
Longswamp 221	314530	6974090	PL260	15-Jul-23
Longswamp 222	314518	6974099	PL260	15-Jul-23
Longswamp 223	314506	6974108	PL260	15-Jul-23
Longswamp 224	314494	6974117	PL260	15-Jul-23
Longswamp 225	314482	6974126	PL260	15-Jul-23
Longswamp 267	316562	6974394	PL260	2-Jun-23
Longswamp 115	312369	6975944	PL260	14-May-23
Longswamp 111	312429	6975945	PL260	12-May-23
Longswamp 112	312414	6975944	PL260	12-May-23
Longswamp 113	312399	6975944	PL260	12-May-23
Longswamp 114	312384	6975944	PL260	12-May-23
Longswamp 116	312354	6975943	PL260	12-May-23
Longswamp 236	314899	6976003	PL260	12-May-23
Longswamp 117	312339	6975943	PL260	11-May-23
Longswamp 231	314974	6976006	PL260	11-May-23
Longswamp 232	314959	6976005	PL260	11-May-23
Longswamp 233	314944	6976005	PL260	11-May-23
Longswamp 234	314929	6976004	PL260	11-May-23
Longswamp 235	314914	6976004	PL260	11-May-23
Longswamp 237	314884	6976003	PL260	11-May-23

Longswamp 238	314869	6976002	PL260	11-May-23
Longswamp 251	310890	6976557	PL260	11-May-23
Longswamp 252	310875	6976559	PL260	11-May-23
Longswamp 266	316259	6975610	PL260	11-May-23
Tipton 391	318191	6974909	PL198	11-May-23
Tipton 392	318176	6974911	PL198	11-May-23
Tipton 393	318161	6974913	PL198	11-May-23
Tipton 394	318146	6974915	PL198	11-May-23
Tipton 395	318131	6974916	PL198	11-May-23
Tipton 396	318116	6974918	PL198	11-May-23
Tipton 397	318101	6974920	PL198	11-May-23
Tipton 398	318087	6974922	PL198	11-May-23
Tipton 445	317067	6976581	PL198	11-May-23
Tipton 446	317069	6976595	PL198	11-May-23
Longswamp 131	314579	6978311	PL260	15-Apr-23
Longswamp 132	314577	6978326	PL260	12-Apr-23
Longswamp 133	314575	6978341	PL260	12-Apr-23
Longswamp 134	314572	6978356	PL260	6-Apr-23
Longswamp 135	314570	6978370	PL260	4-Apr-23
Longswamp 136	314568	6978385	PL260	4-Apr-23
Longswamp 124	312150	6978755	PL260	26-Mar-23
Longswamp 121	312144	6978710	PL260	25-Mar-23
Longswamp 122	312146	6978725	PL260	25-Mar-23
Longswamp 123	312148	6978740	PL260	25-Mar-23
Longswamp 125	312152	6978770	PL260	25-Mar-23
Longswamp 126	312154	6978785	PL260	25-Mar-23
Longswamp 127	312156	6978800	PL260	25-Mar-23
Longswamp 128	312157	6978814	PL260	25-Mar-23
Longswamp 145	311547	6981111	PL260	21-Mar-23
Longswamp 147	311576	6981107	PL260	21-Mar-23
Longswamp 144	311532	6981113	PL260	20-Mar-23
Longswamp 146	311561	6981109	PL260	20-Mar-23
Longswamp 148	311591	6981105	PL260	20-Mar-23
Longswamp 141	311487	6981119	PL260	18-Mar-23
Longswamp 142	311502	6981117	PL260	18-Mar-23
Longswamp 143	311517	6981115	PL260	18-Mar-23
Stratheden 92	305001	6990782	PL 252	7-Mar-23
Kogan North 282	291803	7008595	PL194	6-Mar-23
Kogan North 283	290799	7008998	PL194	6-Mar-23
Kogan North 284	290160	7008714	PL194	6-Mar-23
Kogan North 285	289974	7009456	PL194	6-Mar-23
Kogan North 287	291657	7009535	PL194	6-Mar-23
Longswamp 155	311255	6985022	PL260	21-Feb-23
Longswamp 156	311253	6985007	PL260	21-Feb-23

Longswamp 157	311251	6984992	PL260	21-Feb-23
Longswamp 158	311250	6984978	PL260	21-Feb-23
Stratheden 211	309500	6985234	PL 252	18-Feb-23
Stratheden 212	309498	6985219	PL 252	18-Feb-23
Stratheden 213	309496	6985204	PL 252	18-Feb-23
Stratheden 214	309494	6985189	PL 252	18-Feb-23
Longswamp 351	311394	6987399	PL260	30-Jan-23
Longswamp 341	310767	6989183	PL260	24-Jan-23
Longswamp 342	310769	6989198	PL260	24-Jan-23
Longswamp 352	311392	6987384	PL260	24-Jan-23
Longswamp 353	311390	6987369	PL260	24-Jan-23
Longswamp 354	311388	6987354	PL260	24-Jan-23
Stratheden 231	309391	6986891	PL 252	24-Jan-23
Stratheden 232	309376	6986893	PL 252	24-Jan-23
Stratheden 233	309361	6986894	PL 252	24-Jan-23
Stratheden 234	309346	6986896	PL 252	24-Jan-23
Longswamp 343	310770	6989212	PL260	20-Jan-23
Longswamp 344	310772	6989227	PL260	20-Jan-23
Longswamp 151	311339	6983161	PL260	17-Jan-23
Longswamp 152	311325	6983162	PL260	17-Jan-23
Longswamp 153	311310	6983164	PL260	17-Jan-23
Longswamp 154	311295	6983166	PL260	17-Jan-23

Table 2: 2022 – 2023 water production volumes by month and annual total

Month	Volume extracted (ML)
November 2022	140.8
December 2022	126.7
January 2023	132.5
February 2023	193.5
March 2023	246.8
April 2023	281.5
May 2023	394.8
June 2023	430.2
July 2023	426.8
August 2023	308.2
September 2023	393.1
October 2023	524.9
Total annual	**3599.8**

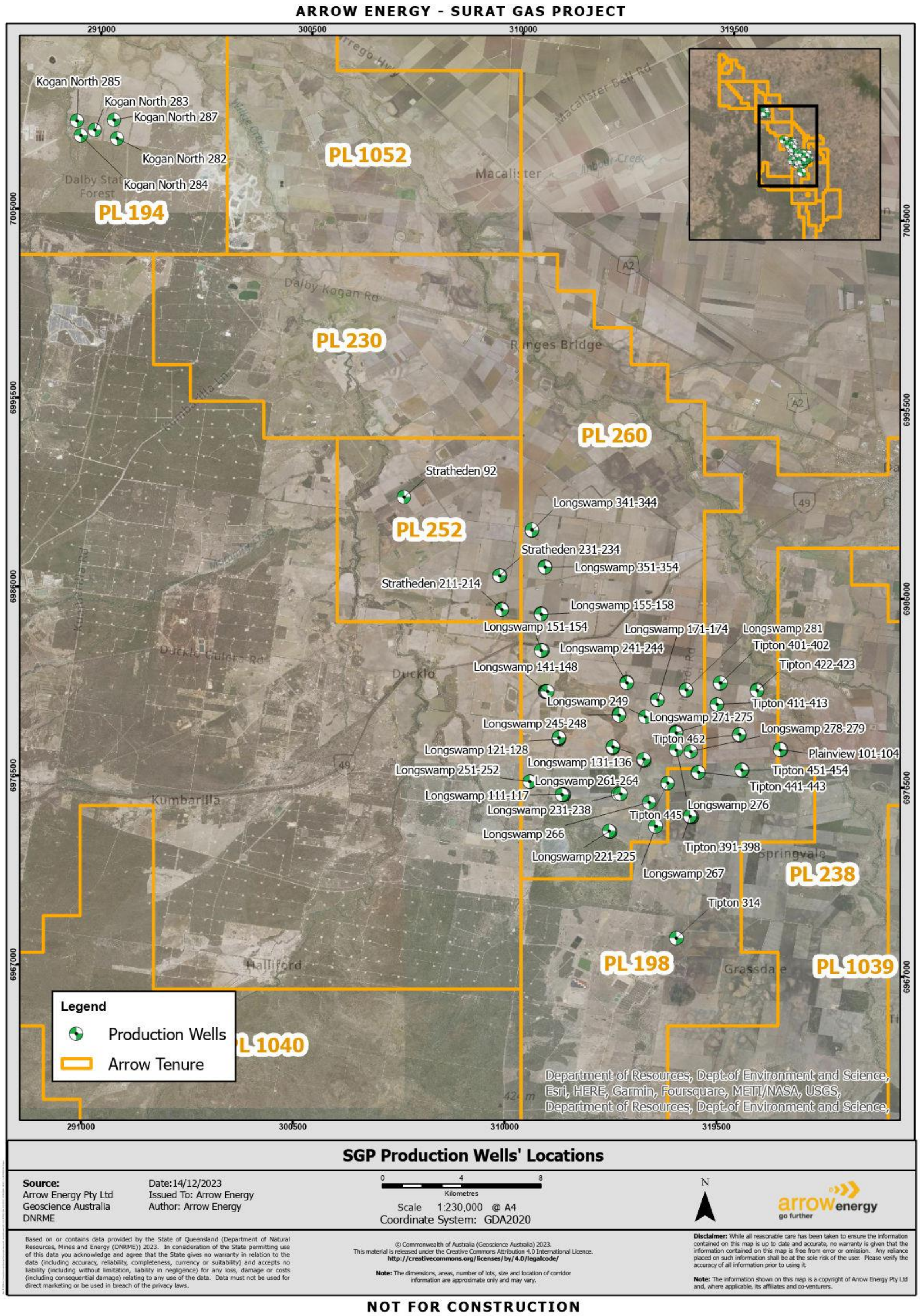

Figure 2-1: SGP production wells' locations that have commenced production during this reporting period (22 October 2022 – 21 October 2023)

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3. Monitoring and Management Programs

3.1 Groundwater pressure/level

Data collection

Groundwater pressure and level data were collected from all operational WMMP monitoring points throughout the reporting period except for Burunga Lane-174 and Burunga Lane-176 which was unable to be accessed due to ongoing land access negotiations (Refer to Table 5). In accordance with Section 7.3 of the SGP Updated WMMP, the locations monitored, and the frequency of monitoring were carried out throughout the reporting period in alignment with the most current Underground Water Impact Report (UWIR), which was the 2021 UWIR prepared by the Office of Groundwater Impact Assessment (OGIA, 2021). A summary of the groundwater pressure / level monitoring program as required by the 2021 UWIR is provided in Section 3.4.

Throughout the reporting period there were instances where hourly data were unable to be collected due to monitoring equipment failure or access to the monitoring point was not in place. These monitoring points are listed below:

- Plainview 16 telemetry issue, intermittent from December 2022 to February 2023
- Tipton-197 Skid offline from April 2023 onwards
- Carn Brea-18/19/20 (single skid) offline up to May 2023
- Plainview 34 skid offline from May to July 2023
- Castldean-18 skid offline from May to August 2023
- Daandine-164 intermittent from June 2023
- Tipton 196A skid offline from July 2023
- Tipton 200 possible hardware calibration issue from July 2023
- Tipton-194 skid offline from August 2023
- Kedron-570 skid offline from September 2023

It should be noted that although not all hourly data were collected from the monitoring points noted here, the majority of hourly data for the reporting period was collected from almost all of these monitoring points. Individual hydrographs for each monitoring point are provided in Appendix A.

In accordance with Section 9.12 of the 2021 UWIR (OGIA, 2021), Arrow provided to OGIA a WMS network implementation report and WMS water monitoring report by the required dates of 1 April and 1 October 2023.

Data analysis

An analysis of data collected to the end of the reporting period is provided in the following sections, noting that water production from SGP production wells continued during the reporting period and, as a result, changes in observed groundwater levels/pressure have been analysed with respect to groundwater extraction.

EWMS comparison

Biannual comparison of the collected groundwater level/pressure data against the EWMS values was undertaken within 90 days of the end of each six-monthly monitoring period. No EWMS exceedances were identified during the reporting period and illustrations of these comparisons are provided in Appendix A.

Condamine Alluvium trend analysis

A hydrograph of the groundwater level data collected from the Condamine Alluvium monitoring bores is shown in Figure 3-1. The data show general groundwater flow in the Condamine Alluvium, within the vicinity of Arrow's monitoring network, is from south to north.

Groundwater level trends are variable within the Condamine Alluvium. The majority of the bores located in the central Condamine Alluvium area (groundwater elevation between 305 and 330 m AHD) displaying strong seasonal responses to non-CSG groundwater take (Figure 3-2) and thus the greatest observed drawdown (and generally subsequent recovery).

A long-term groundwater level data (Figure 3-1) depict a seasonal change in groundwater level trend across most monitoring bores. Bores 42230209, Macalister 5, Pampas 18, Plainview 37, Tipton 195, Tipton 203, Tipton 221, and Wyalla-16 have a generally stable trend with no observable seasonal variation. Carn Brea 23, Carn Brea 17, Daandine-161, Macalister 7, Plainview 25, 42231463, and 42231370 also have a relatively stable trend but show seasonal responses.

Groundwater level of the bore Stratheden-62 was previously following seasonal variations, but it has a more stable trend over the last 4 years. The SGP production wells located near Stratheden-62 commenced extraction from the reservoir in April 2022 and the water level in this bore has remained stable throughout the reporting period.

Bore Tipton 204 groundwater levels have previously shown declining trends but in the last three years have started to show an increasing trend. Groundwater level of Mt Haystack 5 shows a declining trend during this reporting period. It should be noted that this bore has previously also shown a declining trend between 2016 – 2019 before commencement of the SGP and an increasing trend during 2019 – 2022.

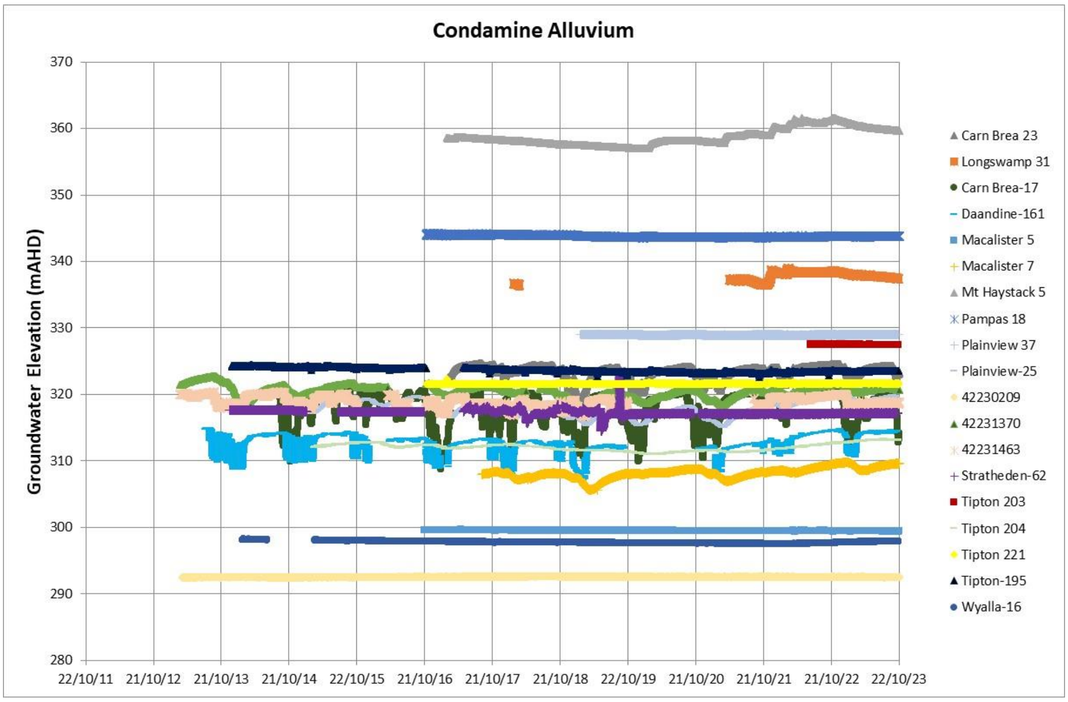

Figure 3-1: Condamine Alluvium monitoring bores hydrograph

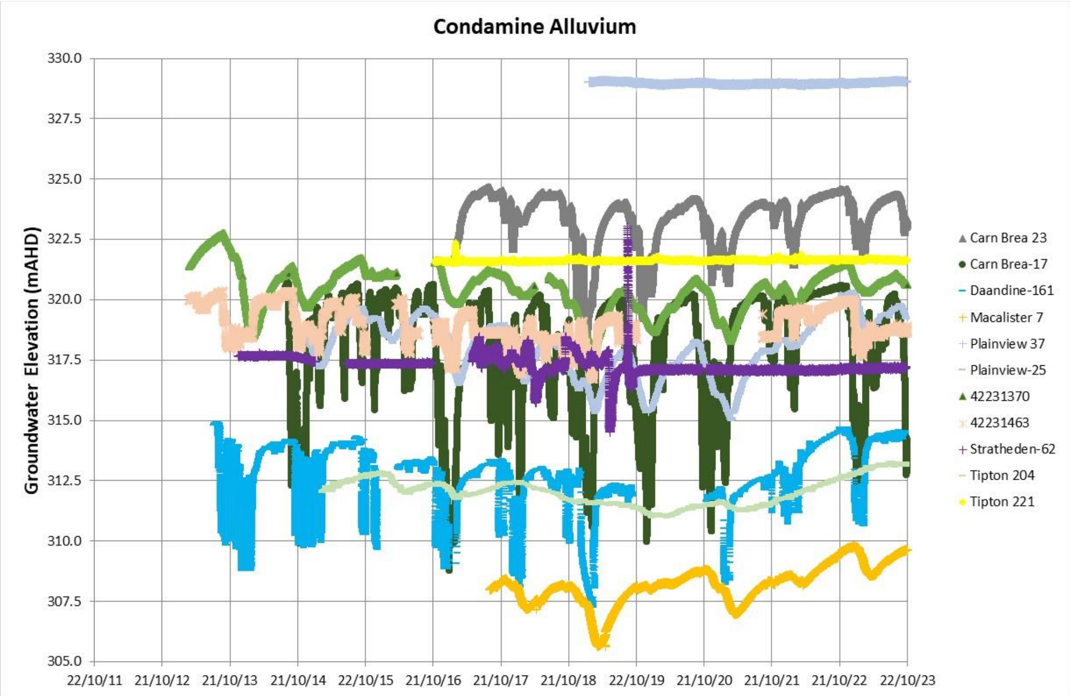

Figure 3-2: Central Condamine Alluvium area monitoring bores hydrograph

Springbok Sandstone trend analysis

Groundwater levels/pressure in the Springbok Sandstone monitoring bores displayed varying trends; however, all monitoring points except for Glenburnie 20 (given its monitoring interval is a perched seepage zone and is not representative of the regional water table) and part of the monitoring record for Hopeland-17 (still recovering from groundwater sampling) displayed a groundwater elevation between 290 and 350 m AHD during this reporting period (Figure 3-3).

Bores Stratheden-63, Meenawarra-21, Glenburnie-18 (following a period of pressure equalisation succeeding bore installation), Glenburnie 20, Plainview 36, Longswamp 29, Longswamp 33 and Tipton 202 displayed generally stable groundwater pressure trends. Hopeland-17 displayed variability in its groundwater pressure, most likely a result of nearby CSG production on neighbouring non-Arrow tenements (as noted in Section 5.6.2.2 of the 2021 UWIR (OGIA, 2021)), a workover in May 2020 to install a new pressure gauge (the gauge failed in November 2018) and swabbing of the bore in December 2020 to collect a groundwater sample (which the bore was still recovering from at the end of the reporting period as a result of low permeability of the formation). The SGP production wells located near Stratheden-63 commenced extraction from April 2022, a response to this production is not evident in the water level data during this time. These trends in the Springbok Sandstone monitoring bores continued throughout the reporting year.

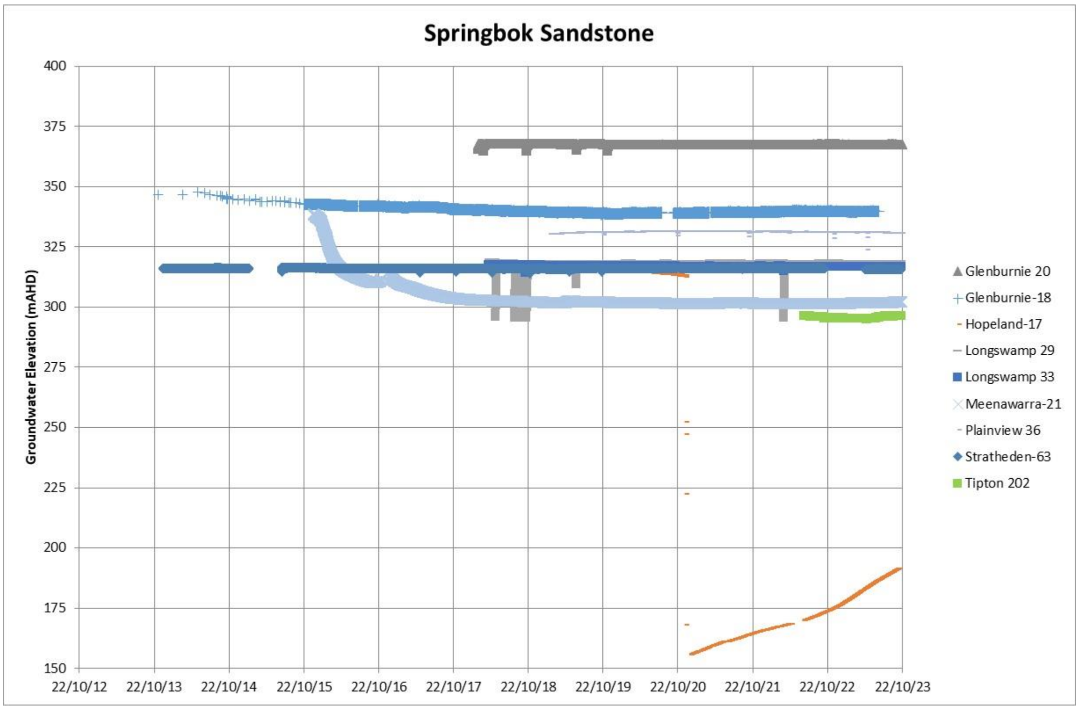

Figure 3-3: Springbok Sandstone monitoring bores hydrograph

Hutton Sandstone trend analysis

All Hutton Sandstone monitoring bores showed a long-term declining trend (Figure 3-4) at rates that are consistent with Section 5.6.2.1 of the 2021 UWIR (OGIA, 2021), which is up to 2 m per year. The largest observed drawdown (21.1 m) has been recorded in bore Wyalla-17 since 2019, the majority of which occurred within the first six months of installation, with a drawdown rate of less than 2 m/year since then. Newly installed monitoring point at Daandine-123 (July 2020) recorded a drawdown of 14.2 m since August 2020 (rate of 4.3 m/year). The least drawdown of 0.07 m (rate of 0.01 m/year) has been observed in Tipton-153 since 2019. The small observed drawdown rate in Kedron-570 (0.18 m/year) is also consistent with the 2021 UWIR (OGIA, 2021) which states that there is generally no groundwater level trends in the Hutton Sandstone north of the Great Dividing Range. The initial steeper drawdown curves observed in Wyalla-17 and when a new pressure gauge was installed in Daandine-123 (July 2020), are likely a result of pressure equalisation between the bore and the formation following workover of the bores to install the gauges. The monitoring bore Plainview 16 was installed relatively recently and has correspondingly short periods of monitoring. However, the Hutton Sandstone groundwater level is stable at this bore. Similar to Plainview, Tipton 200 was installed recently but as mentioned previously there was some hardware calibration issue. In spite of this, the Hutton Sandstone groundwater level at this bore was subjected to a minor fluctuation between 311.0 – 323.5 mAHD. These long-term trends have continued throughout the reporting period, noting that data have not been collected from Burunga Lane-176 since 2018 due to ongoing land access negotiations (Table 5).

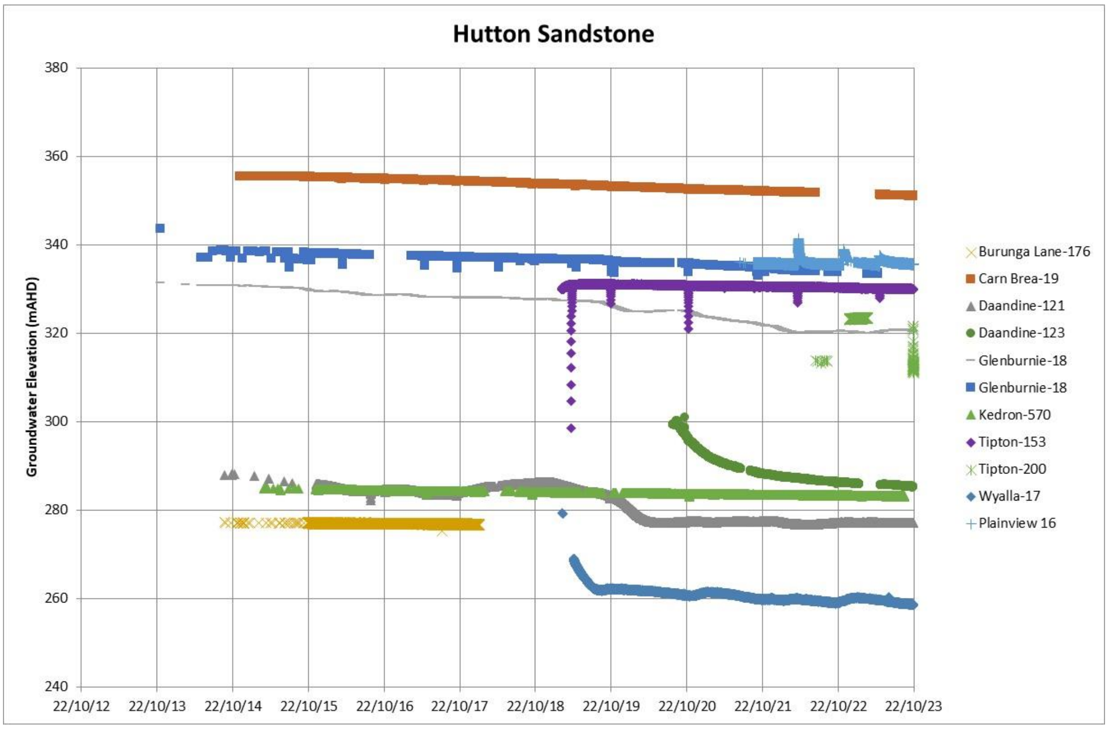

Figure 3-4: Hutton Sandstone monitoring bores hydrograph

Precipice Sandstone trend analysis

Observed groundwater pressure trends in the Precipice Sandstone monitoring bores shows a declining trend in the monitoring bores located further south within Arrow’s tenure (Figure 3-5). These trends are consistent with that described in Section 5.6.2.4 of the 2021 UWIR (OGIA, 2021) where there is extensive non-CSG development (in parallel with the Moonie oil field) which has resulted in regionally observed declines in groundwater pressure in the south. The 2021 UWIR indicates in areas where reinjection is occurring correlates to increasing groundwater level trends, however, no groundwater level data was collected from Arrows northern bore (Burunga Lane-174 – land access is not in place) during this annual period to confirm whether this trend was occurring in this area. The lowest rate of drawdown (0.47 m/year) and highest rate of drawdown (1.31 m/year) during this reporting period have been recorded in Wyalla-17 and Carn Brea-20, respectively.

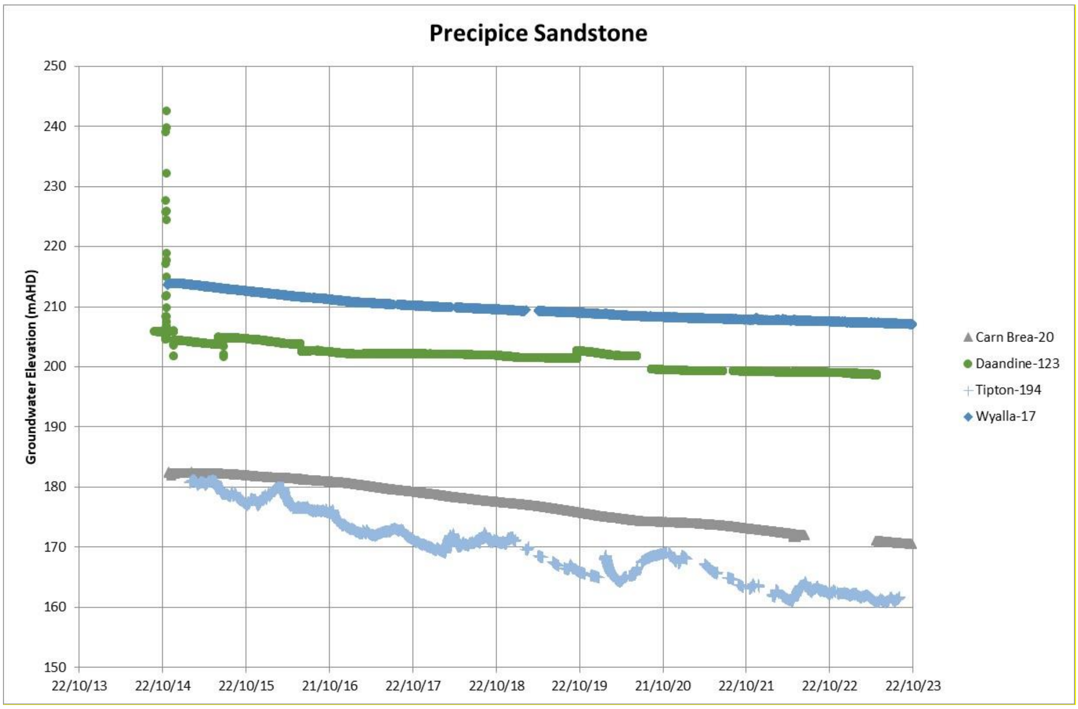

Figure 3-5: Precipice Sandstone monitoring bores hydrograph

Walloon Coal Measures trend analysis

Hydrographs for the Walloon Coal Measures (WCM) observed groundwater pressures are presented in Figure 3-6 to Figure 3-9. The WCM are the reservoir target for production of CSG. The pressure data have been split into four hydrographs since there are a large number of monitoring points and variations in observed pressure value. The hydrographs demonstrate, as predicted, the pressure responses at those locations close to CSG operations such as those monitoring points located at Daandine production field, Tipton production field and Hopeland area, while those monitoring bores further away from CSG operations display a more subdued (or no) pressure response. This relationship between observed drawdown in the WCM and distance from nearest production is consistent with that reported for the WCM across the Surat CMA in the 2019 and 2021 UWIR (OGIA 2019, 2021).

Production from SGP production wells started in April 2022. Further declines in groundwater levels at Longswamp-7 sites were observed after this date as SGP production wells are closer to this bore than other productions wells, however these monitoring points were already showing a decline in groundwater levels due to these other production wells. Insignificant changes in groundwater levels at Daandine-134 and Daandine-254 sites were observed during this reporting period, where CSG production is approaching maturity.

The groundwater levels at Longswamp 34 during this reporting period were consistent with previous years decreasing trend.

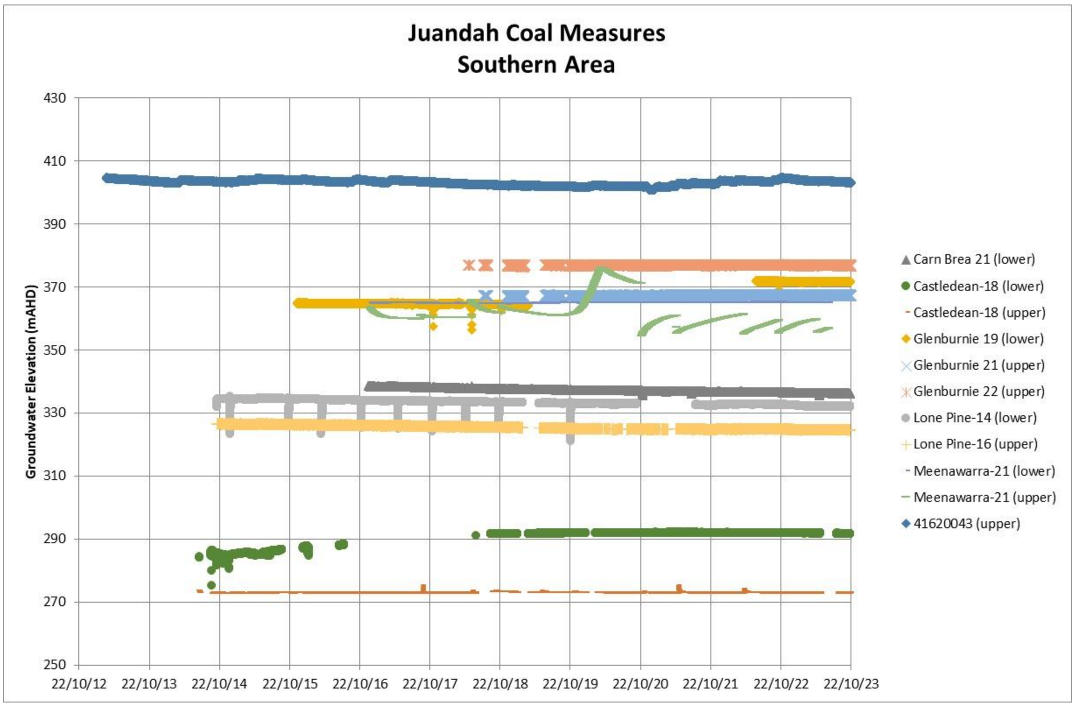

Figure 3-6: Juandah Coal Measures monitoring bores hydrograph – southern area

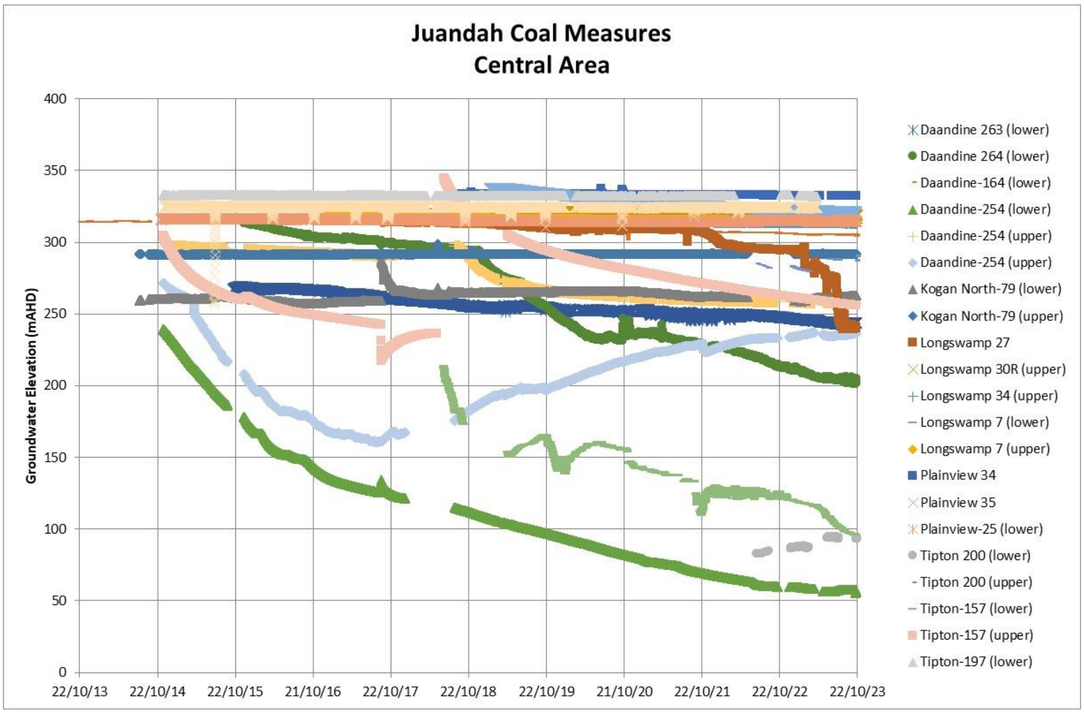

Figure 3-7: Juandah Coal Measures monitoring bores hydrograph – central area

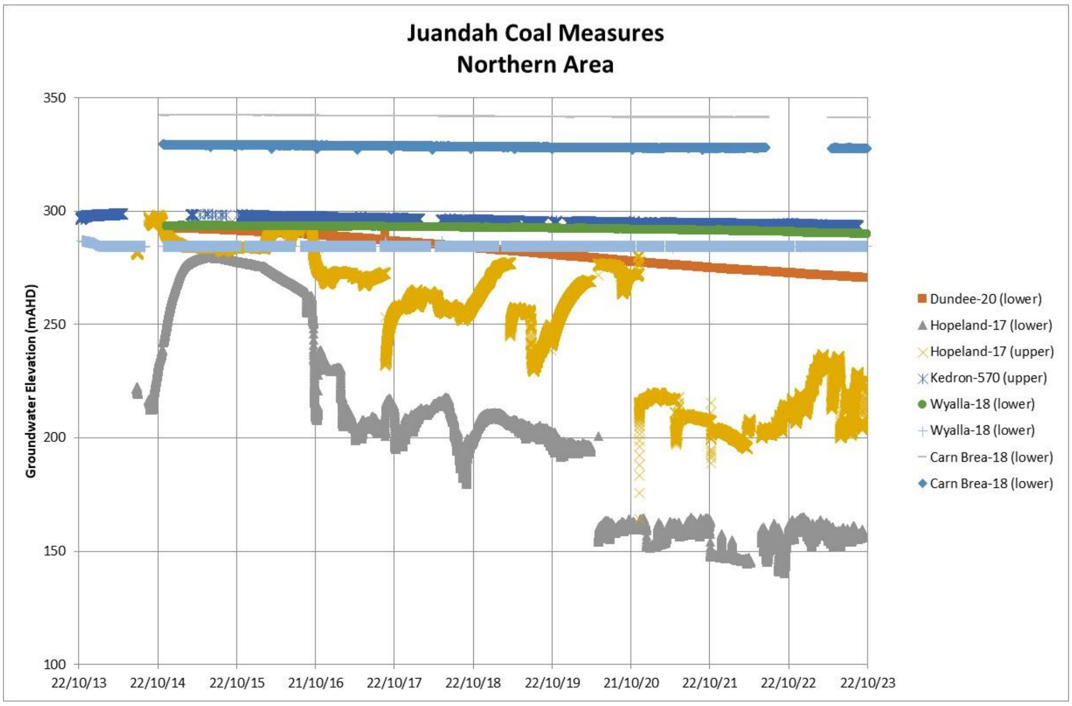

Figure 3-8: Juandah Coal Measures monitoring bores hydrograph – northern area

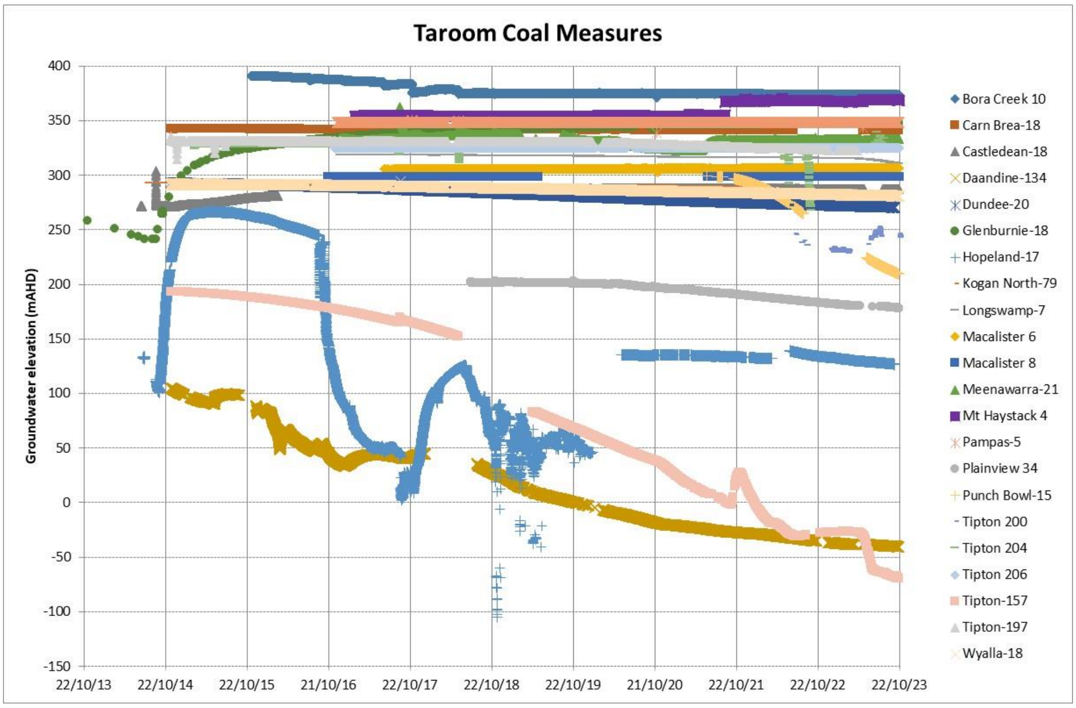

Figure 3-9: Taroom Coal Measures monitoring bores hydrograph

3.2 Groundwater quality

Data collection

Groundwater samples were collected from all operational WMMP monitoring points throughout the reporting period where land access arrangements were in place. In accordance with Section 7.3 of the SGP Updated WMMP, the locations monitored and frequency of monitoring throughout the reporting period were in alignment with the current UWIR, which was the 2021 version. A summary of changes to the groundwater quality monitoring program is provided in Section 3.4 and a list of monitoring bores sampled during the reporting period is provided in Table 3. It should be noted that the 2021 UWIR specifies (Table 9-4) that sampling is no longer required from monitoring points where five samples have been collected (including one sample of dissolved strontium and strontium isotopes ($^{87}Sr/^{86}Sr$) in Springbok Sandstone, Hutton Sandstone and Precipice Sandstone monitoring points).

A summary of groundwater sampling conducted during the reporting period is provided in Table 3. These groundwater samples were analysed for the 2021 UWIR suite which is provided in Table 7 and the results are provided in Appendix B.

Table 3: 2021 UWIR groundwater chemistry monitoring points

Bore Name	OGIA MP ID	Formation	SAMPLING COMPLETED DURING REPORTING PERIOD*
Burunga Lane-176	477	Hutton Sandstone	No sampling completed due to no land access
Carn Brea-17	39	Condamine Alluvium	Not required
Carn Brea-18	41	WCM	Not required
Carn Brea-19	45	Hutton Sandstone	Not required
Daandine-121	183	Hutton Sandstone	Not required
RN 42230209	282	Condamine Alluvium	Not required
Glenburnie-18	739	Hutton Sandstone	Not required
Plainview 36	790	Springbok Sandstone	Sampled November 2022 and April 2023
Stratheden-63	623	Springbok Sandstone	Not required
Tipton-195	85	Condamine Alluvium	Not required
Tipton-197	89	WCM	Not required
Tipton 202	830	Springbok Sandstone	Sampled November 2022, April 2023 and October 2023
Wyalla-16	248	Condamine Alluvium	Not required
RN 42231370	52	Condamine Alluvium	Not required

* Refer to Table 5 and Table 6 for sampling requirements (2021 UWIR monitoring requirement).

Data analysis

The 2021 UWIR discusses the water quality parameters for each groundwater monitoring zone in terms of the 20^{th} 50^{th}, and 80^{th} percentiles. The section below discusses in detail the water quality results for sole formation where water quality data was obtained during this annual reporting period (Springbok Sandstone) as well as a brief comparison of the hydrogeochemistry of the other formations in the form of piper diagrams to demonstrate the differences in proportions of major ions in groundwater samples.

Field parameters

Springbok Sandstone

A statistical summary of the historical field water quality parameters is provided in Table 4 for Springbok Sandstone considering 20th, 50th and 80th percentiles. These statistics were compared to those in the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP), specifically the Lower GAB, Eastern Springbok Outcrop values. The purpose of the EPP is to achieve the objective of the Environmental Protection Act 1994 in relation to Queensland waters— that is, to protect Queensland's water environment whilst allowing for development that is ecologically sustainable. This is achieved through adopting or deriving local Water Quality Objectives (WQO). In deciding local water quality objectives for Queensland waters, Section 8 of the EPP (Water and Wetland Biodiversity) gives precedence to site specific studies for a water (i.e., local studies) (DES 2023).

The 3 bores monitoring this unit have 80th percentiles for EC below the 80th percentile EPP WQ objective. However, Stratheden-63 and Tipton 202 have higher 20th and 50th percentiles than the EPP objectives. The pH measured at the 3 bores is higher than the EPP objectives for the 20th, 50th and 80th percentile. It should be noted that the pH measured at Tipton 202 has likely been affected by cement grout ingress to the gravel pack within the wellbore. Therefore, the pH values measured at Tipton 202 were not included in the calculation of pH percentiles for all bores.

Table 4: Summary field water quality percentiles for Springbok Sandstone

Parameter		Plainview 36	Stratheden -63	Tipton 202	All bores	EPP WQ objective
EC (µS/cm)	Count	6	9	3	18	
	20 per*	1299.00	3865.80	4559.20	1366.40	1420.00
	50 per	1326.00	4121.00	5257.00	3986.50	3175.00
	80 per	1406.00	4461.00	6848.80	4581.00	9480.00
pH	Count	6	9	3	18	
	20 per	8.16	8.92	11.99	8.22	7.50
	50 per	8.20	9.30	12.13	8.64	8.00
	80 per	8.32	9.79	12.56	9.54	8.40
REDOX (mV)	Count	6	9	3	18	
	20 per	-118.50	-237.54	-137.02	-216.78	NA
	50 per	-64.75	-212.40	-129.40	-142.35	NA

	80 per	43.30	-181.64	-36.22	-2.02	NA
TEMP (°C)	Count	6	9	3	18	
	20 per	22.20	22.18	22.46	22.14	NA
	50 per	24.25	26.20	23.00	24.55	NA
	80 per	28.00	30.50	23.72	29.02	NA

[*] per = percentile

Tipton 202 elevated pH values

Tipton 202 was drilled to monitor groundwater level and quality in the Springbok Sandstone. The lithological log records the bore intersected Condamine Alluvium to 22.9 mbgl, before continuing to TD of 137m in the underlying Springbok Sandstone.

Elevated pH ranging from 11.89 to 12.85 has been recorded only in 3 samples from Tipton 202 collected to date. Hydroxide Alkalinity as $CaCO_3$ has also been reported from Tipton 202. High pH values and the presence of Hydroxide Alkalinity are both indicators of cement grout influencing the groundwater hydrochemistry within the borehole. It is likely that cement grout has breached the bentonite seal and percolated into the gravel pack within the annulus. Bore construction details indicate there is approximately 95 m of grout vertically separating the base of the alluvium from the top of the bentonite seal. Groundwater salinity, as EC in samples from this bore, ranges from 4,094 to 7,900 µS/cm.

The Queensland Department of Regional Development, Manufacturing and Water (RDMW) has a monitoring bore RN 42231280 drilled and completed in the Condamine alluvium, located approximately 2,600 m to the east of Tipton 202. A total of 12 groundwater samples have been collected and analysed from this bore, with the reported salinity as EC ranging from 655 to 976 µS/cm. As the groundwater salinity measured in Springbok Sandstone at Tipton 202 is much higher (EC 4,094 to 7,900 µS/cm) than the salinity in the Condamine Alluvium, it is likely the Springbok Sandstone has been effectively isolated from the overlying Condamine Alluvium in Tipton 202. Therefore, other data collected from Tipton 202 are considered representative and fit for purpose.

EC data (laboratory data and field measurements where no laboratory data is available) collected to date is shown in Figure 3-10. The data show EC levels in the monitoring bores are generally stable with an increasing trend in Stratheden-63.

The collected pH data are presented in Figure 3-11, showing that pH levels in the monitoring bores are generally stable with a slight declining trend in Stratheden-63.

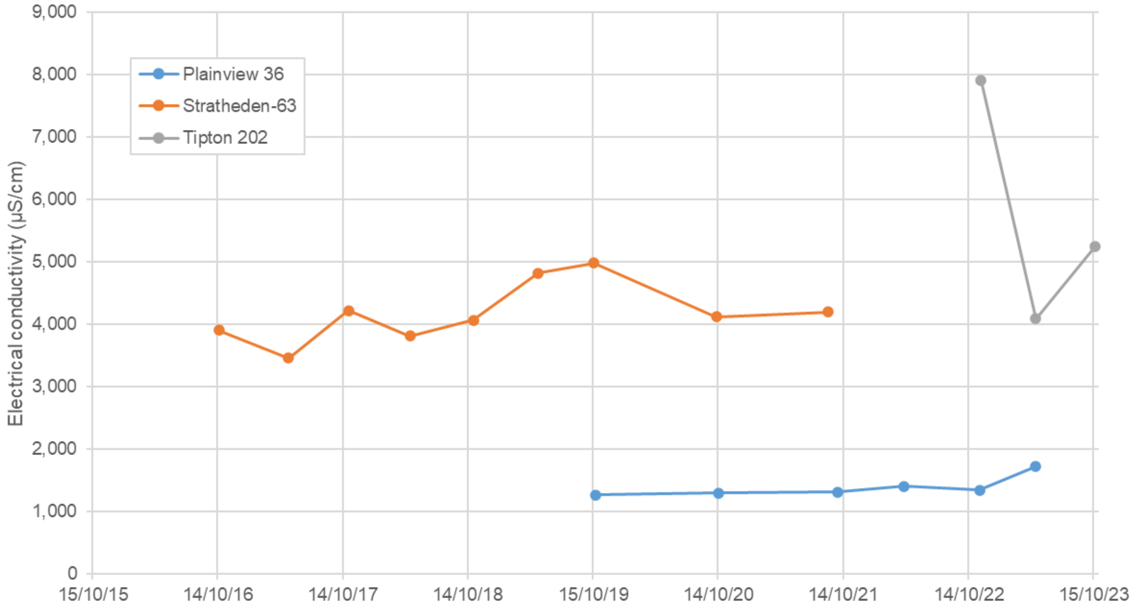

Figure 3-10: Springbok Sandstone electrical conductivity

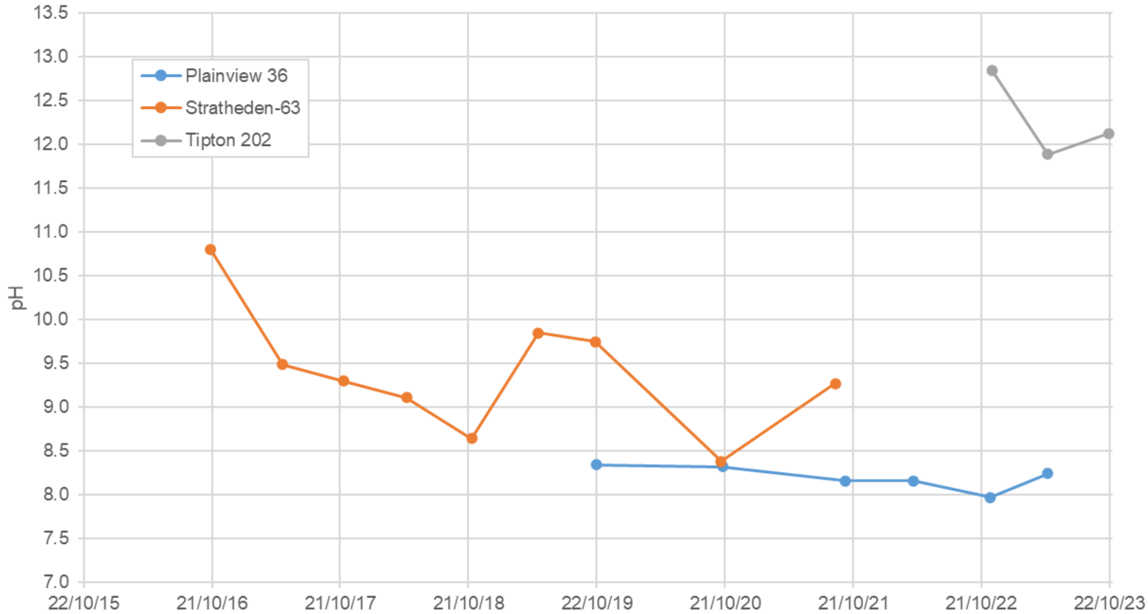

Figure 3-11: Springbok Sandstone pH

Metals, major ions and other key analytes

In the analysis of the water quality results, the Queensland Department of Environment and Science (DES) (DES, 2021) recommends a minimum of eight samples at each site be used in the comparison of water quality. In this instance, historical samples from bores have also been combined to statistically analyse the results into 20th, 50th and 80th percentiles. A comparison of the water quality results for the Springbok Sandstone (the sole formation sampled this reporting period) for analytes listed in the 2021 UWIR along with the relevant water quality guideline values are shown in Appendix B.

Springbok Sandstone

Water quality data is obtained from three bores (Plainview 36, Strathedan-63, and Tipton 202) within the Springbok Sandstone, however Tipton 202 has limited data and thus is insufficient to comment on the statistical results for this bore separately. The water quality results and statistical summary for Springbok Sandstone are provided in Appendix B. The water quality results for chloride 20th and 50th percentiles, magnesium for the 20th percentile, sodium for the 20th and 50th percentiles and sulphate for 20th and 80th percentiles are higher than the aquatic ecosystem value (Appendix B). Concentrations for chloride, sodium and TDS were also exceeded for drinking water guidelines and TDS for stock watering.

Key time series plots were developed for analytes exceeding guidelines criteria. Figure 3-12 shows fluctuations in calcium concentrations at Stratheden-63; concentrations in the two samples taken at Plainview-36 were similar to previous samples at this bore. Chloride concentrations at Stratheden-63 (>1,000 mg/L) are significantly higher than that at Plainview-36 (around 200 mg/L) as shown in Figure 3-13. Figure 3-14 illustrates that concentrations of magnesium are more similar between the two bores with the last readings at the bores only being different by 4 mg/L. Similar to chloride, sodium concentrations are much higher in Stratheden-63 (>600 mg/L) than that at Plainview-36 (around 300 mg/L) as shown in Figure 3-15. Sulphate concentrations are quite variable in Stratheden-63 (Figure 3-16) but are much lower at Plainview 36 (around detection limit of 1 mg/L). Total Dissolved Solids also display a large degree of difference between these two bores, with a difference of greater than 1,500 mg/L (Figure 3-17). It can be observed from water quality time series plots that all peak concentrations at Stratheden-63 occurred in 2019 and samples have not been required to be collected from this bore since 2021.

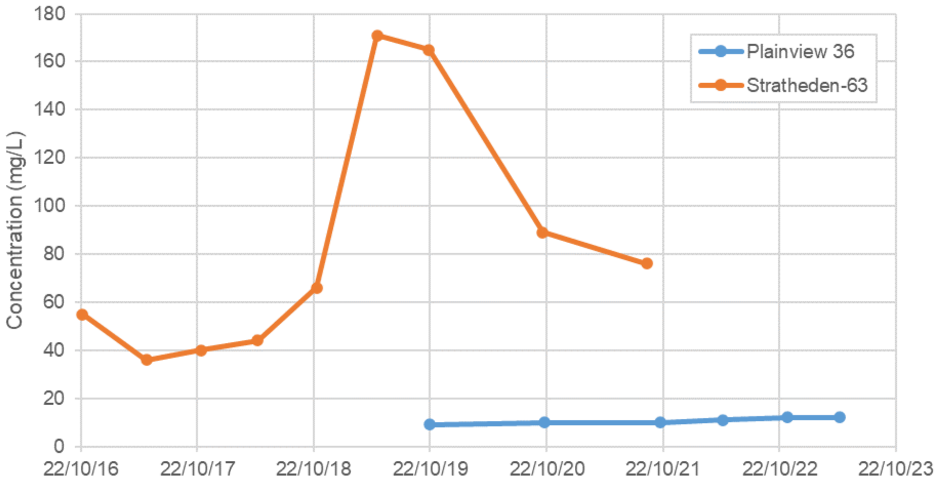

Figure 3-12: Springbok Sandstone: Calcium

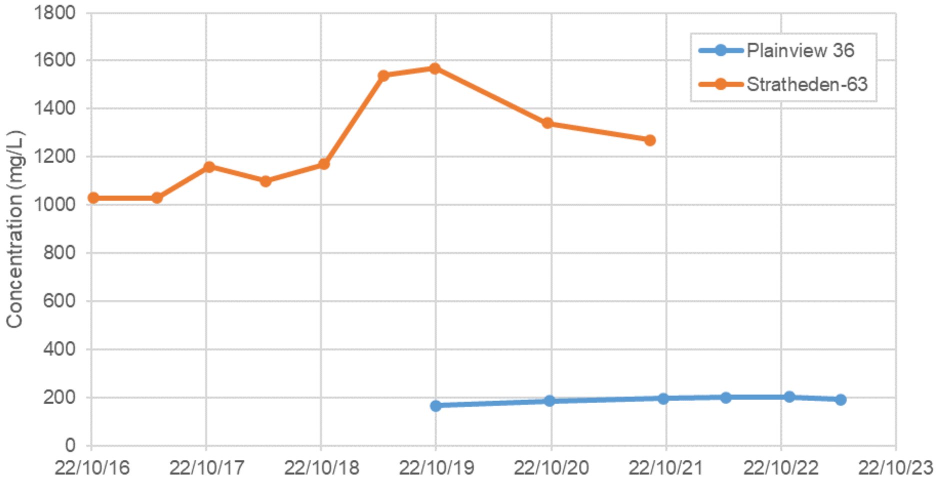

Figure 3-13: Springbok Sandstone: Chloride

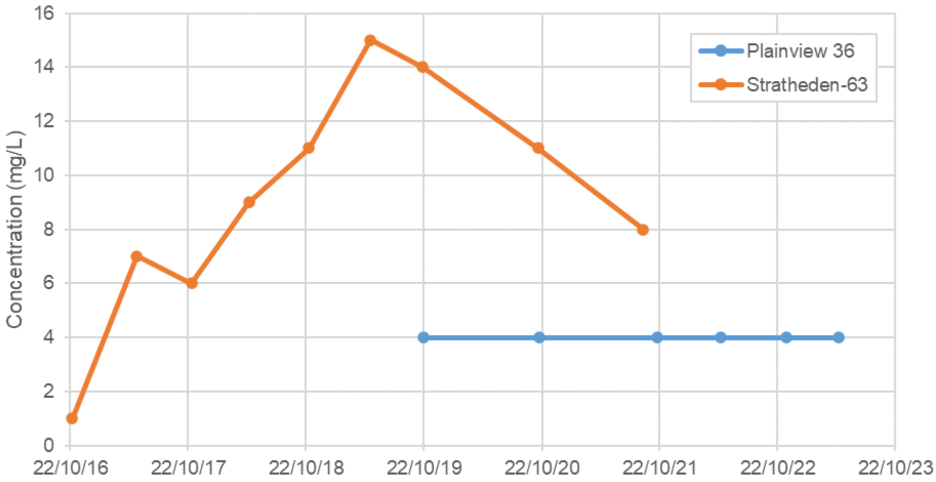

Figure 3-14: Springbok Sandstone: Magnesium

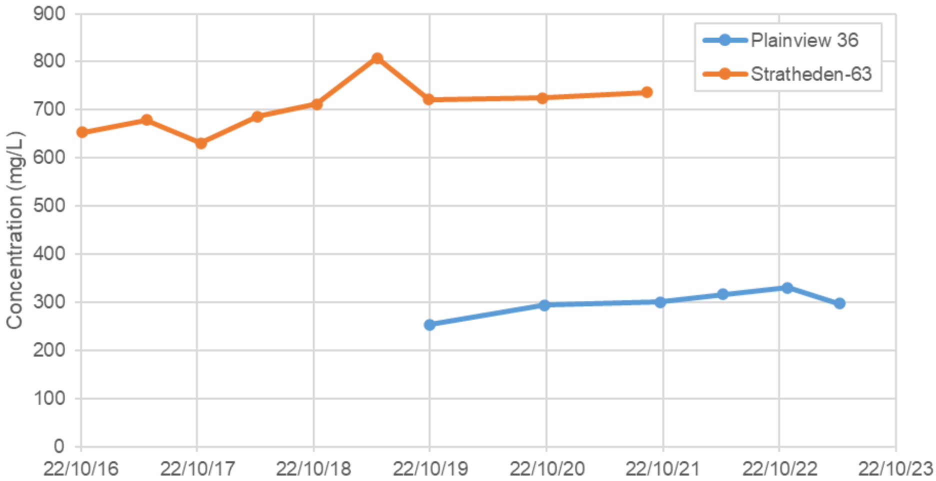

Figure 3-15: Springbok Sandstone: Sodium

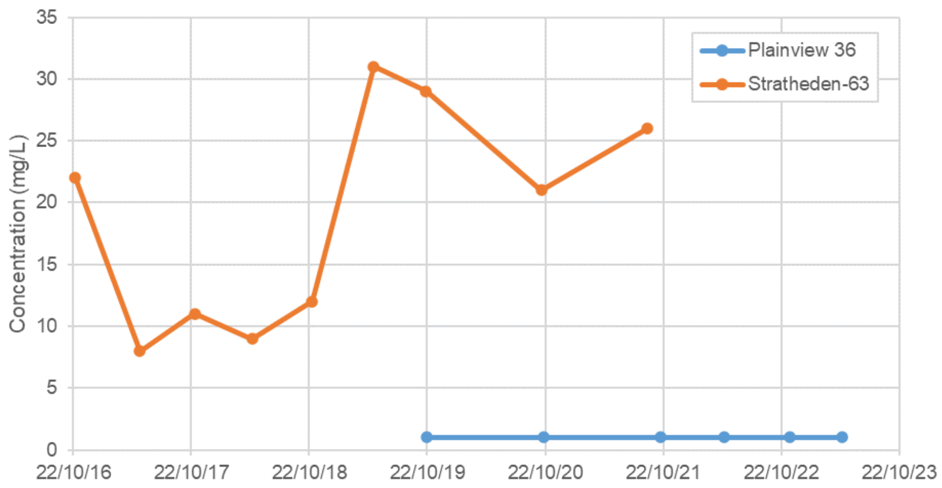

Figure 3-16: Springbok Sandstone: Sulphate

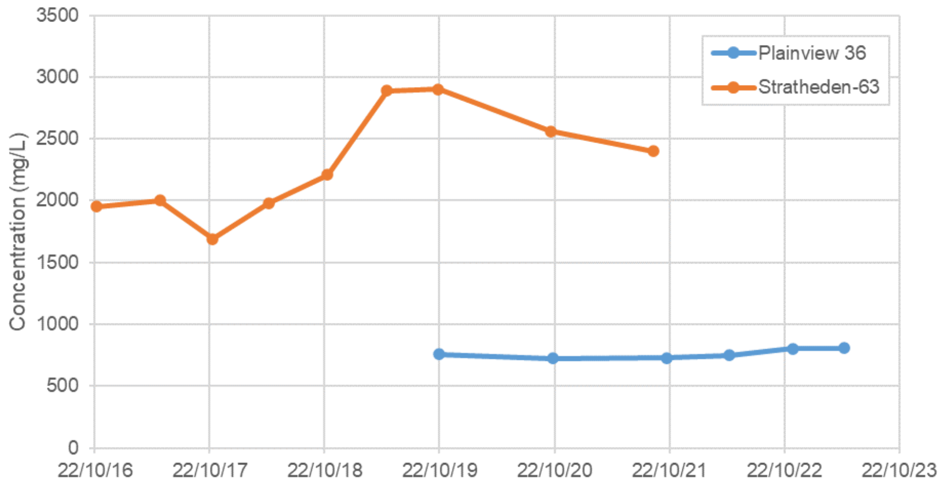

Figure 3-17: Springbok Sandstone TDS

Chemical composition

The chemical composition of samples collected since 2017 from each of the geological formations is presented in Figure 3-18 to Figure 3-23 as Piper diagrams to highlight the similarities and differences in the proportions of major ions in groundwater from the various formations.

No major ion data was required to be collected for the Condamine Alluvium during this annual reporting period. The Condamine Alluvium piper diagram (Figure 3-18) shows all bores except for Carn Brea-17 are predominantly sodium-chloride type water with carbonate-bicarbonate contributions and a magnesium and calcium contribution in Tipton-195. The chemical composition of samples collected from Carn Brea-17 indicate it is a magnesium-bicarbonate type water.

There is either no trend or a clustered recurring trend in chemical composition evident in all bores except for Wyalla-16 which shows a steady increasing carbonate-bicarbonate contribution.

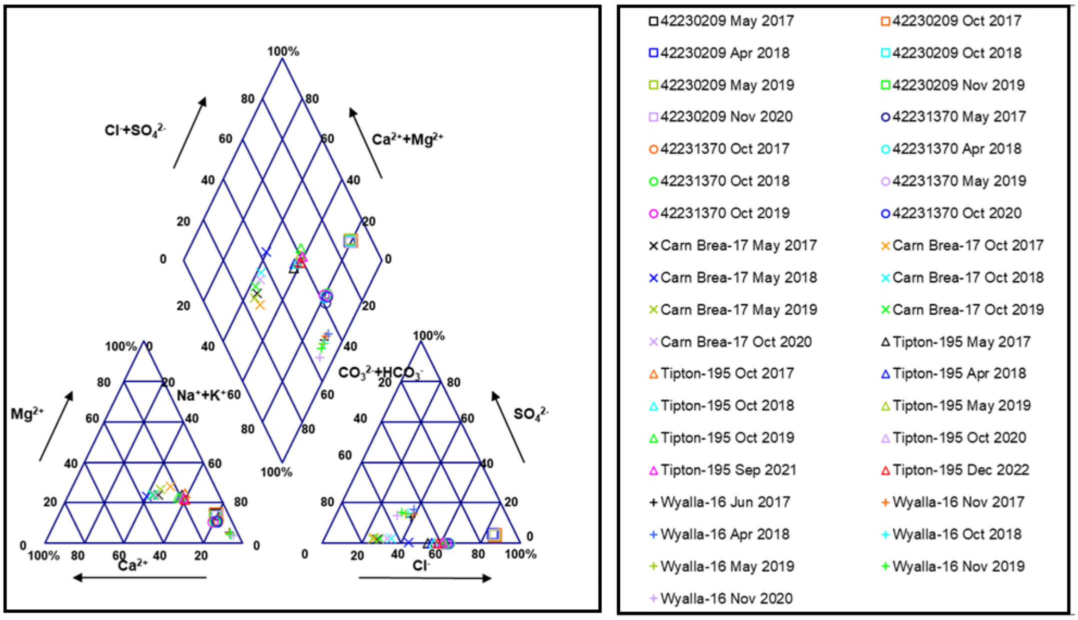

Figure 3-18: Condamine Alluvium Piper Diagram

No major ion data was required to be collected for the Westbourne Formation monitoring point (Daandine-124) (Figure 3-19) during this annual reporting period. Data previously collected shows it is sodium-chloride type water with no trend in chemical composition evident over time.

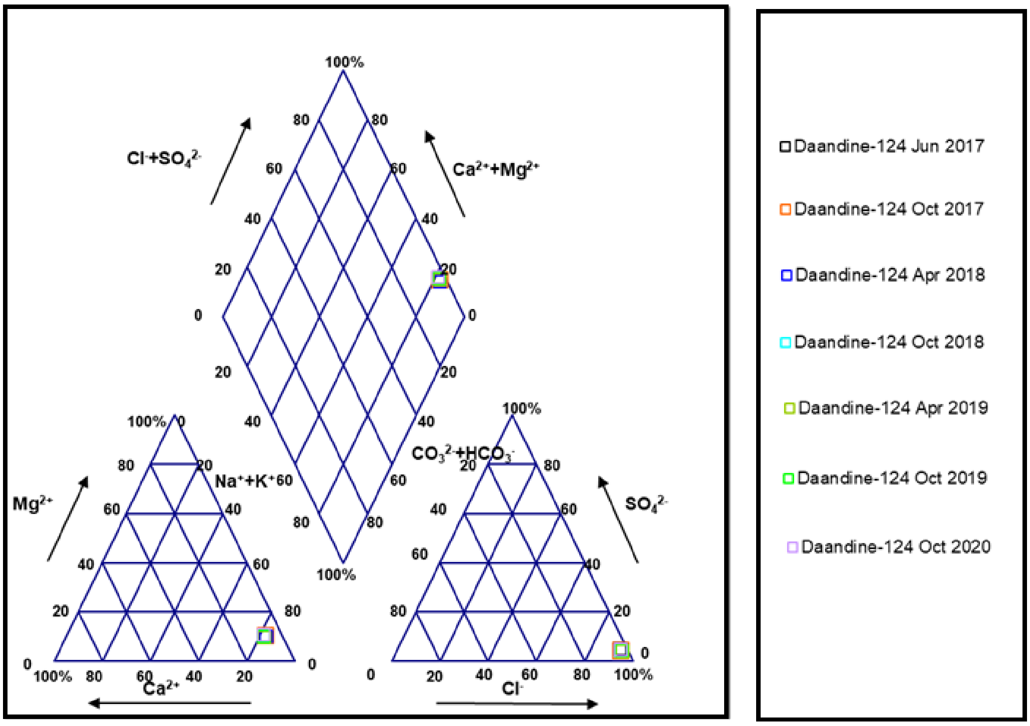

Figure 3-19: Westbourne Formation Piper Diagram

The major ion data for the Springbok Sandstone monitoring point Stratheden-63 (Figure 3-20) show it is sodium-chloride type water and there is a recurring trend in the calcium to sodium ratio evident over time. The chemical composition of Plainview 36 shows it is sodium-bicarbonate type water and there is no trend in the data. Two samples from this monitored formation at Plainview 36 were collected during this reporting period, having similar chemical composition to previous samples collected at this location. Three samples were collected from Tipton 202 during the reporting period, which shows the groundwater was initially calcium, magnesium-chloride type water then plots as sodium-chloride type water. As discussed earlier in this report, groundwater at Tipton 202 is likely influenced by cement grout ingress to the gravel pack, which may explain the differences in major ion composition observed in samples collected from this bore relative to other samples from the Springbok Sandstone.

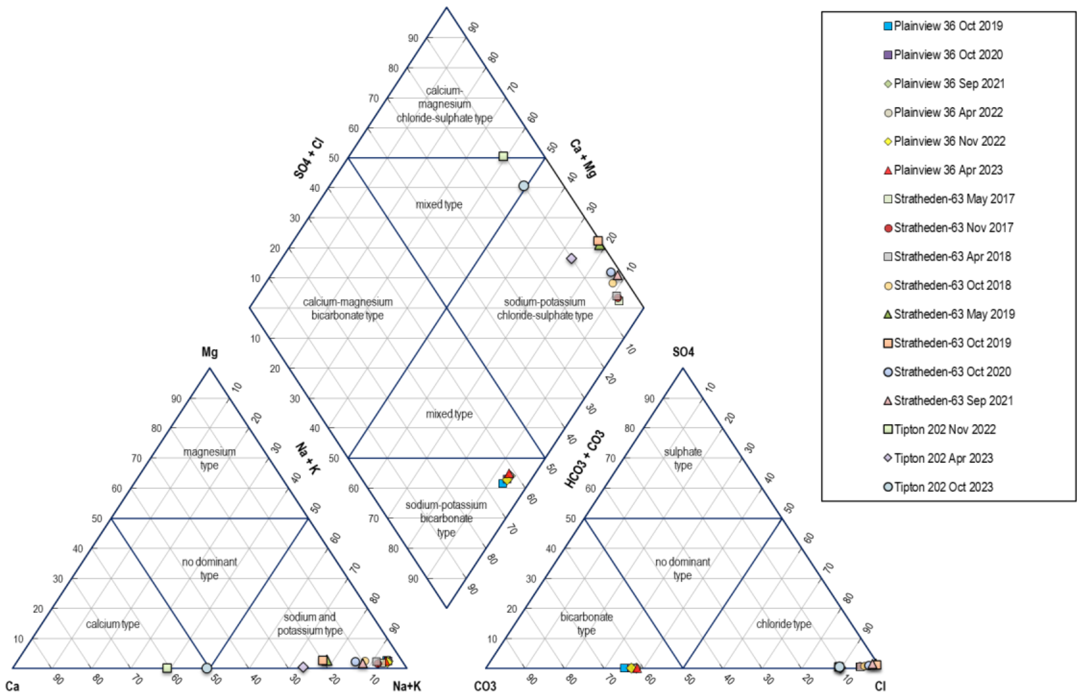

Figure 3-20: Springbok Sandstone Piper Diagram

No major ion data was required to be collected for the WCM monitoring points (Figure 3-21) during this annual reporting period. Data previously collected shows Tipton-197 is sodium-chloride type water with a carbonate-bicarbonate contribution, and Carn Brea-18 is a sodium-bicarbonate type water. There is no trend evident in chemical composition in Tipton-197 while Carn Brea-18 is displaying a steady increasing carbonate-bicarbonate and decreasing chloride contributions over time.

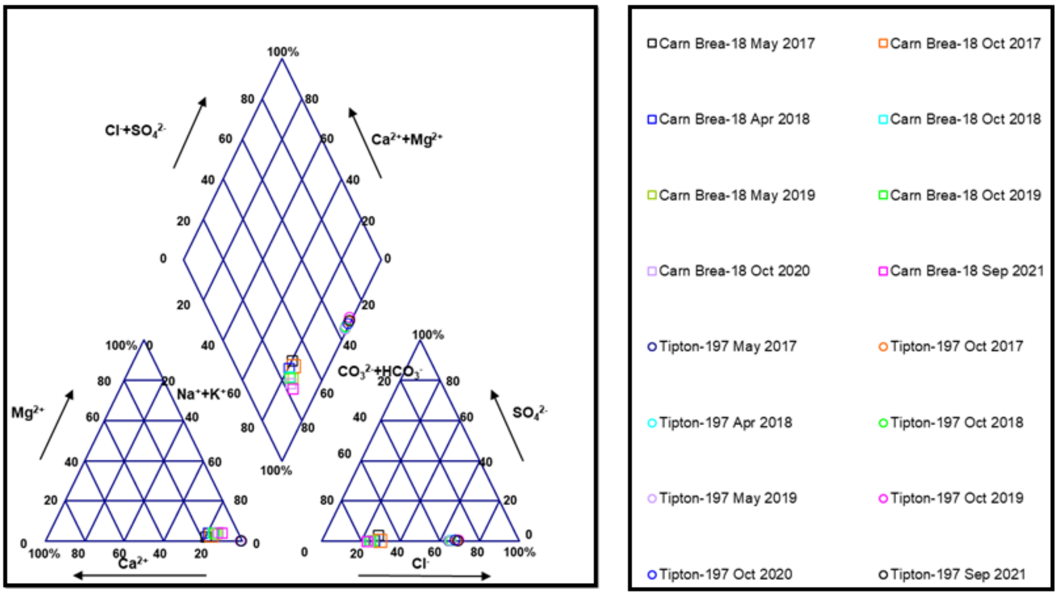

Figure 3-21: WCM Piper Diagram

No major ion data was required to be collected for the Hutton Sandstone monitoring points (Figure 3-22) during this annual reporting period. Data previously collected show the Hutton comprises sodium-bicarbonate type water. There is a recurring trend in the calcium to sodium ratio evident over time in Carn Brea-19, and a recurring trend in the bicarbonate to chloride ratio evident over time in Daandine-121.

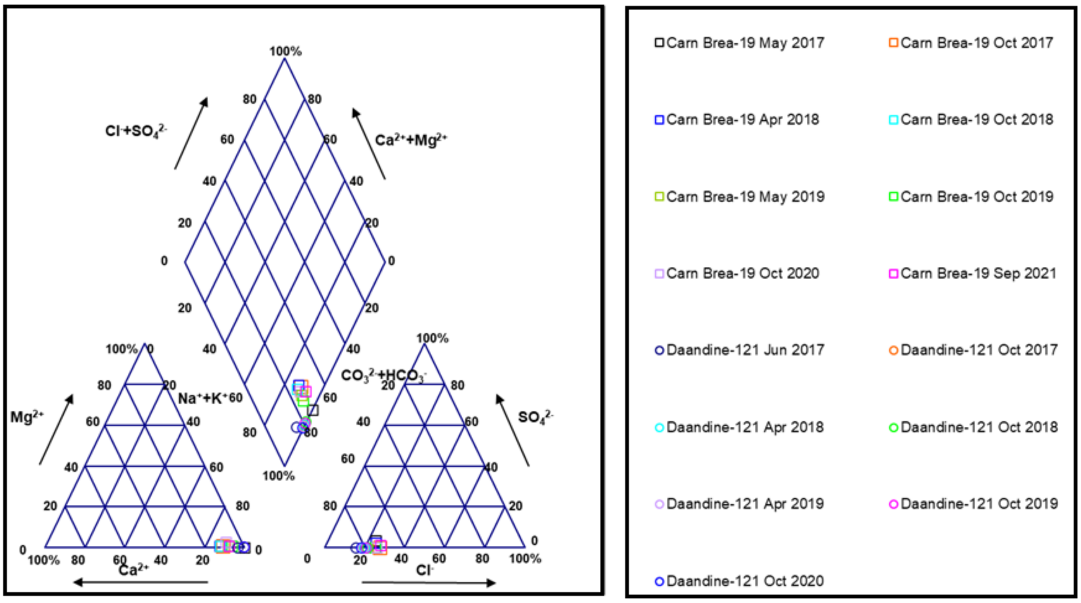

Figure 3-22: Hutton Sandstone Piper Diagram

No major ion data was required to be collected for the Precipice Sandstone monitoring points (Figure 3-23) during this annual reporting period. Data previously collected show Wyalla-17 is sodium-chloride type water with a carbonate-bicarbonate contribution, and Carn Brea-20 is a sodium-bicarbonate type water. There is no trend evident in chemical composition in Wyalla-17 while Carn Brea-20 is displaying a slight but steady increasing chloride contribution over time.

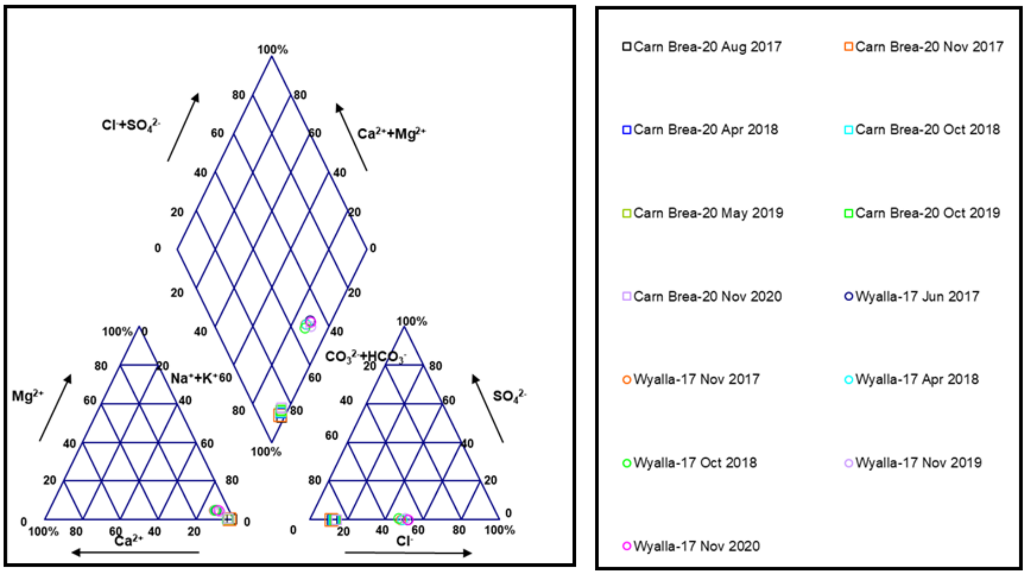

Figure 3-23: Precipice Sandstone Piper Diagram

Trend analysis

Mann-Kendall trend analysis has been undertaken to evaluate increasing and decreasing trends in concentrations for monitored water quality parameters (with more than four data points). Water quality samples were only collected within the Springbok Sandstone (Plainview 36) during the current annual reporting period and thus only a summary from this bore is provided in Figure 3-24 (trend analysis for the other formations can be found in the previous annual report). Although samples were collected from Springbok Sandstone monitoring bore Tipton 202 during the current reporting period, the number of samples (3) is currently insufficient for Mann-Kendall trend analysis; trends in water quality from this bore will be analysed in future reports. The axis on the charts indicates the number of analytes, within that formation, with an observed increasing (positive number) or decreasing (negative number) trend in the analyte concentration. A zero number represents no trend in the data.

For the Springbok Sandstone, the analysis is based on 6 samples at Plainview 36. The data displays there is either an increasing trend, decreasing trend or no trend. Decreasing trends were recorded for carbonate alkalinity, DO (field), pH (field), Redox (field), fluoride, potassium and total alkalinity.

The magnitude of trends for individual monitoring points are presented in Appendix C for monitoring points sampled during this reporting period.

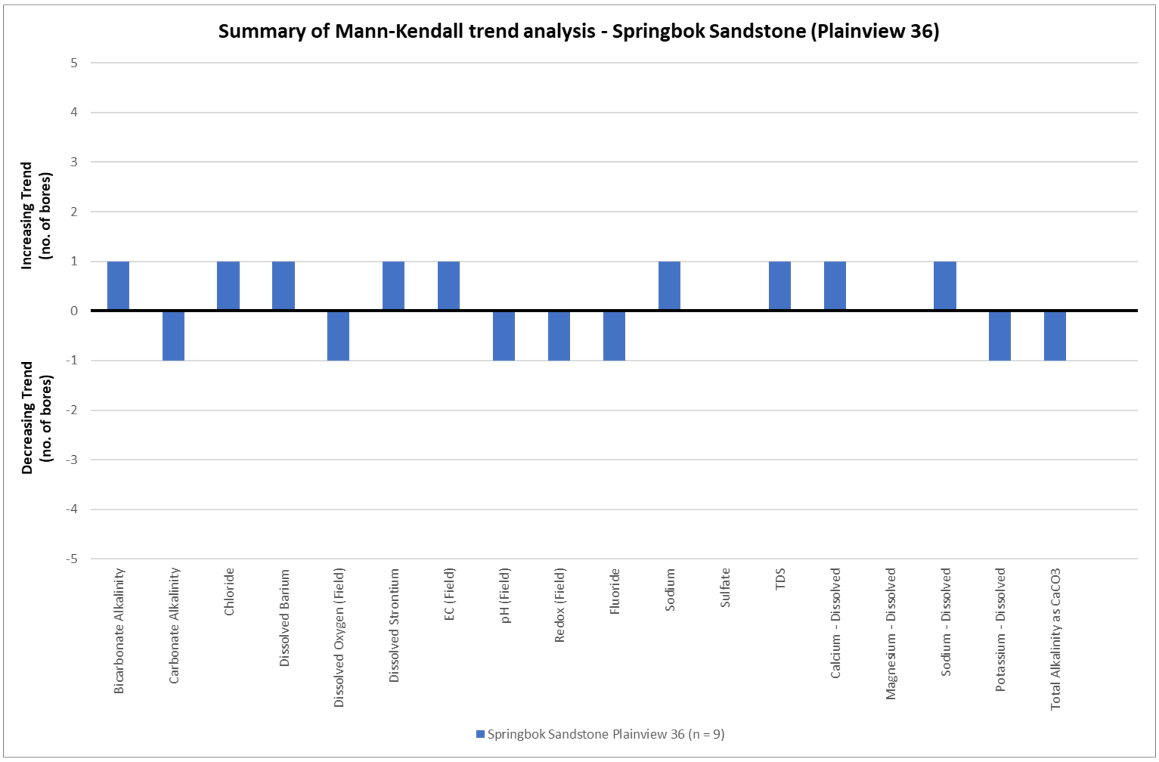

Figure 3-24: Summary of Mann-Kendall trend analysis for Springbok Sandstone monitoring bore Plainview 36

3.3 Ground movement monitoring

Coal seam gas occurs within coal formations through adsorption to the surface of the coal under hydrostatic pressure. Depressurisation of the coal seams below a threshold by groundwater extraction reduces hydrostatic pressure and liberates the gas from the formation. As the pressure falls, the gas migrates to the extraction wells. This process requires substantial lowering of groundwater pressure.

At any point below the ground surface, the weight of overlying strata is supported partly by water pressure and partly by the fabric of the rock mass. Any reduction in water pressure therefore results in an increased proportion of the load being carried by the rock mass, leading to compression of the rock. This is known as an increase in effective stress. The combined compression over the thickness of rock strata affected by reduced water pressure will result in some compaction of the coal seams and may cause overlying formations to subside, resulting in some subsidence at the ground surface.

The development of a CSG field, where the effect of depressurisation of individual wells interact with each other over time, results in relatively uniform depressurisation within a field and a depressurisation surface which gradually decreases away from the CSG field. Any CSG induced ground surface movement is normally expected to be regionally consistent and, with the magnitudes predicted, unobtrusive in terms of environmental and land use impacts. However, monitoring systems have been established to distinguish any significant ground surface movement as a result of CSG operations from natural ground surface changes, such as attrition and climatic induced soil swelling and depletion.

During the previous reporting period OGIA developed a 3D numerical model coupling geomechanics to groundwater depressurisation, predicting magnitude of subsidence and change in slope as a result of CSG operations in the area of the Condamine Alluvium, and developed an analytical model predicting magnitude of subsidence in the greater Surat Basin, as reported in the 2021 UWIR (OGIA, 2021).

The 3D numerical geomechanical model was built incorporating all available data on local geomechanical properties and lithological distribution, with predicted depressurisation from the OGIA groundwater model used as an input to make predictions of subsidence. A model grid ranging from 250 by 250m to 750 by 750m with 88 vertical layers was used to account for variations in lithology, and OGIA generated a set of 1,000 models from stochastic realisations of geomechanical properties to explore the range of uncertainty in predictions. History matching these models to the available Interferometric Synthetic Aperture Radar (InSAR) data in the vicinity of the Condamine Alluvium allowed the 50 best fitting models to be selected to generate predictions of subsidence. Predicted subsidence and change in slope are therefore reported statistically in the 2021 UWIR as a median (P50) prediction derived from those 50 model runs. Predicted subsidence from the 2021 UWIR, including predicted temporal development of subsidence at specific locations, is presented in Figure 3-25, with predicted maximum changes in slope within the cropping areas of the Condamine River floodplain at any time during CSG field development presented in Figure 3-26.

OGIA processed outputs from the uncertainty analysis to derive probability of magnitudes of subsidence and slope occurring at each model cell. This is presented as maps of the probability of 0.001% (0.01m in 1km) and 0.005% (0.05m in 1km) slope change, together with probability of 100mm and 150mm magnitude subsidence occurring within the cropping areas of the Condamine River floodplain, in Figure 3-27. The Horrane Fault is a large north-south trending fault zone east of Cecil Plains, with displacement of up to approximately 100m. Displacement of the fault and the low permeability of the fault core can result in differential depressurisation patterns either side of the fault, resulting in the greatest predicted change in slope across the Horrane Fault.

During this reporting period, OGIA published a report on coal shrinkage (Aghighi, H, et. al. 2023). Coal shrinkage is the reduction in coal volume due to the extraction of gas. Coal shrinkage contributes to the total subsidence observed at the surface and is implicitly represented in OGIAs prediction model (Aghighi, H, et. al. 2023, p21).

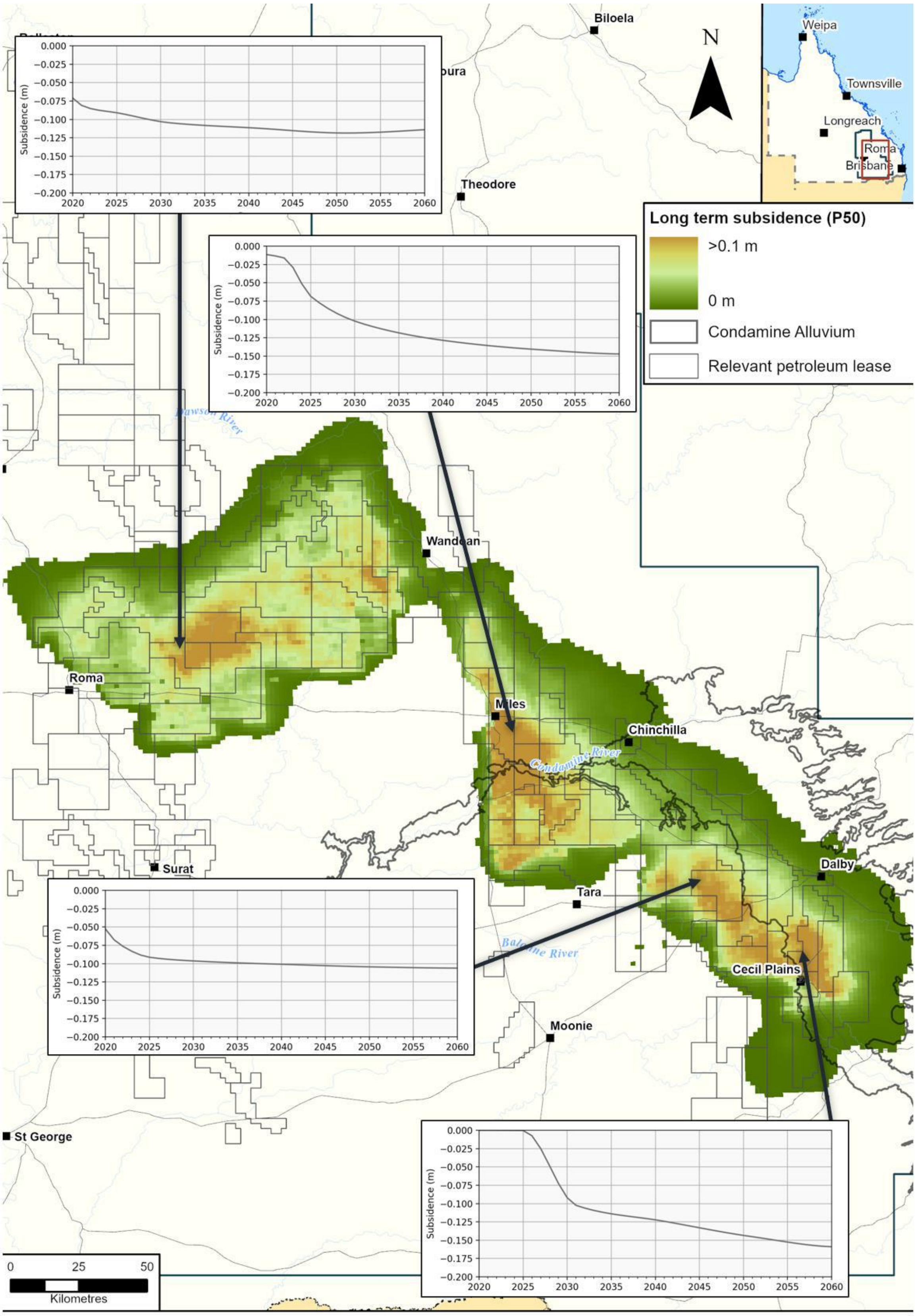

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Figure 3-25: 2021 UWIR predicted long-term CSG-induced subsidence across the Surat Basin (after OGIA, 2021)

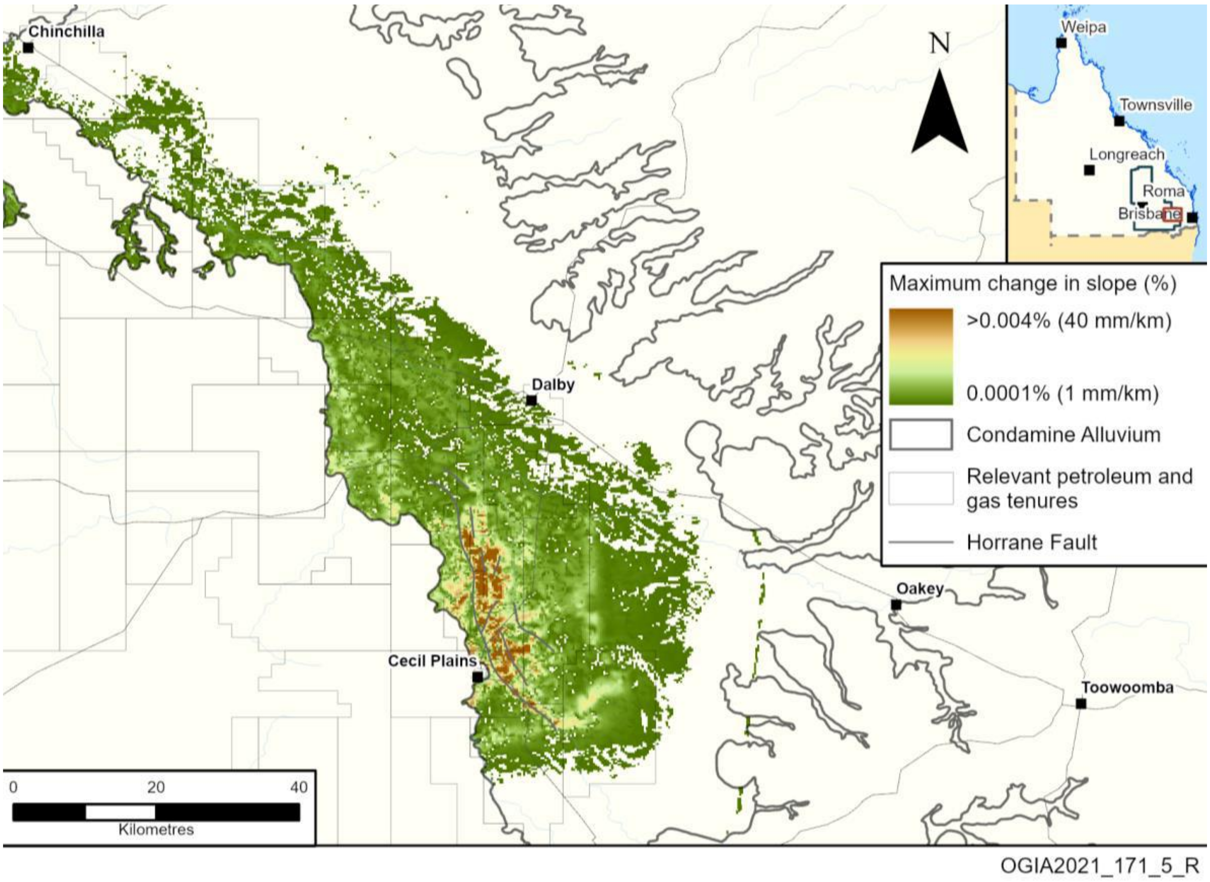

Figure 3-26: Predicted maximum change in ground slope from CSG-induced subsidence within the Condamine Alluvium area (after OGIA, 2021)

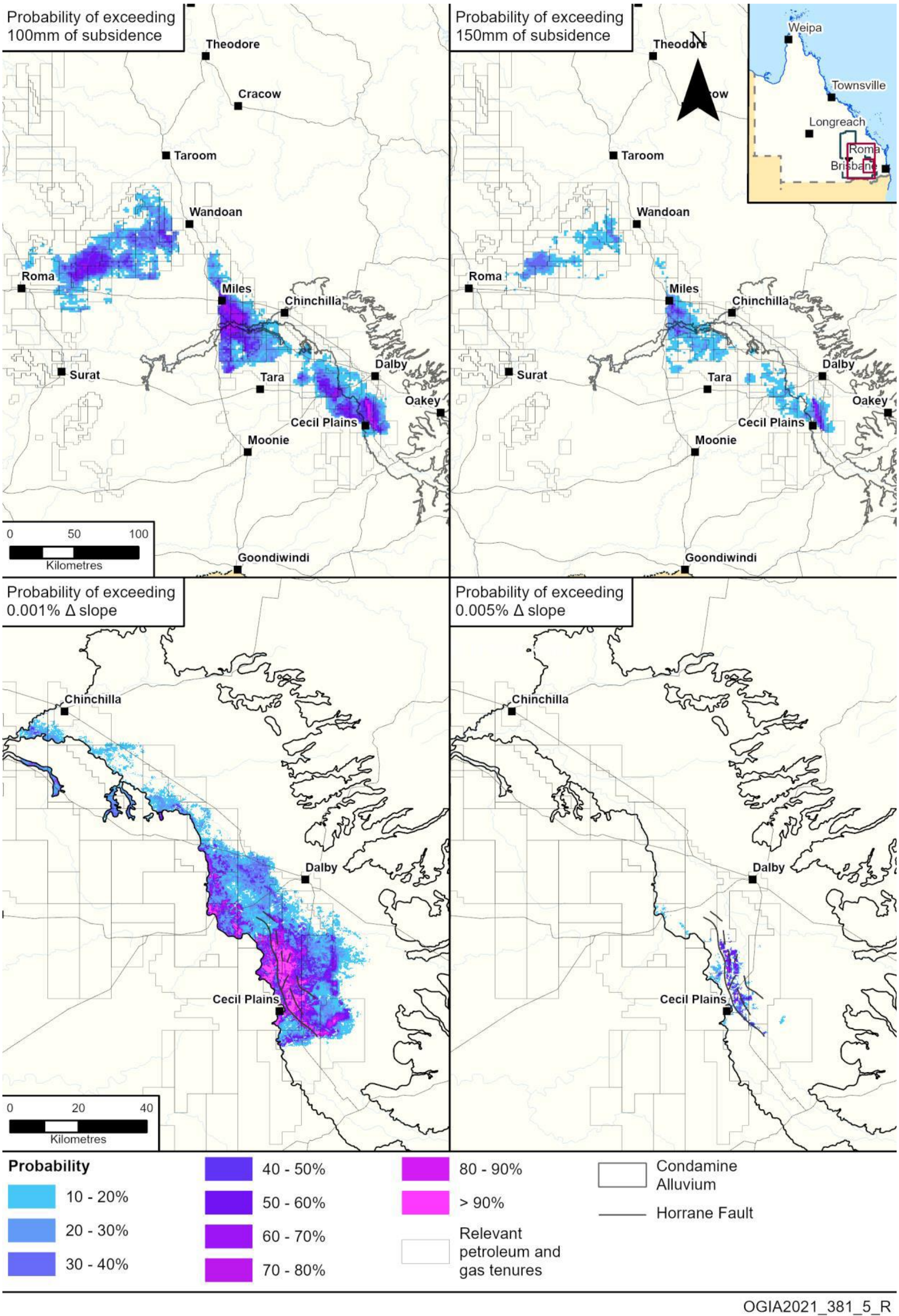

Figure 3-27: Probabilities of predicted subsidence and resulting change in slope within the Condamine Alluvium area (after OGIA, 2021)

Data collection

Monitoring of subsidence was carried out by Altamira using satellite borne InSAR, a radar technique used in geodesy and remote sensing (Altamira, 2016), which provides change in ground elevation over time.

Arrow has acquired InSAR data since 2006, with the most recent satellite system (Sentinel) providing data since 2015. The Sentinel satellite system passes every 12 days (every 6 days since 2017) providing high frequency ground motion monitoring, with a vertical resolution to approximately 1mm.

The InSAR data provides a baseline from which future data can be assessed to determine changes in vertical ground elevation, and also provides a snapshot of current vertical ground movement.

Geotechnical ground movement monitoring points have also been installed to provide a ground-truthing check of the InSAR data. These points are instrumented with Global Navigation Satellite System (GNSS) Continually Operating Reference Stations (CORS), and provide millimetric accuracy of changes in vertical elevation.

Periodic surveys using Light Detection And Ranging (LiDAR), a remote-sensing technique using airborne laser scanning systems, have been undertaken to provide snapshots of relative elevation of the land and derived slopes at moment of capture. These surveys, which provide for accurate assessment of slopes at property and regional scale, have been acquired for Arrow in 2012, 2014, 2020, 2021, 2022 and 2023. The LiDAR data provides a temporal baseline from which future data can be assessed to determine changes in slope.

These monitoring methods detect changes in the ground surface from all potential causes, not just CSG induced subsidence.

Data analysis

Following the baseline InSAR survey for the period 2006 to 2015, and reported in the Stage 1 WMMP, Tre-Altamira was commissioned for ongoing surface deformation monitoring across the Arrow tenements, with the latest data available up to the end of June 2023.

Figure 3-28 shows a down-sampled data set, where the point cloud InSAR data was reduced to the median vertical velocity within a 1,000 m x 1,000 m grid. Stable has been classified as ground motion of less than 8 mm per year (subsidence or uplift) as related to the screening level identified in the Stage 1 WMMP.

These data show stability across most of Arrow’s tenure, together with areas of downward ground movement, majority of which being away from areas of gas production. Areas of downward ground movement are particularly observed over the vertosol soils of the Condamine Alluvium, and are likely related to decreased rainfall observed over the monitoring period, compared to previous, causing shrinkage of the clay soils. Areas of poor satellite data coherence, with only a small number of InSAR points per square km, also occur within the area of the Condamine Alluvium. Coherence is a measure of the local spatial correlation between radar images, where changes to the reflection of the radar signal (such as due to rapid vegetation growth or changes in soil moisture) result in irregular variation in phase and higher noise in the data.

As shown below, 243 of the (1km x 1km) cells had recorded downward ground movement in excess of the screening level of 8 mm per year for more than 50% of the coherent InSAR points within those cells. Of these, 66 of these grid cells located within 4.5km of Arrow producing wells (the reasonable distance within which CSG induced subsidence might be detectable). As these 66 areas exceeded the screening level, further assessment of changes to the ground surface and slopes within and around the grid cell areas was undertaken, using the InSAR point clouds and LiDAR surveys, to assess if there was any CSG induced subsidence impacts and exceedance of investigation levels.

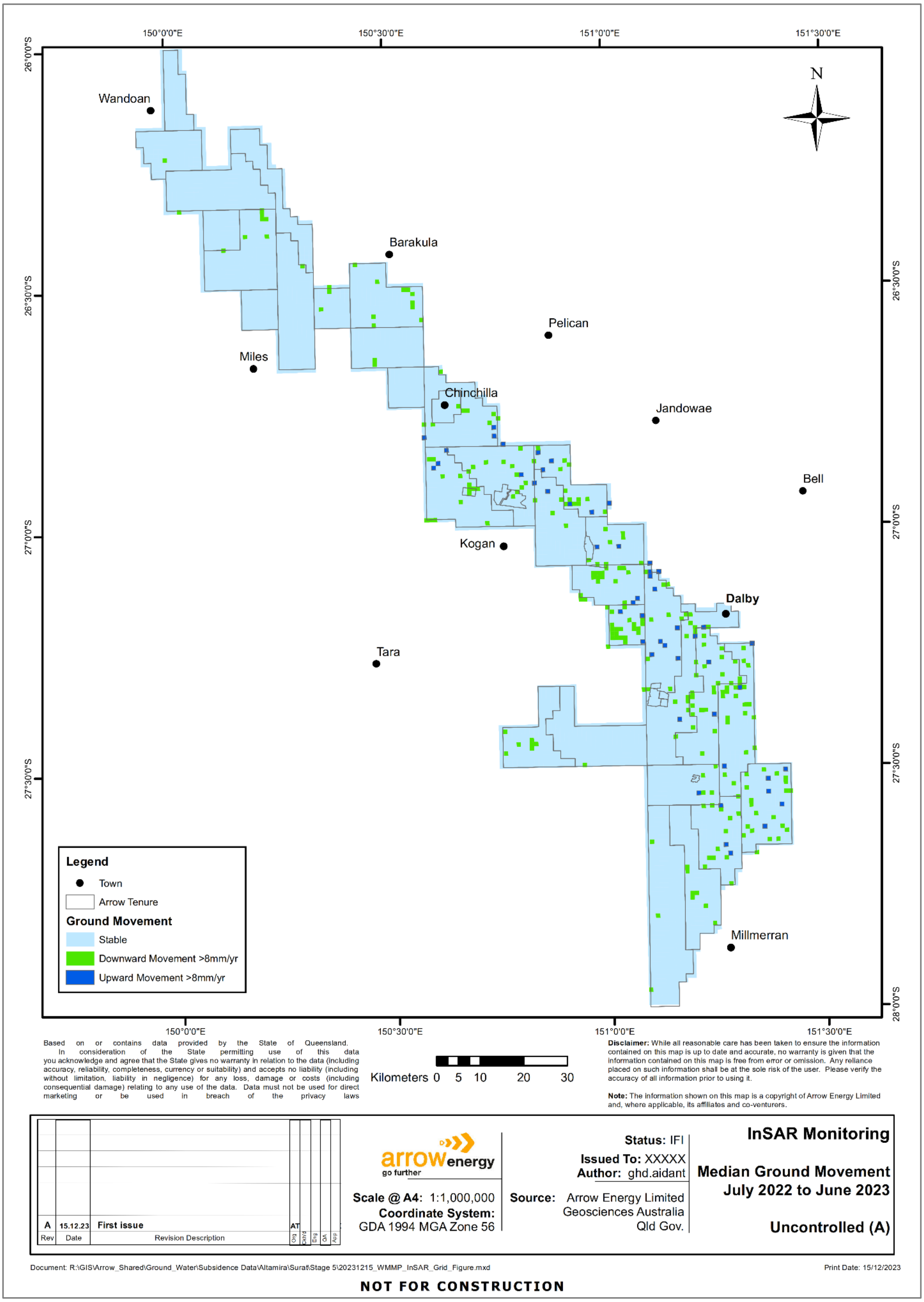

Figure 3-28: InSAR Median Ground Movement (July 2022 to June 2023 inclusive)

A process was undertaken considering areal slope change on a 250m resolution grid, as well as investigation of the number of 2D InSAR points per cell. For grid cells with less than 5 valid 2D InSAR points, persistent scatter points from line of site (ascending and descending satellite) data were preferentially adopted. Overall, it was determined that 34 of the 66 grid cells had areal slope change (LiDAR derived) in excess of 0.001m/m and over 50% of InSAR points with vertical movement greater than 8mm/yr. These 34 cells were investigated further to validate if investigation levels had actually been exceeded due to CSG activity.

Transects were taken along structural and natural features within the cells, the location and results of these are summarised in Appendix E. Of the 156 transects taken across the 34 grid cells, 3 exceeded the investigation level of 0.001 m/m (0.1%). On further inspection of those locations, it was apparent that the slope change recorded was isolated and due to causes other than CSG, as summarised below. Therefore, no site specific investigations or trigger threshold exceedance action plans were required or initiated from the assessment or during the reporting period.

Transect 3 taken in grid 2039 was found to exceed 0.001m/m slope change. The location and profile are shown in Figure 3-29 and Figure 3-30 respectively.

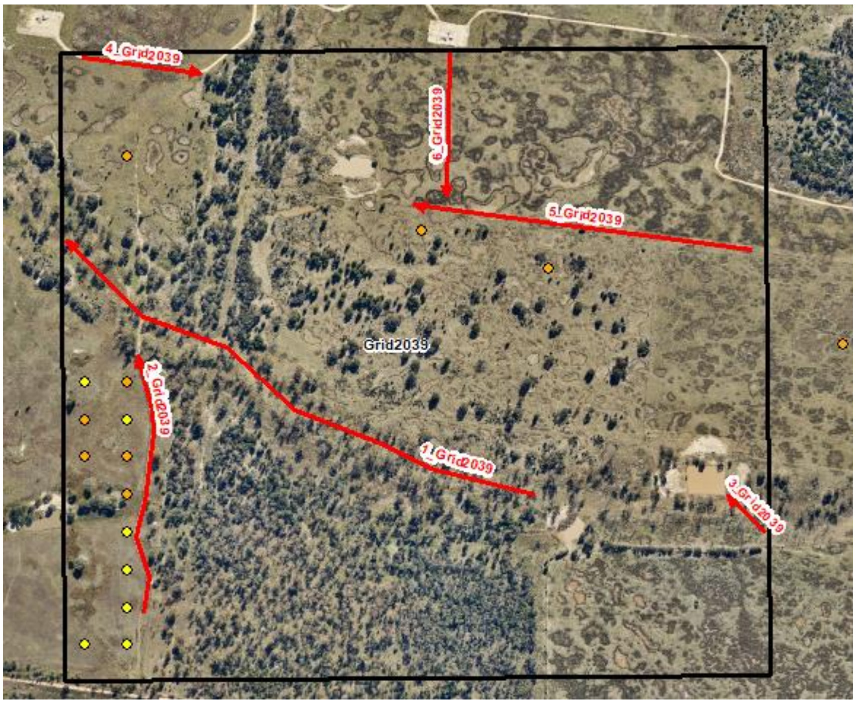

Figure 3-29: 1x1km Grid Cell ID 2039 showing location of transects under

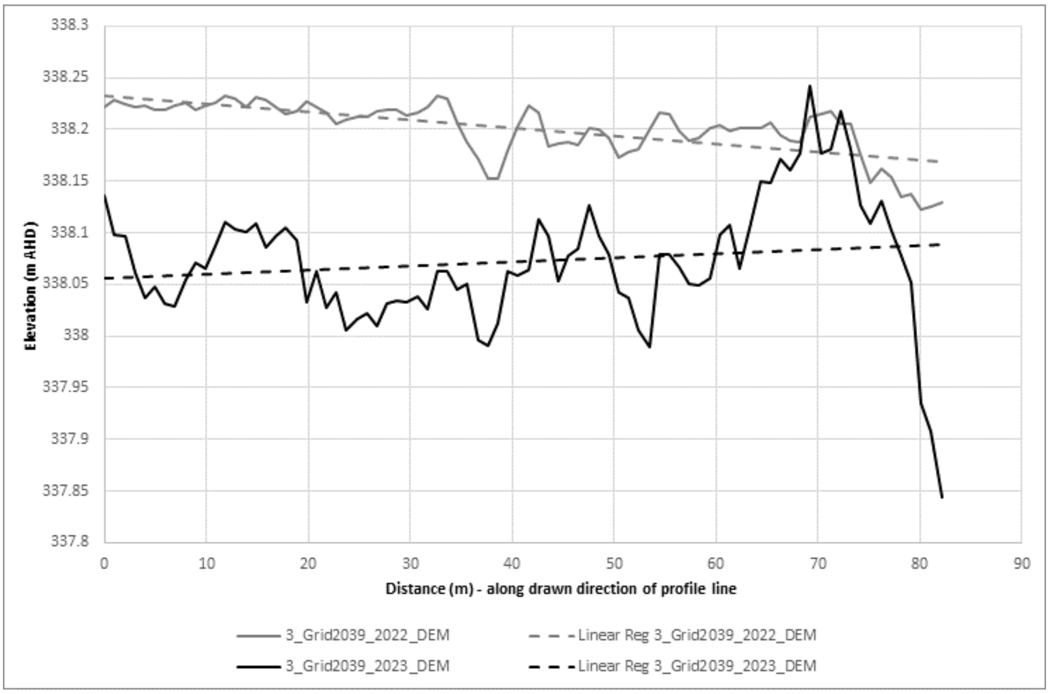

Figure 3-30: Profile of Transect 3 on Grid Cell ID 2039

As shown above, there was vertical movement exceeding 150mm vertically along the majority of the transect. Considering the vicinity of Gilgai visible in the image, the short length of the transect and that no other profiles experienced material slope change in the area, it is concluded that this slope change is localised and due to natural causes.

Transect 1 taken in grid 2571 was found to exceed 0.001m/m slope change. The location and profile are shown in Figure 3-31 and Figure 3-32 respectively.

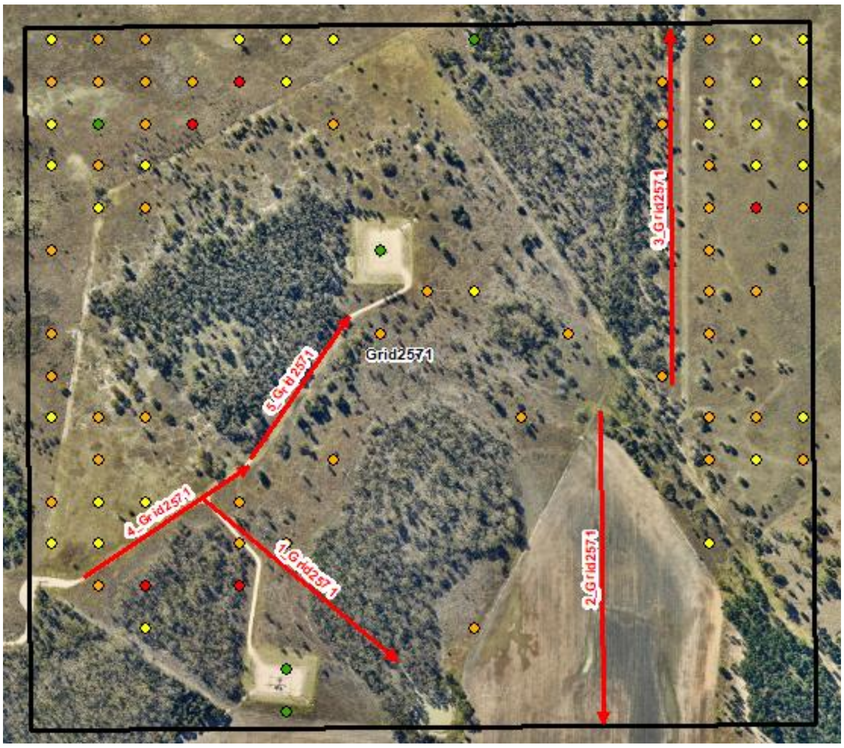

Figure 3-31: 1x1km Grid Cell ID 2571 showing location of transects undertaken

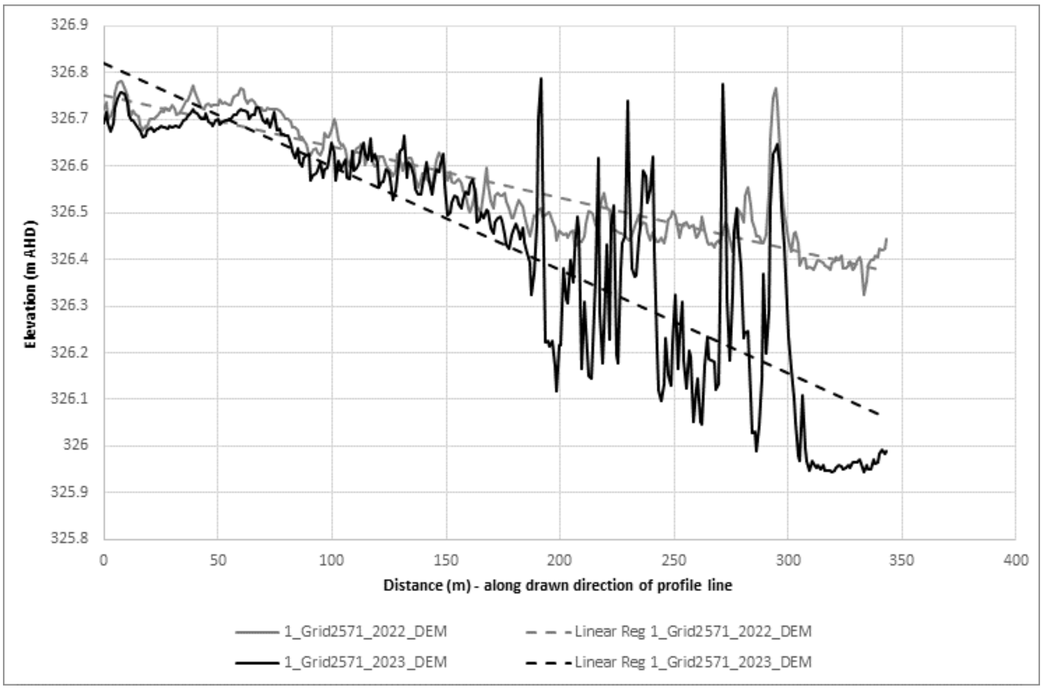

Figure 3-32: Profile of Transect 1 on Grid Cell ID 2571

As shown above, there was vertical movement exceeding 400mm vertically at the end of the transect, which is unprecedented for CSG induced subsidence. Water ponding is also visible in the imagery at this same end point of the transect. There is apparent surface variability detected in the 2023 DEM compared to 2022 where the profile enters heavy bushland. It can be observed that there is no material slope change in the transect from chainage 0-180m along the roadway and through open grassland. The remaining transects in this cell did not experience material slope change. It is therefore concluded that material slope change has not occurred at this transect due to CSG, and rather it is due to variability between DEMs caused by a combination of vegetation and/or ponded water.

Transect 5 taken in grid 2346 was found to exceed 0.001m/m slope change. The location and profile are shown in Figure 3-33 and Figure 3-34 respectively.

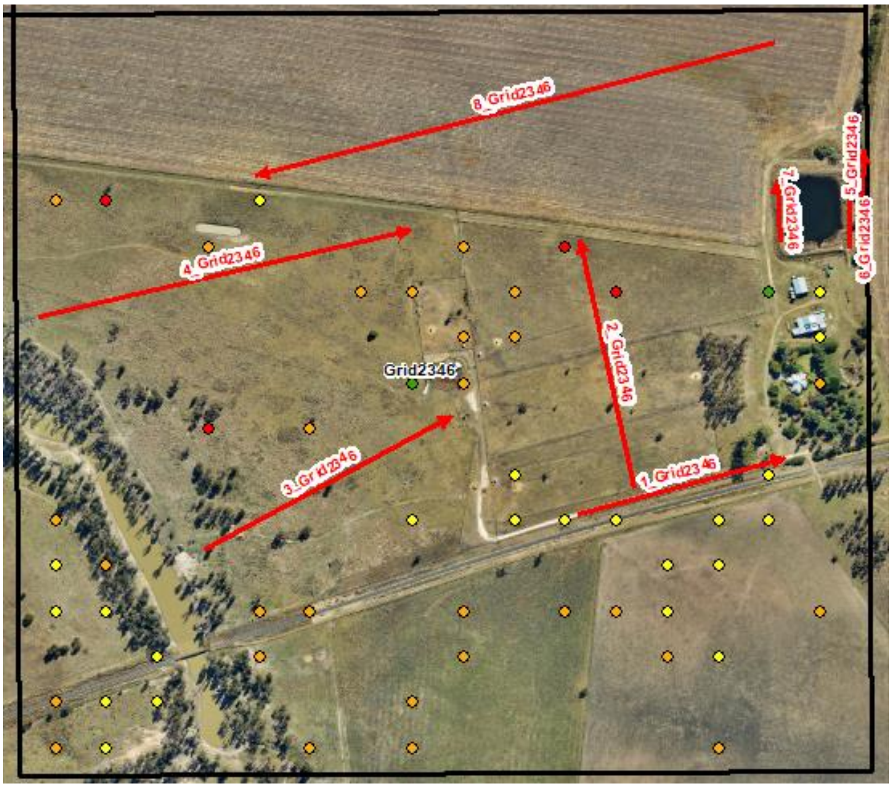

Figure 3-33: 1x1km Grid Cell ID 2346 showing location of transects undertaken

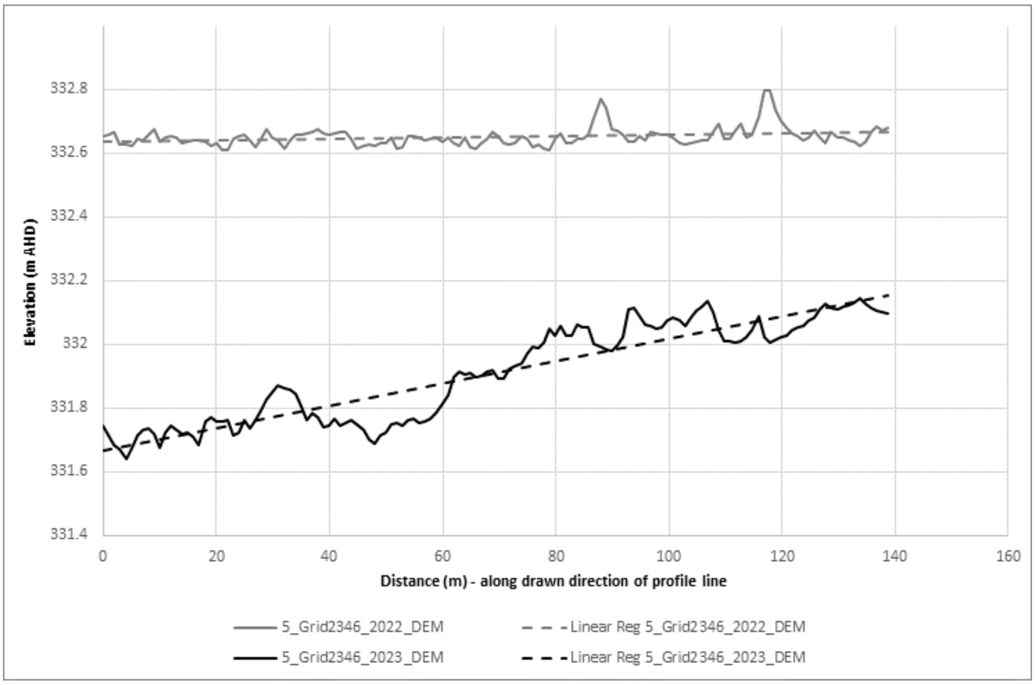

Figure 3-34: Profile of Transect 5 on Grid Cell ID 2346

As shown above, there was vertical movement exceeding 800mm vertically at the start of the transect, which is unprecedented for CSG induced subsidence. The profile was taken along a drainage channel, and considering the profile in 2022 was relatively level, it is likely that this drainage channel was holding water in the 2022 LiDAR flight. The remaining transects in this cell did not experience material slope change. It is therefore concluded that this slope change is isolated and due to changes in water levels along the drainage line.

3.4 Update to monitoring network

Groundwater monitoring locations and frequency of monitoring were revised upon the release of the 2021 UWIR in line with Section 7.3 of the SGP Updated WMMP. The monitoring network presented in Table 7-1 of the SGP Updated WMMP has been aligned with the 2021 UWIR water monitoring strategy (WMS) to ensure monitoring is undertaken proportionally to the predicted impacts presented in the 2021 UWIR. A summary of the changes to the monitoring network is provided in Table 5 and the updated list of monitoring points (and their purpose) is provided in Table 6 and illustrated in Figure 3-35 and Figure 3-36. In addition to the changes noted in Table 5, the groundwater chemistry suite and sampling frequency have been revised to align with 2021 UWIR and is presented in Table 7.

Key changes to the monitoring programs are:

- the number of monitoring points has increased from 120 in the SGP Updated WMMP to 150 to align with the 2021 UWIR,
- the groundwater analysis suite has been expanded to include strontium isotopes (87Sr/86Sr) (this was changed under the 2019 UWIR),
- Table 4-2 of the 2021 UWIR supporting document "*Details of the Water Monitoring Strategy for the Underground Water Impact Report 2021*" (OGIA 2021b) (and also Table H-4 of the 2019 UWIR) stipulates a groundwater sampling frequency of every six months until five samples have been obtained, with one of these samples analysed for dissolved strontium and strontium isotopes ($^{87}Sr/^{86}Sr$) in Springbok Sandstone, Hutton Sandstone and Precipice Sandstone monitoring points.

Table 5: Summary of changes to the Updated CSG WMMP monitoring points to align with the 2021 UWIR monitoring requirements

Location ID	Target Aquifer	Original monitoring requirement as per Updated CSG WMMP			2021 UWIR Monitoring Requirement	Monitoring point status and current monitoring requirement based on 2021 UWIR
		Level / pressure	Water Quality	CA-WCM flux		
Bora Creek-10	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Burunga Lane-174	Evergreen	✓			No change. Still required to be monitored for the 2021 UWIR.	Access to the site was not possible during the reporting period due to ongoing negotiations with the landholder. The monitoring points are currently offline. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring in Burunga Lane-174 (removed from UWIR).
Burunga Lane-174	Precipice	✓	✓		No change to the pressure monitoring requirement. Water quality monitoring requirement has been removed from the 2021 UWIR.	
Burunga Lane-176	Hutton	✓	✓		No change. Still required to be monitored for the 2021 UWIR.	
Burunga Lane-176	WCM	✓				
Carn Brea-17	Condamine Alluvium	✓	✓	✓	No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Carn Brea-18	WCM	✓	✓ (at UWIR MP 41 only)	✓	No change to the pressure monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Carn Brea-19	Evergreen	✓			No change to the pressure monitoring requirement.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Carn Brea-19	Hutton	✓	✓		No change to the pressure monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Carn Brea-20	Precipice	✓	✓		No change to the level monitoring requirement. Water quality monitoring requirement has been removed from the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (removed from UWIR).
Carn Brea-21	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Carn Brea-23	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Carn Brea-24	CA / WCM transition layer	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Castledean-18	Springbok	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point is operational but dry. Monitoring point operational. Monitoring as per Updated CSG WMMP.
Castledean-18	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Daandine-121	Hutton	✓	✓		No change to the pressure monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Daandine-123	WCM	✓			Not listed to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring is no longer required under the 2021 UWIR.
Daandine-124	Westbourne	✓	✓		No change to the level monitoring requirement. Water quality monitoring requirement has been removed from the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (removed from UWIR).
Daandine-134	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Daandine-134	Eurombah	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.

Location ID	Target Aquifer	Original monitoring requirement as per Updated CSG WMMP			2021 UWIR Monitoring Requirement	Monitoring point status and current monitoring requirement based on 2021 UWIR
		Level / pressure	Water Quality	CA-WCM flux		
Daandine-161	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	No monitoring data available for Daandine-161 as bore was isolated by standing water during monitoring events.
Daandine-163	CA / WCM transition layer	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Daandine-164	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Daandine-254	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Daandine-263	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Daandine-264	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Dundee-20	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Glenburnie-19	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Pressure gauge had failed. Pressure gauge became operational again in June 2022. Monitoring as per Updated CSG WMMP.
Hopeland-17	Springbok	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Hopeland-17	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Periods of no data (between April and June 2022) within the annual period within bores monitoring the WCM and jumps in recorded levels. Data validation ongoing to confirm observed pressure trends. Monitoring as per Updated CSG WMMP.
Kedron-570	Eurombah	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Kedron-570	Hutton	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Kedron-570	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Kedron-570	Springbok	✓			Monitoring point removed from the previous UWIR (2019).	Monitoring point no longer monitored as per the 2019 and 2021 UWIRs.
Kogan North-56	WCM	✓		✓	Monitoring point removed from the 2021 UWIR (previously removed in 2019 UWIR).	Monitoring point no longer monitored as per the 2021 UWIR (previously removed in 2019 UWIR) Monitoring point plugged and abandoned.
Kogan North-79	CA / WCM transition layer	✓		✓	Monitoring point removed from the 2021 UWIR (previously removed in 2019 UWIR).	Monitoring point no longer monitored as per the 2021 UWIR.
Kogan North-79	Condamine Alluvium	✓		✓	Monitoring point removed from the 2021 UWIR (previously removed in 2019 UWIR).	Monitoring point no longer monitored as per the 2021 UWIR.
Tipton-153	Hutton	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Long Swamp-1 (replaced by Longswamp 27)	WCM	✓			Monitoring point replaced by Longswamp 27 installed adjacent to Long Swamp-1.	Monitoring point (Longswamp 27) operational. Monitoring as per Updated CSG WMMP.
Longswamp-7	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Period of no monitoring data (between February and March 2022) in annual period. Monitoring point operational. Monitoring as per Updated CSG WMMP.
Macalister-5	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Macalister-8	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.

Location ID	Target Aquifer	Original monitoring requirement as per Updated CSG WMMP			2021 UWIR Monitoring Requirement	Monitoring point status and current monitoring requirement based on 2021 UWIR
		Level / pressure	Water Quality	CA-WCM flux		
Meenawarra-21	Springbok	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Meenawarra-21	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Meenawarra-5	WCM	✓			Monitoring point removed from the 2021 UWIR.	Monitoring point no longer monitored as per the 2021 UWIR.
Pampas-18	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Pampas-5	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Plainview-35	WCM	✓			No change. Monitoring point replaced previous UWIR monitoring point Plainview-1.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Plainview-25	CA / WCM transition layer	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring points operational. Monitoring as per Updated CSG WMMP.
Plainview-25	Condamine Alluvium	✓		✓		
Plainview-25	WCM	✓		✓		
RN 41620043	WCM (previously assessed by OGIA as Springbok Sandstone)	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
RN 42230088	Condamine Alluvium	✓		✓	Monitoring point removed from the 2021 UWIR.	Monitoring point no longer monitored as per the 2021 UWIR.
RN 42230209	Condamine Alluvium	✓	✓	✓	No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
RN 42231294	Condamine Alluvium	✓		✓	Monitoring point removed from the 2021 UWIR.	Monitoring point no longer required to be monitored as per the 2021 UWIR.
RN 42231295	WCM	✓		✓	Monitoring point removed from the 2021 UWIR.	Monitoring point no longer required to be monitored as per the 2021 UWIR.
RN 42231339	Condamine Alluvium	✓			Monitoring point removed from the 2021 UWIR.	Monitoring point no longer required to be monitored as per the 2021 UWIR.
RN 42231370	Condamine Alluvium	✓	✓		No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
RN 42231463	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Stratheden-63	Springbok	✓	✓		No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020, and collection of samples for analysis of strontium isotopes completed in Q4 2021).
Tipton-157	WCM	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-195	Condamine Alluvium	✓	✓	✓	No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Tipton-196A	CA / WCM transition layer	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.

Location ID	Target Aquifer	Original monitoring requirement as per Updated CSG WMMP			2021 UWIR Monitoring Requirement	Monitoring point status and current monitoring requirement based on 2021 UWIR
		Level / pressure	Water Quality	CA-WCM flux		
Tipton-197	WCM	✓	✓ (at UWIR MP 89 only)	✓	No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Tipton-204	CA / WCM transition layer	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-204	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-204	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-206	Eurombah	✓			No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-206	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-221	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Tipton-222	CA / WCM transition layer	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Macalister 7	Condamine Alluvium	✓		✓	No change. Still required to be monitored for the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Macalister 6	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Macalister 6	Eurombah	✓			No change. Still required to be monitored for the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP.
Wyalla-17	Hutton	✓			No change. Still required to be monitored for the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP.
UWIR Site 94	Hutton	✓			Monitoring point not yet installed as 2016 UWIR timing requirement for installation (two years prior to production within 10km) was not triggered. This monitoring point is no longer required under the 2021 UWIR (previously not required in 2019 UWIR).	Monitoring point no longer required.
UWIR Site 94 (Burunga Lane 186)	WCM	✓			Monitoring point not yet installed as 2016 UWIR timing requirement for installation (two years prior to production within 10km) was not triggered. The 2019 UWIR requires this monitoring point to be installed in 2022.	Monitoring point is scheduled to be installed in 2022 as per the 2021 UWIR.
Wyalla-16	Condamine Alluvium	✓	✓	✓	No change to the level monitoring requirement. Water quality monitoring is no longer required as sufficient number of samples have been collected as per Table 9-4 of the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Wyalla-17	Precipice	✓	✓		No change to the level monitoring requirement. Water quality monitoring requirement has been removed from the 2021 UWIR	Monitoring point operational. Monitoring as per Updated CSG WMMP except for the cessation of water quality monitoring (completion of collection of five samples in Q4 2020).
Wyalla-18	WCM	✓		✓	No change. Still required to be monitored for the 2021 UWIR.	Monitoring point operational. Monitoring as per Updated CSG WMMP.

Table 6: Revised Updated CSG WMMP Monitoring Network as per the 2021 UWIR WMS

Location ID	OGIA MP ID	Latitude	Longitude	Target Aquifer	UWIR Required Online Date	Monitoring point purpose			
						Level / pressure	Quality	CA-WCM flux	Early warning
41620043	578	-27.922222	151.121389	WCM	Complete	✓			✓
42230209	281	-26.7422	150.6799	Condamine Alluvium	Complete	✓	✓	✓	✓
42231370	51	-27.491498	151.393194	Condamine Alluvium	Complete	✓	✓		✓
42231463	37	-27.548794	151.313017	Condamine Alluvium	Complete	✓		✓	✓
42231597	597	-27.73082	151.76343	Main Range Volcanics	Complete	✓			
Baking Board 4	877	-26.567	150.653	WCM	2022	✓			
Baking Board 5	891	-26.48009491	150.5512695	Alluvium	2022	✓			
Barakula 2	878 and 869	-26.480094	150.551269	WCM, Hutton Sandstone	2022	✓			
Bora Creek 10	579	-27.924504	151.12492	WCM	Complete	✓			
Burunga Lane 186	494, 495, 496	-26.2301	149.9534	WCM	2022	✓			
Burunga Lane-174	478, 625	-26.242667	150.050176	Precipice, Evergreen	Monitoring points installed. Awaiting land access to recommence monitoring	✓			✓ (478)
Burunga Lane-176	473, 474, 475, 476, 477	-26.242897	150.049993	WCM, Hutton	Monitoring points installed. Awaiting land access to recommence monitoring	✓	✓ (477)		✓ (476)
Carn Brea 21	94	-27.437622	151.357504	WCM	Complete	✓		✓	
Carn Brea 22	882	-27.43779	151.357466	Hutton	2022	✓			
Carn Brea 23	92	-27.43762778	151.3576733	Condamine Alluvium	Complete	✓		✓	✓
Carn Brea 24	93	-27.437628	151.357707	Condamine Alluvium - Walloon Transition Layer	Complete	✓		✓	
Carn Brea-17	38	-27.533016	151.36648	Condamine Alluvium	Complete	✓	✓		✓
Carn Brea-18	40, 41, 42, 43	-27.532995	151.36633	WCM	Complete	✓	✓ (41)	✓	
Carn Brea-19	44, 45, 46	-27.532975	151.36618	Hutton, Evergreen	Complete	✓	✓ (45)	✓	✓ (44)
Carn Brea-20	47	-27.532954	151.36603	Precipice	Complete	✓	✓		✓
Castledean-18	375, 376, 377, 378	-26.552914	150.221984	WCM, Springbok	Complete	✓			✓ (375)
Daandine 263	181	-27.102426	150.961255	WCM	Complete	✓			
Daandine 264	148	-27.15307149	151.0442114	WCM	Complete	✓			
Daandine-121	182	-27.100415	150.955656	Hutton	Complete	✓	✓		✓
Daandine-123	719, 720	-27.144075	150.948059	WCM, Precipice	Complete	✓			
Daandine-124	157	-27.144119	150.948001	Westbourne Formation	Complete	✓			
Daandine-134	162, 163, 164	-27.14401378	150.9485653	Tangalooma Sandstone, Eurombah, WCM	Complete	✓			
Daandine-161	166	-27.118534	151.075606	Condamine Alluvium	Complete	✓		✓	✓
Daandine-163	167	-27.119974	151.075875	Condamine Alluvium - Walloon Transition Layer	Complete	✓		✓	
Daandine-164	168	-27.120008	151.075969	WCM	Complete	✓		✓	
Daandine-254	160, 161, 159	-27.144104	150.948239	WCM	Complete	✓			
Dundee-20	283, 284, 285	-26.743476	150.678351	WCM	Complete	✓		✓	
Glenburnie 19	23	-27.639218	151.167664	WCM	Complete	✓			
Glenburnie 20	732	-27.83304667	151.0972642	Springbok	Complete	✓			
Glenburnie 21	733	-27.83242474	151.0980474	WCM	Complete	✓			
Glenburnie 22	734	-27.83252476	151.0981482	WCM	Complete	✓			
Glenburnie-18	735, 736, 737, 738, 739	-27.72017464	151.1565154	Hutton, WCM, Springbok	Complete	✓	✓ (739)		
Hopeland-17	615, 616, 617, 618	-26.973208	150.611817	Springbok, WCM	Complete	✓			✓ (615)
Kedron-570	626, 627, 628, 629	-26.413424	150.153717	WCM, Tangalooma Sandstone, Hutton	Complete	✓			✓ (629)

Location ID	OGIA MP ID	Latitude	Longitude	Target Aquifer	UWIR Required Online Date	Monitoring point purpose			
						Level / pressure	Quality	CA-WCM flux	Early warning
Kogan North-79	747, 748, 749	-26.99886636	150.9018044	WCM	Complete	✓			
Lone Pine-14	750	-27.55472483	151.3591434	WCM	Complete	✓			
Lone Pine-16	751	-27.55468423	151.3587845	WCM	Complete	✓			
Long Swamp 27	83	-27.343091	151.124186	WCM	Complete	✓			
Longswamp 28	752	-27.3415143	151.0917476	Westbourne Formation	Complete	✓			
Longswamp 29	753	-27.34150399	151.0915948	Springbok	Complete	✓			
Longswamp 30R	754	-27.34148851	151.0914061	WCM	Complete	✓			
Longswamp 31	755	-27.34347302	151.0957158	Condamine Alluvium	Complete	✓			
Longswamp 33	756	-27.26852415	151.0953309	Springbok	Complete	✓			
Longswamp 34	757	-27.26851019	151.0952109	WCM	Complete	✓			
Longswamp-7	145, 146, 147	-27.184333	151.127397	WCM	Complete	✓			
Macalister 5	244	-26.895087	150.954269	Condamine Alluvium	Complete	✓		✓	✓
Macalister 6	205, 206	-27.025681	151.133187	Eurombah Formation, WCM	Complete	✓		✓	
Macalister 7	203	-27.025639	151.133279	Condamine Alluvium	Complete	✓		✓	✓
Macalister 8	245	-26.895103	150.954439	WCM	Complete	✓		✓	
Meenawarra-21	34, 35, 36, 619	-27.57994613	151.1333987	WCM, Springbok	Complete	✓			✓ (619)
Mt Haystack 2	598	-27.727166	151.763337	WCM	Complete	✓			
Mt Haystack 4	600	-27.724061	151.276431	WCM	Complete	✓			
Mt Haystack 5	599	-27.723972	151.276483	Condamine Alluvium	Complete	✓			
Pampas 18	24	-27.61473529	151.2266555	Condamine Alluvium	Complete	✓		✓	✓
Pampas-5	25	-27.614646	151.226669	WCM	Complete	✓		✓	
Plainview 34	1053,1054	-27.3828	151.1869	WCM	Complete	✓			
Plainview 35	77	-27.3842	151.2044	WCM	Complete	✓			
Plainview 36	789, 790	-27.3868	151.216	Springbok	Complete	✓	✓ (790)		
Plainview 37	791	-27.3868	151.216	Condamine Alluvium	Complete	✓			
Plainview-25	119, 120, 121	-27.25210762	151.2922186	Condamine Alluvium, Condamine Alluvium - Walloon Transition Layer, WCM	Complete	✓		✓	✓ (119)
Punch Bowl-15	796, 797	-26.55156345	150.3782458	WCM	Complete	✓			
Stratheden-62	822	-27.19895544	151.0267434	Condamine Alluvium	Complete	✓			
Stratheden-63	622, 623	-27.198933	151.026801	Springbok	Complete	✓	✓ (623)		✓ (622)
Tipton 153	620	-27.358607	151.153091	Hutton	Complete	✓			✓
Tipton 200	832, 834, 835, 836	-27.383	151.173	Hutton, WCM	Complete	✓			
Tipton 202	830, 833	-27.383	151.173	Springbok	Complete	✓	✓ (830)		
Tipton 203	831	-27.383	151.173	Condamine Alluvium	Complete	✓			
Tipton 204	149, 150, 151	-27.149552	151.20938	Condamine Alluvium, Condamine Alluvium - Walloon Transition Layer, WCM	Complete	✓		✓	✓ (149)
Tipton 206	141, 142	-27.215683	151.348949	Eurombah, WCM	Complete	✓		✓	
Tipton 221	138	-27.215626	151.348869	Condamine Alluvium	Complete	✓		✓	✓
Tipton 222	139	-27.215589	151.348817	Condamine Alluvium - Walloon Transition Layer	Complete	✓		✓	
Tipton-157	72, 73, 74	-27.398089	151.088923	WCM	Complete	✓			
Tipton-194	861	-27.38748328	151.1181328	Precipice	Complete	✓			
Tipton-195	84, 85	-27.32054	151.20535	Condamine Alluvium	Complete	✓	✓ (85)	✓	✓ (84)

Location ID	OGIA MP ID	Latitude	Longitude	Target Aquifer	UWIR Required Online Date	Monitoring point purpose			
						Level / pressure	Quality	CA-WCM flux	Early warning
Tipton-196A	86	-27.320232	151.205042	Condamine Alluvium - Walloon Transition Layer	Complete	✓		✓	
Tipton-197	88, 89, 90, 91	-27.320228	151.205316	WCM	Complete	✓	✓ (89)	✓	
Plainview 16	792	-27.3858	151.2165	Hutton	Complete	✓			
Punch Bowl 53	868	-26.312681	150.377656	Hutton	2023	✓			
UWIR MP ID 1047	1047	-27.4429	151.2887	Springbok	Timing to be determined by OGIA	✓			
UWIR MP ID 1048	1048	-27.4429	151.2887	WCM	Timing to be determined by OGIA	✓			
UWIR MP ID 1049	1049	-27.4429	151.2887	Condamine Alluvium	Timing to be determined by OGIA	✓			
UWIR MP ID 1050	1050	-27.4822	151.1834	Springbok	Timing to be determined by OGIA	✓			
UWIR MP ID 1051	1051	-27.4822	151.1834	WCM	Timing to be determined by OGIA	✓			
UWIR MP ID 1052	1052	-27.4822	151.1834	Springbok	Timing to be determined by OGIA	✓			
UWIR MP ID 1060	1060	-27.4340	151.2272	Condamine Alluvium	Timing to be determined by OGIA	✓			
UWIR MP ID 1061	1061	-27.4340	151.2272	Springbok	Timing to be determined by OGIA	✓			
UWIR MP ID 1062	1062	-27.4340	151.2272	WCM	Timing to be determined by OGIA	✓			
Wyalla-16	246, 248	-26.86619798	150.7550201	Condamine Alluvium	Complete	✓	✓ (248)	✓	✓
Wyalla-17	252, 624	-26.86632619	150.7549919	Precipice, Hutton	Complete	✓			✓ (252)
Wyalla-18	249, 250, 251	-26.8660577	150.7550667	WCM	Complete	✓		✓	

Notes:

(1) As noted in Revision 0 of the SGP Updated WMMP, the baseline monitoring assessment indicated Condamine Alluvium bores 42231370, Daandine-161 and Carn Brea-17 exhibited regular drawdown and recovery cycles of several metres because of nearby groundwater extraction for agricultural or other non-CSG uses. The magnitude of these groundwater fluctuations is such that these bores have limited use for early warning monitoring, and as such, have been excluded as early warning monitoring bores in the SGP Updated WMMP.

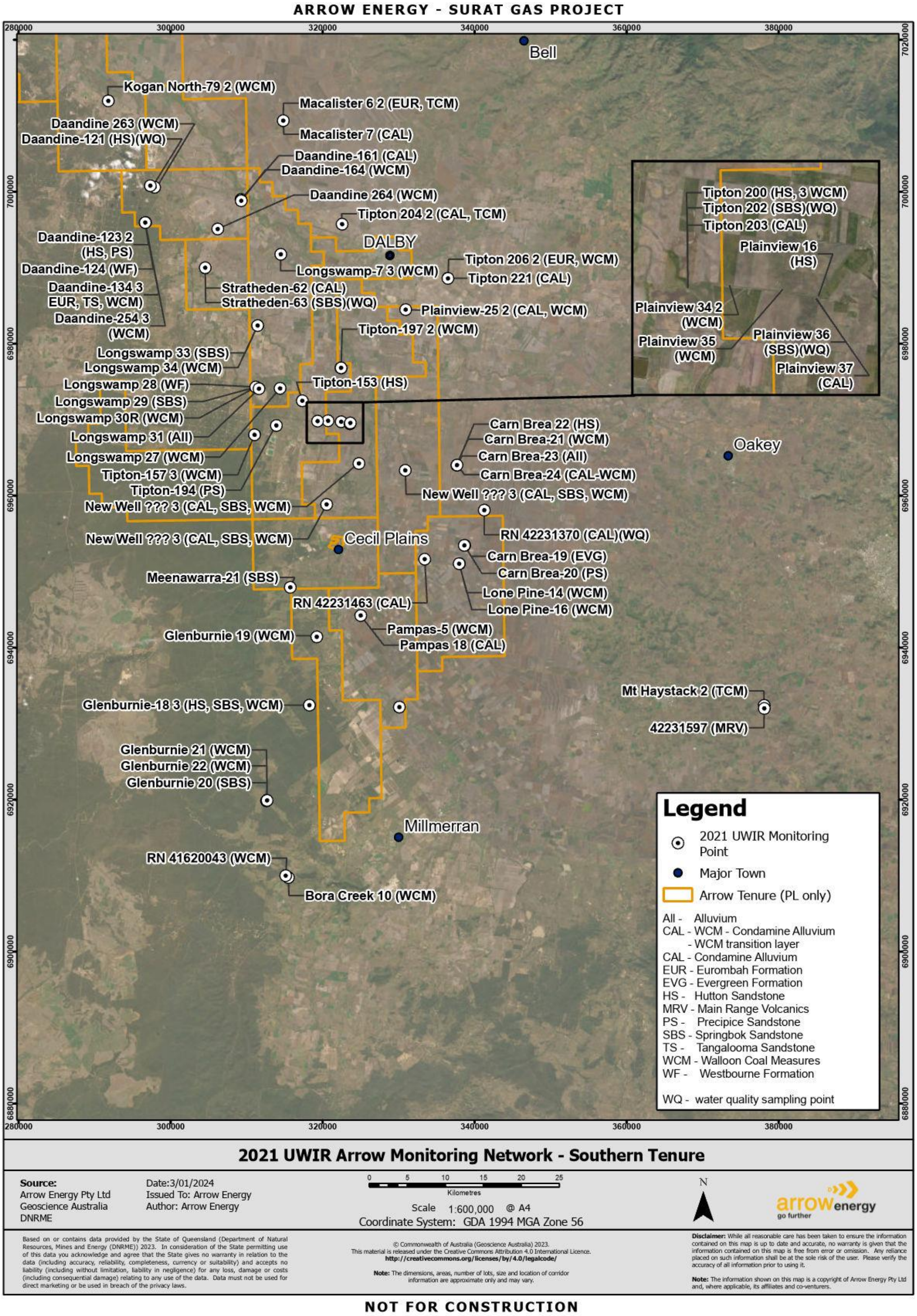

Figure 3-35: 2021 UWIR Arrow Monitoring Network – southern tenure

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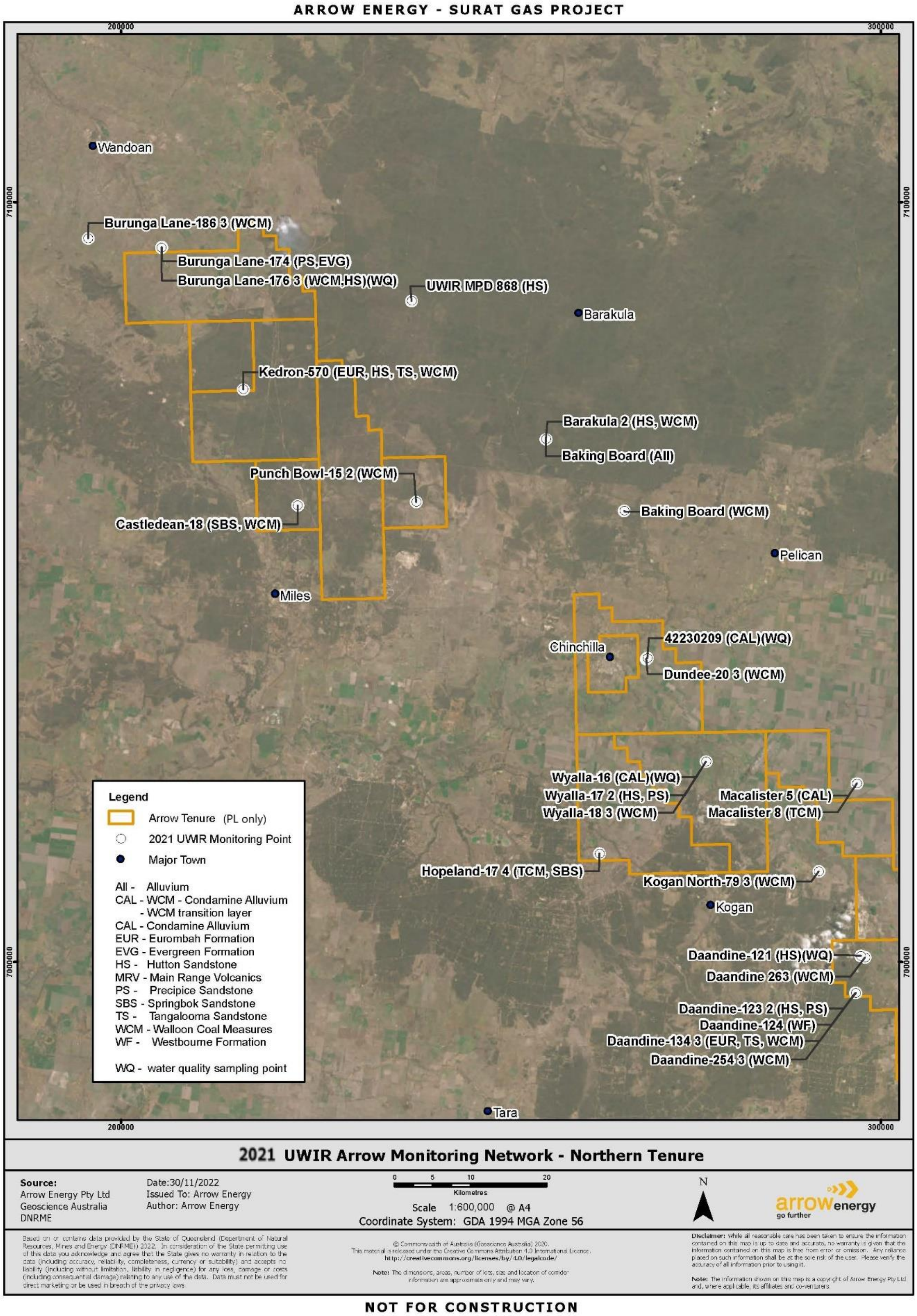

Figure 3-36: 2021 UWIR Arrow Monitoring Network – northern tenure

Table 7: 2021 UWIR groundwater sampling parameters and frequency for groundwater monitoring points

Suite	Type	Parameters to be measured as part of the suite	Frequency
Suite A	Field Parameters	Electrical Conductivity (µS/cm @ 25°C), pH, Redox Potential (Eh), Temperature (°C), Free gas at wellhead (CH_4)	Every six months until five samples obtained
	Laboratory analytes	Major cations and anions: Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Potassium (K^+), Sodium (Na^+), Bicarbonate (HCO_3^-), Carbonate (CO_3^-), Chloride (Cl^-), Sulphate (SO_4 2^-), Total Alkalinity	
		Metals (dissolved): Arsenic (As), Barium (Ba), Boron (B), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Strontium (Sr^{2+}), Zinc (Zn)	
		Fluoride (F^-), Total Dissolved Solids	
		Gas (dissolved): Methane (CH_4)	
Suite B	Laboratory analytes	Isotopes: Strontium (87Sr/86Sr)	Once only in: SBK, HUT, PCP
		Metals (dissolved): Strontium (Sr^{2+})	

4. Updated Impact Predictions

4.1 Groundwater drawdown extent

Following the approval of the Updated CSG WMMP on 22 November 2019, the 2019 UWIR for the Surat CMA was approved by the DES on 16 December 2019. On 17 March 2022, the 2021 UWIR for the Surat CMA was approved for release by the DES (this UWIR came into effect on 1 May 2022) and was the current UWIR at the time of writing this Report. The 2021 UWIR simulated an updated Arrow field development plan (FDP) compared to the 2019 UWIR.

Changes have occurred in the predicted groundwater drawdown extent across the different iterations of the UWIR regional groundwater model, resulting from the simulation of cumulative production from all operators FDP which have been revised over time.

At the time of reporting the 2021 UWIR model files had not yet been provided to Arrow in order to estimate the Arrow only predicted impacts. As such, a comparison of the 2019 UWIR long term cumulative predictive impacts to the UWIR 2021 long term cumulative predictive impacts has been undertaken in relation to Arrow's lease area.

The Springbok Sandstone 5m predicted drawdown extent is relatively the same as the 2019 UWIR (Figure 4-1), however there are some minor changes such as there being only one drawdown contour instead of the two in the 2019 UWIR. Similarly, the 2021 UWIR WCM 5 m predicted drawdown extent is relatively the same as the 2019 UWIR contours (Figure 4-2).

The Hutton Sandstone drawdown contour has decreased in the 2021 UWIR compared to the 2019 UWIR (Figure 4-3). The location of both predicted 5m drawdown contours are associated with the Horrane Fault; however, it should be noted that Arrow's investigation of the fault indicates that clay smearing in the fault zone limited hydraulic connectivity between the WCM and the Hutton

Sandstone (as per Section 4.4.5 of the 2021 UWIR). Nonetheless, the distribution of the 2021 UWIR Hutton Sandstone monitoring points is sufficiently spread across the predicted drawdown extent to detect any hydraulic connection.

The Precipice Sandstone drawdown contour has decreased in the 2021 UWIR compared to the 2019 UWIR (Figure 4-4). However, it is noted that the 2019 UWIR did not predict any Arrow-only drawdown greater than 5 m in the Precipice Sandstone.

The adequacy of the monitoring network to monitor Arrows predicted impacts is normally assessed based on the Arrow only predicted impact drawdown contours. However, based on the changes between the 2019 UWIR and 2021 UWIR cumulative predicted contours and that the monitoring network has not significantly changed since the last annual reporting, the monitoring network is considered adequate.

In regard to the Condamine Alluvium, section 6.5.2.5 of the 2021 UWIR notes the magnitude of impact is less than 0.3m for most of the area and the footprint of predicted impact is similar to that in the previous UWIR. The average net loss of water from the Condamine Alluvium to the WCM is predicted to be about 1,270 ML/year over the next 100 years. This is higher than predictions in the 2019 UWIR but comparable to predictions in the 2012 UWIR and 2016 UWIR.

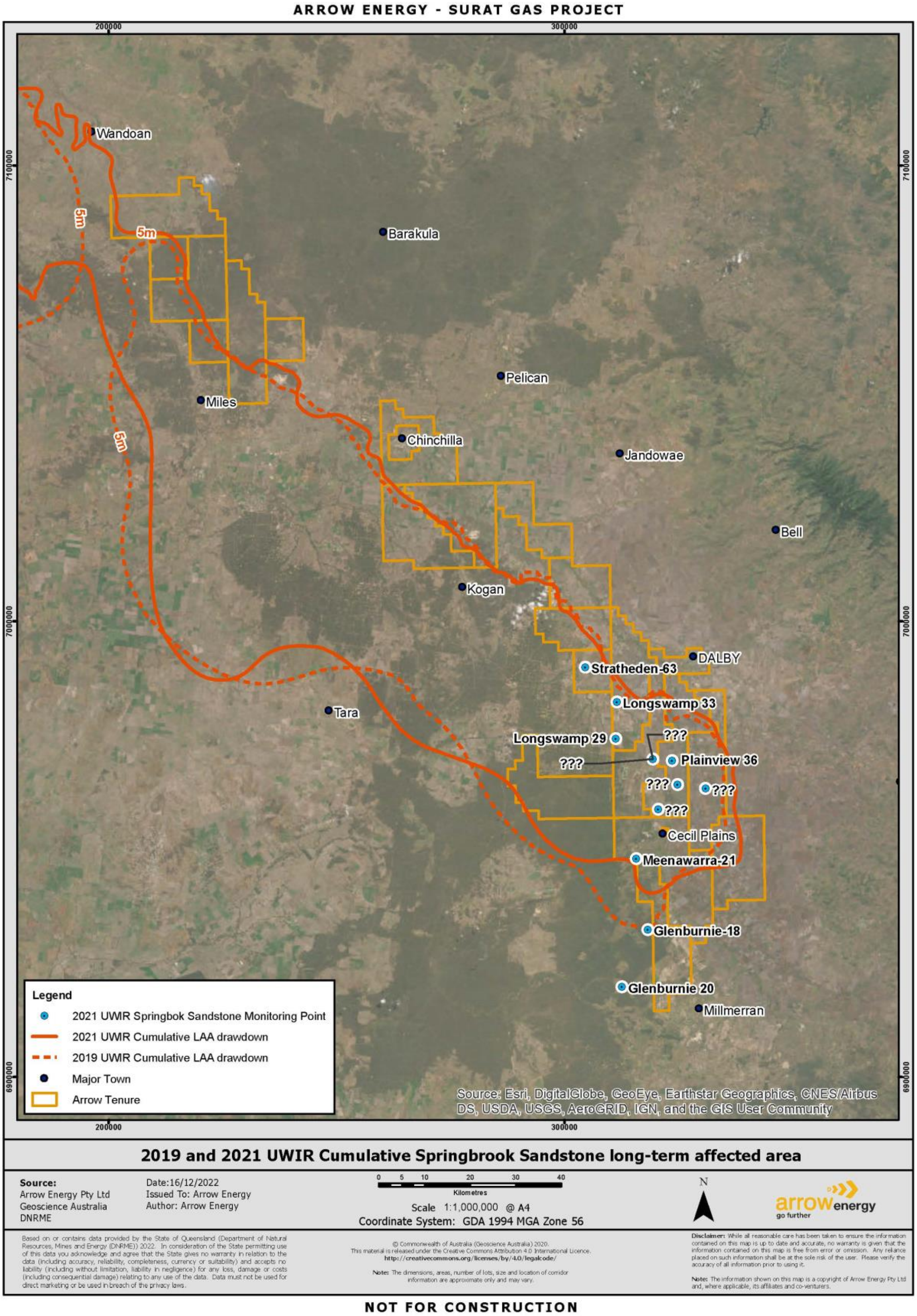

Figure 4-1: Updated CSG WMMP and 2019 and 2021 UWIR Combined Springbok Sandstone long-term affected area

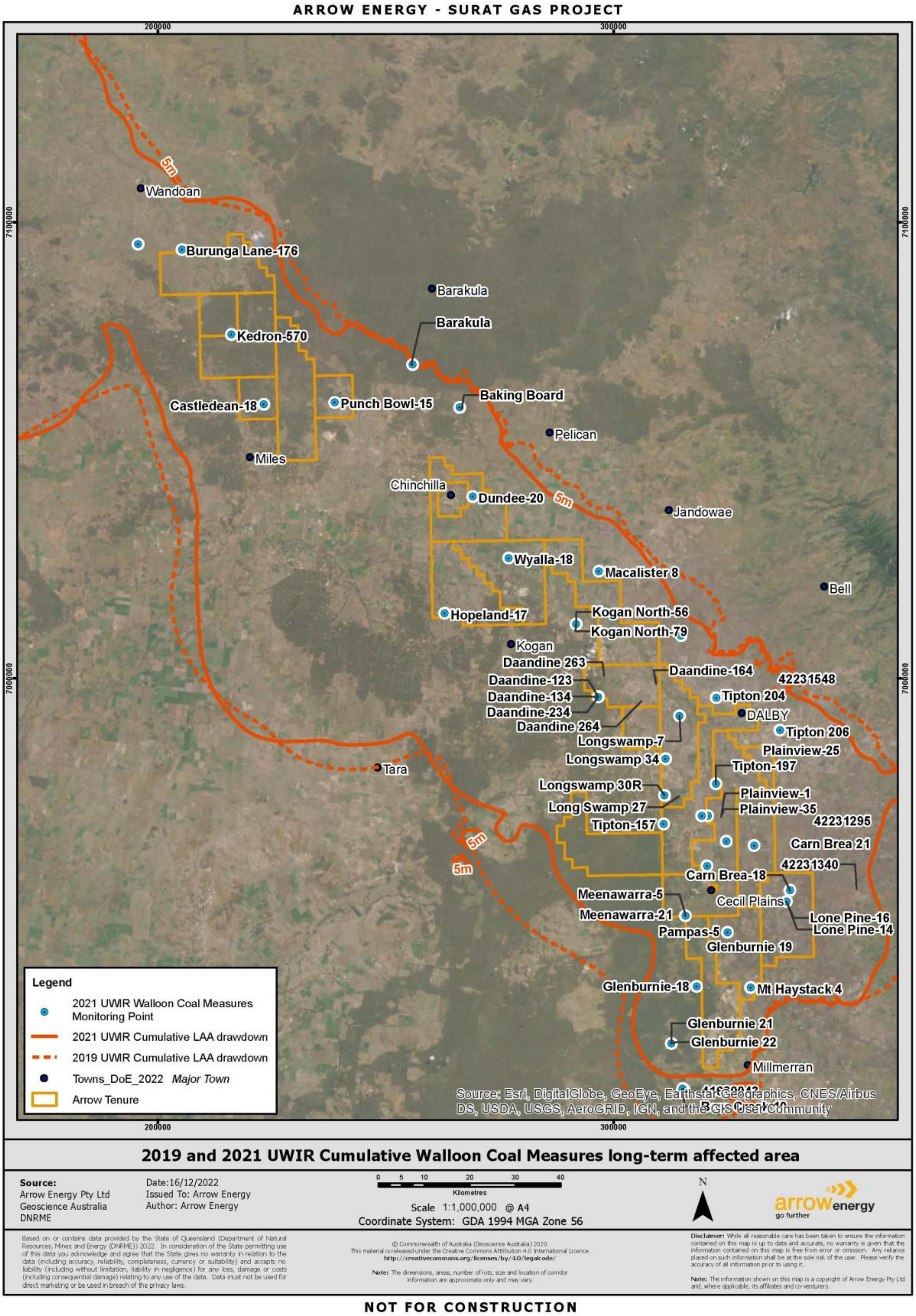

Figure 4-2: Updated CSG WMMP and 2019 and 2021 UWIR Combined WCM long-term affected area

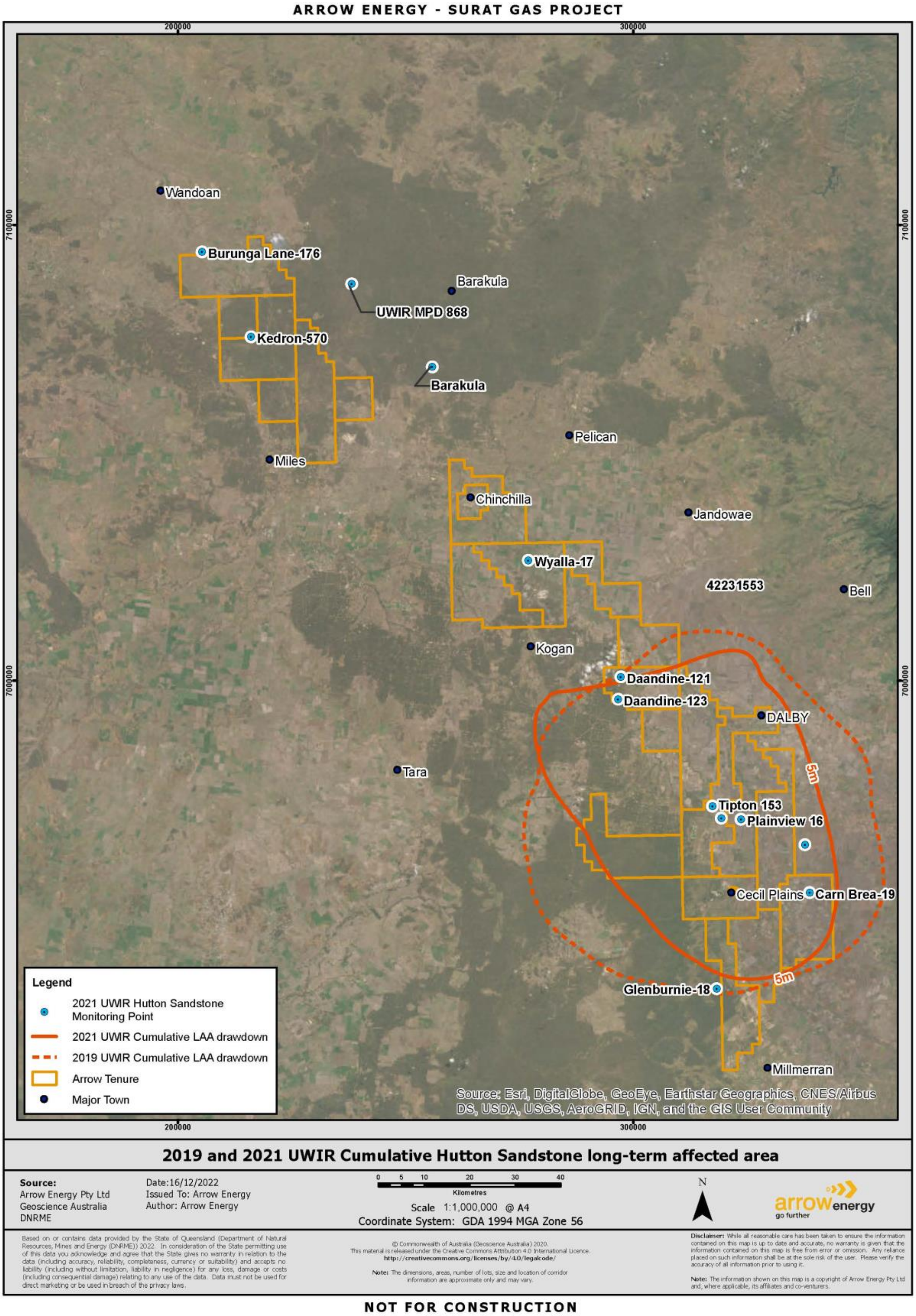

Figure 4-3: Updated CSG WMMP and 2019 and 2021 UWIR Combined Hutton Sandstone long-term affected area

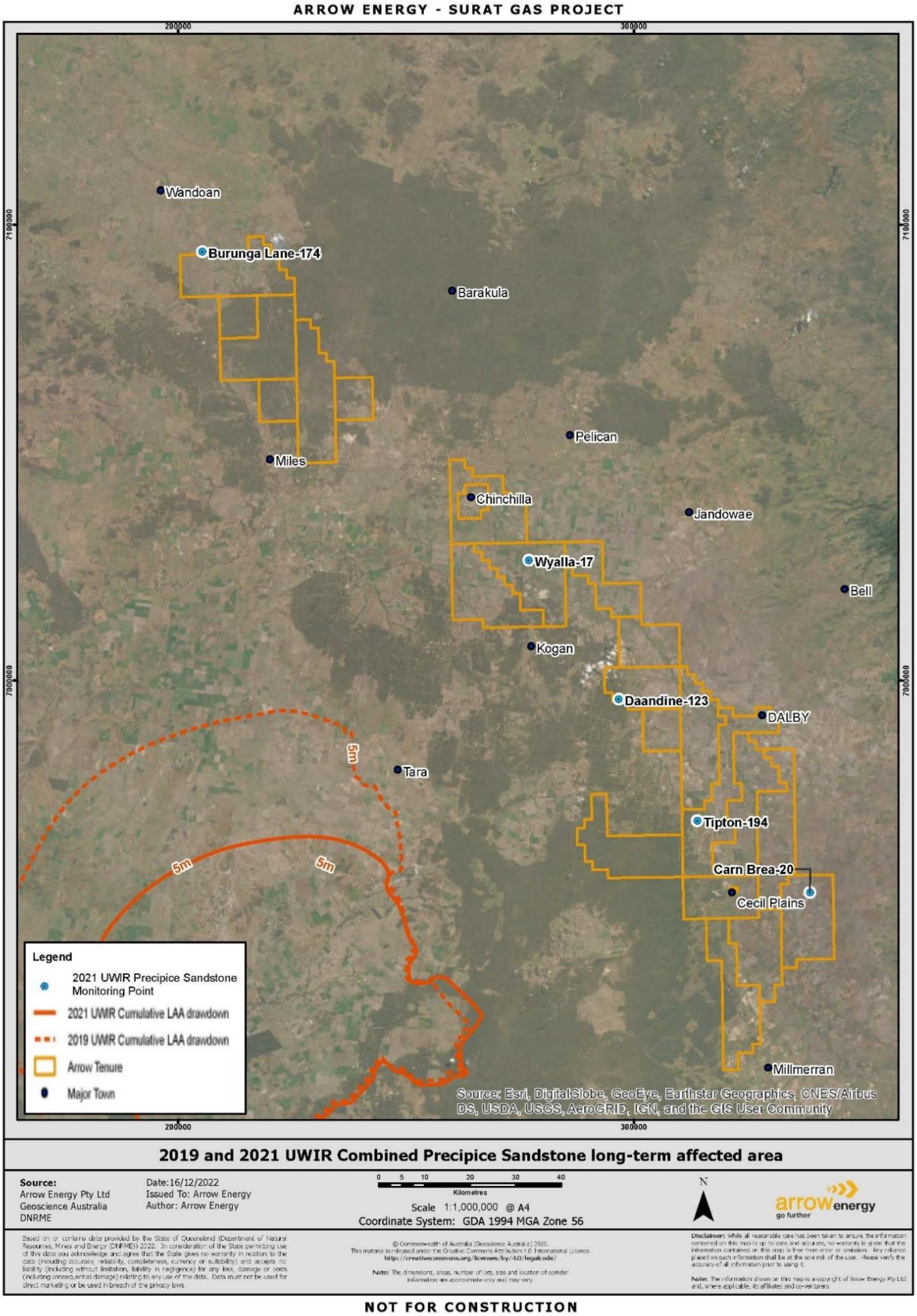

Figure 4-4: Updated CSG WMMP and 2019 and 2021 UWIR Combined Precipice Sandstone long-term affected area

5. WMMP Revision

In accordance with Section 8.6 of the SGP Updated WMMP, assessments are required to be undertaken upon the release of a new UWIR and after receiving technical files for that UWIR. These assessments are:

- revision of the Early Warning Monitoring System (EWMS);
- risk assessment of potential terrestrial groundwater dependent ecosystems (TGDE); and
- potential changes to stream connectivity.

The 2021 UWIR took effect on 1 May 2022. Technical files for the UWIR were partly received on 6 October 2022 related to the TGDE, and 10 May 2023 related to the EWMS. The desktop risk assessment of potential TGDEs has been completed on 21 December 2022 and review of the EWMS on 21 July 2023 (within 90 days of receiving the technical files as per the Updated WMMP).

The other assessment noted above (stream connectivity) is currently unable to be undertaken given their technical files have not yet been received. As noted in Section 4, there is minimal change to predicted drawdown between the 2019 and 2021 UWIR, therefore is unlikely that there would be significant change to the stream connectivity assessment.

An update on the EWMS and field assessment of potential TGDEs is provided in the following sections.

5.1 Early Warning Monitoring System (EWMS)

The EWMS has been updated following receipt of the technical files from OGIA. Revised EWMS values are presented in Table 8. The 2021 UWIR groundwater model was used to derive reduced EWMS levels for the Condamine Alluvium, Hutton Sandstone and Precipice Sandstone using the framework outlined in Section 7.5.2 of the SGP Updated WMMP. The EWMS levels for the Springbok Sandstone were not amended as the 2021 UWIR model predicts greater maximum cumulative drawdown in this formation, therefor maintaining the existing EWMS levels is a conservative approach for monitoring potential impacts of CSG related impacts.

Table 8: Revised Early Warning Monitoring System (EWMS)

Aquifer	Early Warning Indicator (EWI) (Commencing Jan 2022 to Dec 2024)	Trigger threshold (Commencing Jan 2022 to Dec 2024)	Limit
Condamine Alluvium	3.73m	5.59m	7.46m
Springbok Sandstone	31.2m	54.1m	77m
Hutton Sandstone	32.16m	48.23m	64.31m
Precipice Sandstone	3.11m	4.66m	6.21m

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The reasons for this variance between the original and revised EWMS levels are predominantly due to model structure and parameter changes between the 2012 UWIR (the 2012 model was used in the SGP Updated WMMP because this model included uncertainty analysis from 200 realisations), the 2019 UWIR and the 2021 UWIR groundwater models, as well as changes in the development profile of CSG operations. An overview of these changes are provided in Section 6.4 of the 2021 UWIR.

Even with these reduced EWMS levels, there were no exceedances of early warning indicators, trigger thresholds or limits during the reporting period.

5.2 Field assessment of potential TGDEs

Section 5.2 of the WMMP Annual Report for the 2020-21 period outlined the results of the TGDE desktop assessment completed based on the 2019 UWIR. The assessment identified two sites (Juandah Creek and Wilkie Creek) which required field assessments to confirm they are TGDEs to be completed by 30 June 2022 and a summary report/s prepared within 90 days thereafter. This summary report is provided in Appendix D with key information provided here.

Ecological and hydrogeological field surveys of Juandah Creek and Wilkie Creek were completed on 13 October 2021 and 15 October 2021 respectively.

Juandah Creek

The assessment of the Juandah Creek site identified that Quaternary alluvial deposits of primarily sand with some clay extend along the Juandah Creek potential TGDE area. Juandah creek traverses and shallowly incises the regionally south-westerly dipping Great Artesian Basin (GAB) sequence, including the WCM at the far northern end of the area, Springbok Sandstone in the central to northern section of the area and Westbourne Formation at the southernmost end of the area.

Most lines of evidence supported that the deeper-rooted trees assessed were utilising relatively fresh and isotopically enriched groundwater from the basal alluvium, likely recharged primarily from rainfall directly infiltrating the alluvium in addition to surface water run off / stream flow. One of the three conceptual models developed as part of the assessment identified the potential for vertical upward leakage, namely:

- Dry season with vertical upward leakage: where upward leakage of bedrock aquifers is occurring into the base of the alluvium in the dry season, which is acting to support floodplain vegetation where other sources of moisture have been depleted. The capacity of this leakage to stimulate vegetation growth and vigour is dependent to a degree on the groundwater salinity of the leaking aquifers. It is not possible to predict the extent to which this is occurring without more detailed assessment during a drier climatic period. It is however conceptualised to be restricted to discrete areas and pockets where the function is supported by underlying geology, rather than occurring more extensively across the landscape.

The conceptual model will be subjected to further testing through additional assessment during a prolonged dry period to address abovementioned critical research gaps and subsequent refinement of the eco-hydrogeological conceptual model. Attempts were made to visit reaches of Juandah Creek in the dry season of 2023 to collect additional data for testing the conceptual model, however, land access was not granted.

While the collected data indicate that the site is not a TGDE reliant on the regional aquifer hosted within the GAB, an EWMS (Early Warning Management System) has been developed for the site as per the required timelines in the updated WMMP which dated back to 29 December 2022. EWMS trigger levels were plotted along with EWMS monitoring bores hydrographs (refer to Appendix A), illustrating that EWMS monitoring bores groundwater levels are higher than EWMS trigger levels confirming that the risk to TGDE is low.

Wilkie Creek

Prior to commencement of significant identified hydrological and hydrogeological alteration which commenced in 1990, it is considered likely that vegetation within portions of the identified reach of Wilkie Creek and an extension downstream to the north was dependant, at least seasonally, on groundwater. This is consistent with the classification of river red gum as a facultative phreatophyte.

However severe degradation of the ecosystem including widespread mature tree dieback, likely due to exposure to shallow saline groundwater, has resulted in ecosystem collapse. In the current hydrogeological regime, no trees within the affected reach were identified as being groundwater reliant. Elevated groundwater salinity is considered the major factor contributing to the poor ecological health of the reach of Wilkie Creek that is subject to this assessment. The riparian vegetation is still relatively intact immediately north of Dalby-Kogan Road where the preferential source of water appeared to be shallow soil moisture at the time of assessment.

The conceptual model identifies numerous potential stressors to the riparian ecosystem on Wilkie Creek which appear to have commenced from 1990 and are likely a result of activities other than Arrow's operations.. Further investigations will be conducted to address the impact of potential stressors to the riparian ecosystem of Wilkie Creek and subsequently refine the eco-hydrogeological conceptual model. Similar to Juandah Creek, attempts were made to visit reaches of Wilkie Creek in the dry season of 2023 to collect additional data for testing the conceptual model, however, land access was not granted. Arrow will continue efforts to visit both of the abovementioned creeks.

5.3 Potential terrestrial groundwater dependent ecosystems

The 2019 UWIR included an assessment of terrestrial groundwater dependent ecosystems (GDE) which was further revised in OGIA's 2019 UWIR Approval Condition 3 Response (OGIA, 2020) released on 16 December 2020. This document was submitted to the DES by OGIA as part of the conditions of approval of the 2019 UWIR[1]. The document is available from OGIA upon request. The 2021 UWIR also included an assessment of terrestrial GDEs which required a follow up desktop assessment to be conducted by Arrow. The associated technical data were provided to Arrow on 6 October 2022 in response

[1] The Chief Executive of the Department of Environment and Science approved the 2019 Surat CMA UWIR on 16 December 2019 with conditions including Condition 3 which required submission of an environmental values assessment with the first annual review that updates the assessment of impacts presented in the approved UWIR on the following environment values: a. terrestrial groundwater dependent ecosystems; b. changes in water quality of each aquifer; and c. irrigation land.

to Arrow's request in June 2022 following the SGP commencement on 22 October 2020 and the 2021 UWIR taking effect on 1 May 2022.

Arrow was obliged to revise the terrestrial GDE risk assessment in accordance with Section 8.6 of the SGP Updated WMMP. Arrow completed the revised desktop risk assessment on 21 December 2022 (within 90 days from 6 October 2022) i.e. within 90 days of a new approved UWIR being issued (and upon receiving technical files from OGIA). Arrow's revised risk assessment is provided in Appendix D.

The risk assessment identified eight potential terrestrial GDEs predicted to be at risk of being impacted from the Action or the cumulative CSG operation. A summary of the desktop risk assessment is provided below, with further detail provided in Appendix D. As a result, further work is required to be undertaken to gather supporting data to confirm the ecosystems' reliance on groundwater and validate the findings of the desktop assessment. The risk assessment for terrestrial GDEs was included as a revision to the Updated WMMP in the form of an addendum, which was submitted to DCCEEW on 15 March 2023. The proposed approach was confirmed by DCCEEW on 5 April 2023 to be in accordance with commitments in Section 5.4.3 of the active Update CSG WMMP. Arrow is conducting the further work in compliance with the addendum.

Risk assessment

OGIA's terrestrial GDE desktop assessment method (OGIA, 2020), detailed in the document Attachment 1 Condition 3 Response, integrates:

- GIS mapping of potential terrestrial GDEs
- areas of predicted drawdown in the 2019 UWIR groundwater model within outcropping aquifers
- regional ecosystem (RE) mapping
- biodiversity status.

Twelve potential terrestrial GDE areas were identified by OGIA on Arrow tenure as potentially at risk of impact. Arrow assessed these twelve sites against available data such as depth to groundwater, landscape setting, field survey vegetation mapping, and previous assessments conducted in the Stage 1 CSG WMMP and Revision 0 of the Updated CSG WMMP (Appendix D – Stream Connectivity and GDE Impact Assessment memo). Arrow's review identified that eight of the twelve areas are considered to be at risk of impact or likely to represent a terrestrial GDE.

OGIA (2020) note that the priority knowledge gaps for further investigation of medium or high-risk sites are:

- validation and confirmation of the GDE mapping and associated REs
- conceptualisation of the identified terrestrial GDEs in terms of:
    - quantification of their ecological water requirements – the temporal nature, quantity and quality of groundwater use
    - their likely ecological response to changes in groundwater regime.

6. Compliance with the WMMP

The approved SGP Updated WMMP was developed based on an adaptive management framework which meets the water-related approval conditions. Compliance, therefore, with the SGP Updated WMMP demonstrates compliance with the approval conditions.

Throughout the reporting period, Arrow maintained compliance with the WMMP with the exception of twelve bores which had periods with no groundwater level/pressure monitoring (Section 3.1). Compliance with the WMMP is demonstrated through:

- publication of the approved Updated CSG WMMP on Arrow's website
- publication of this annual report on Arrow's website within three months of the anniversary of the start of the SGP
- providing raw data to OGIA as required in Section 9.13 of the 2021 UWIR for potential inclusion (at the discretion of Department of Regional Development, Manufacturing and Water [DRDMW]) on the Queensland Globe database
- met performance measure criteria for assessment of the protection of matters of national environmental significance (MNES), namely:
  - adequacy of the groundwater monitoring network was reviewed according to the predicted drawdown from a new OGIA model (2021 UWIR) (Section 4.1)
  - the desktop terrestrial GDE risk assessment was reviewed following the release of a new UWIR (2021 UWIR) (Section 5.3)
  - monitoring obligations (groundwater and subsidence) were carried out in accordance with the 2021 UWIR with the exception of Plainview 16, Tipton-197, Carn Brea-18, Carn Brea-19, Carn Brea-20, Plainview 34, Castledean-18, Daandine-164, Tipton 196A, Tipton 200, Tipton-194 and Kedron-570 which had periods with no groundwater level/pressure monitoring (Section 3.1)
- the EWMS was implemented noting that there were no exceedances of early warning indicators, trigger thresholds or limits during the reporting period.

In addition to the above, Arrow's compliance with all EPBC Approval 2010/5344 conditions is documented in the report Surat – EPBC Approval 2010/5344 Annual Compliance Report 2022/2023 (S00-ARW-ENV-REP-00064) available on Arrow's website.

7. Document Administration

This document has been created using ORG-ARW-IMT-TEM-00005 v4.0

Revision history

Revision	Revision Date	Revision Summary	Author
1	19/01/2024	Issued for Use	Yousef Beiraghdar

Related documents

Document Number	Document title

Acceptance and release

Author

Position	Incumbent	Release Date
Team Lead Hydrogeology	Yousef Beiraghdar	19/01/2024

Stakeholders and reviewers

Position	Incumbent	Review Date
Team Lead Subsidence	Kane Eskola	19/01/2024
Senior Hydrogeologist	Andrew Wilson	19/01/2024
Groundwater Manager	Stephen Denner	19/01/2024

Approver(s)

Position	Incumbent	Approval Date
Groundwater Manager	Stephen Denner	19/01/2024

8. References

Aghighi, H, Schöning, G, Cui, T, Pandey, S, (2023). *Exploring the contribution of coal shrinkage to coal seam gas induced subsidence: a research update paper by the Office of Groundwater Impact Assessment (OGIA)*, Department of Regional Development, Manufacturing and Water, Queensland Government, April 2023.

Department of Natural Resources, Mines and Energy, 2017. *Identification of Gaining Streams in the Surat Cumulative Management Area, Hydrogeology Investigation Report*, March 2017, Office of Groundwater Impact Assessment

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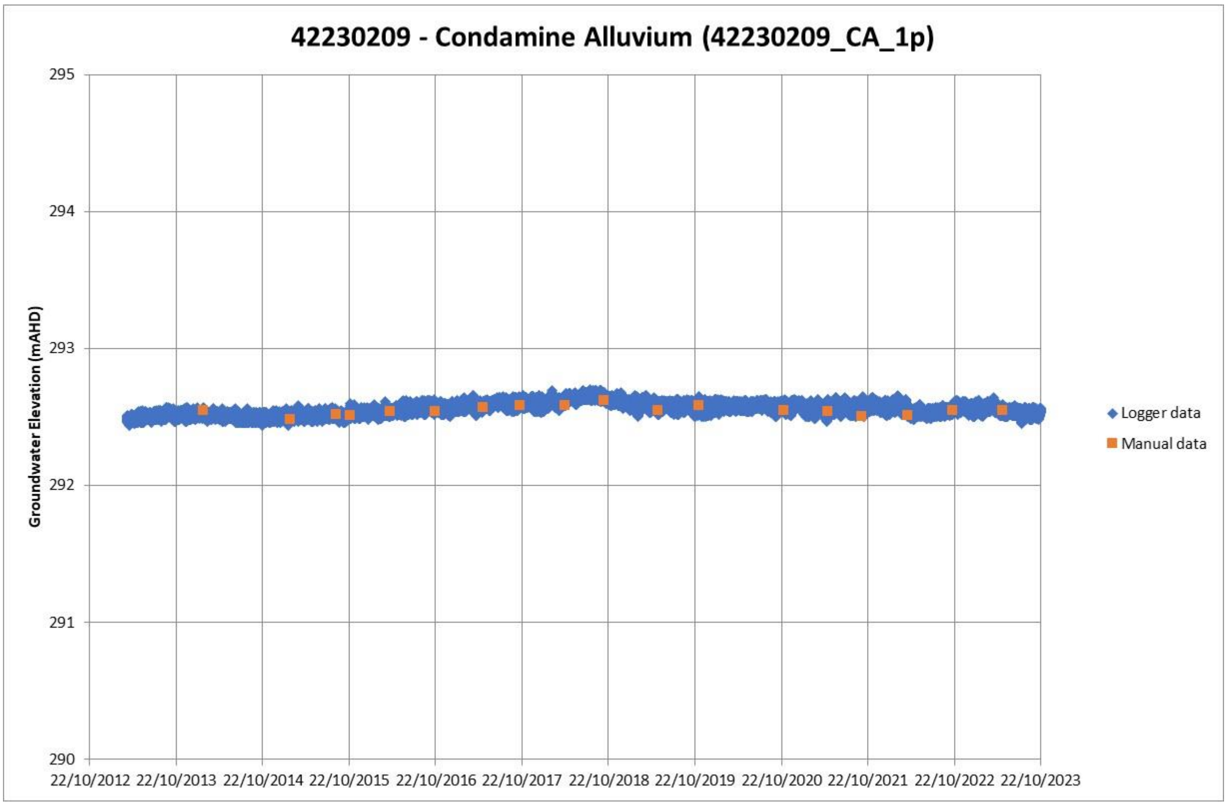
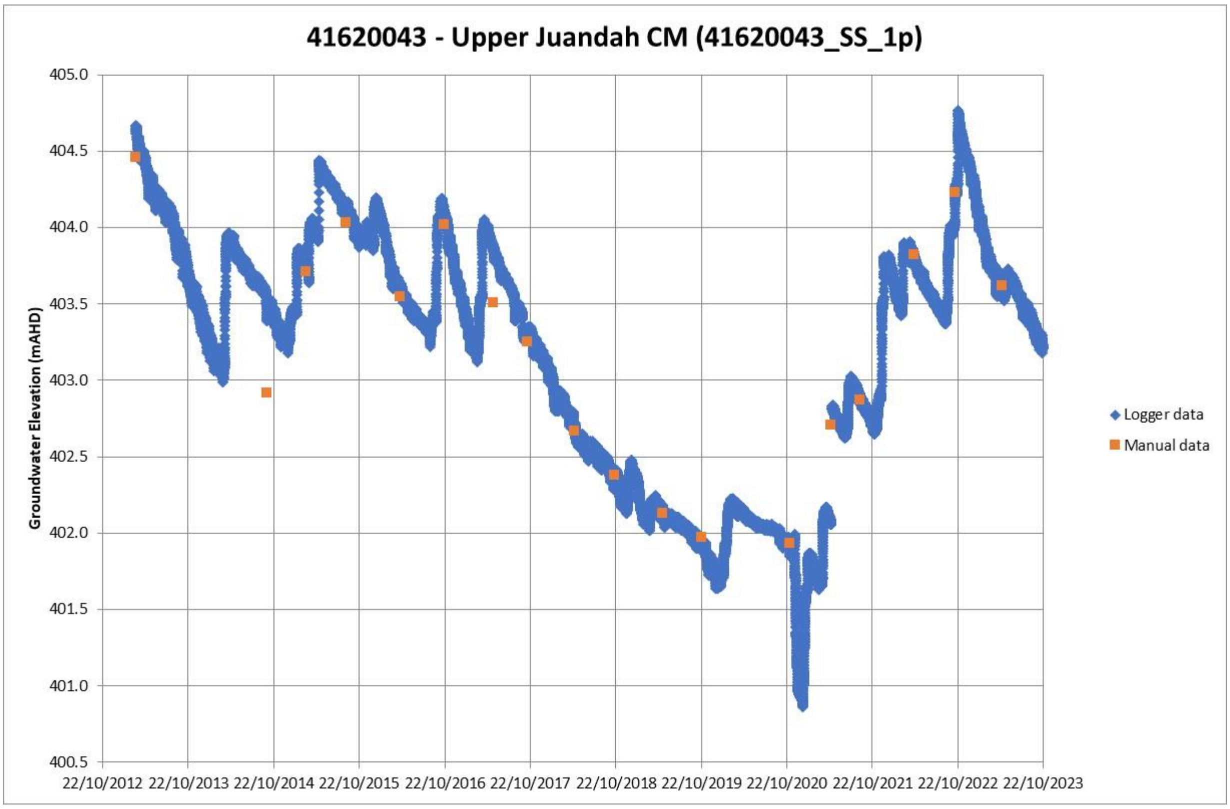
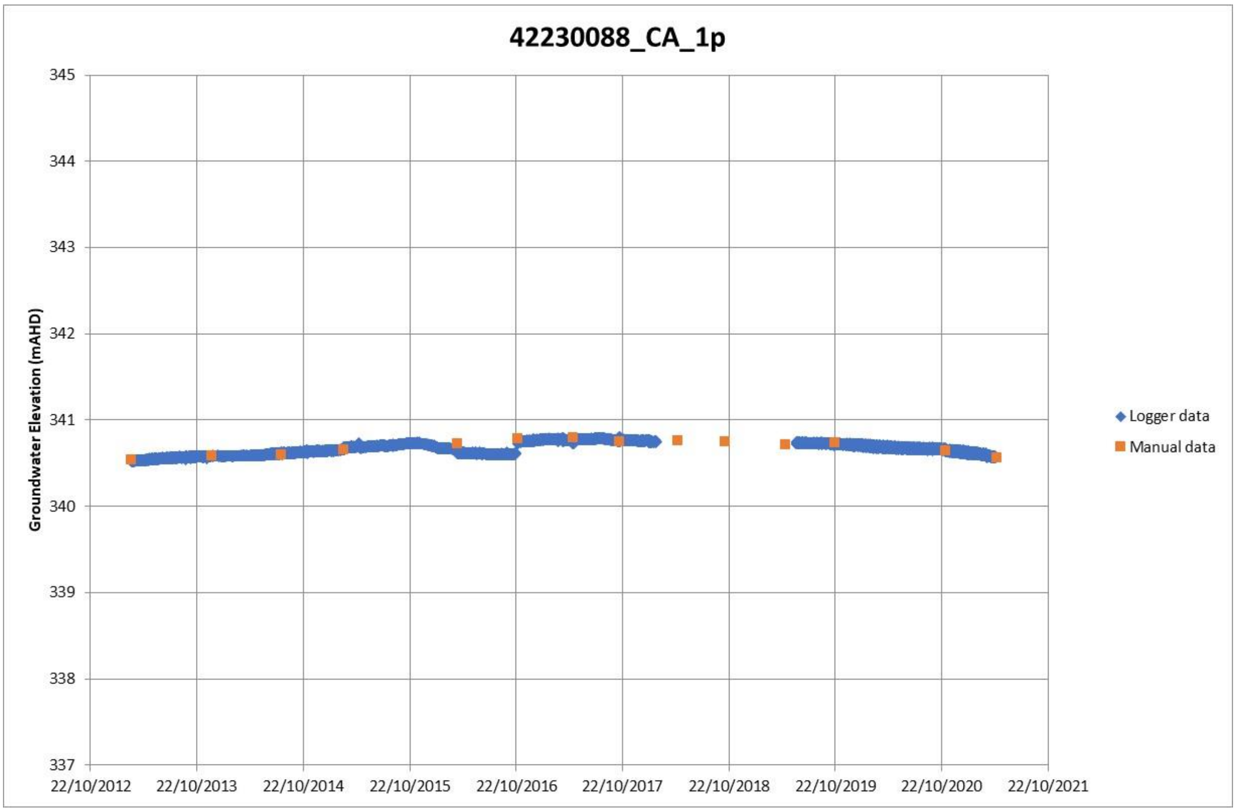
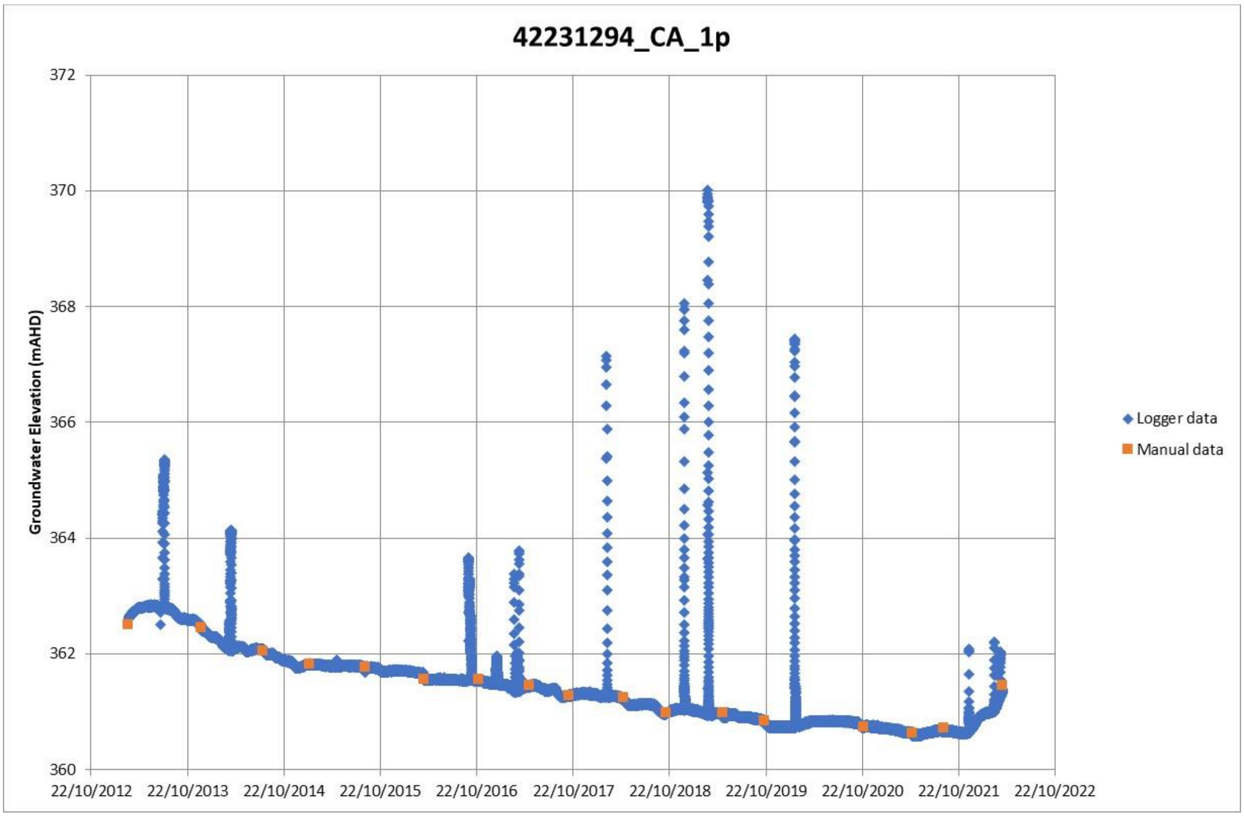
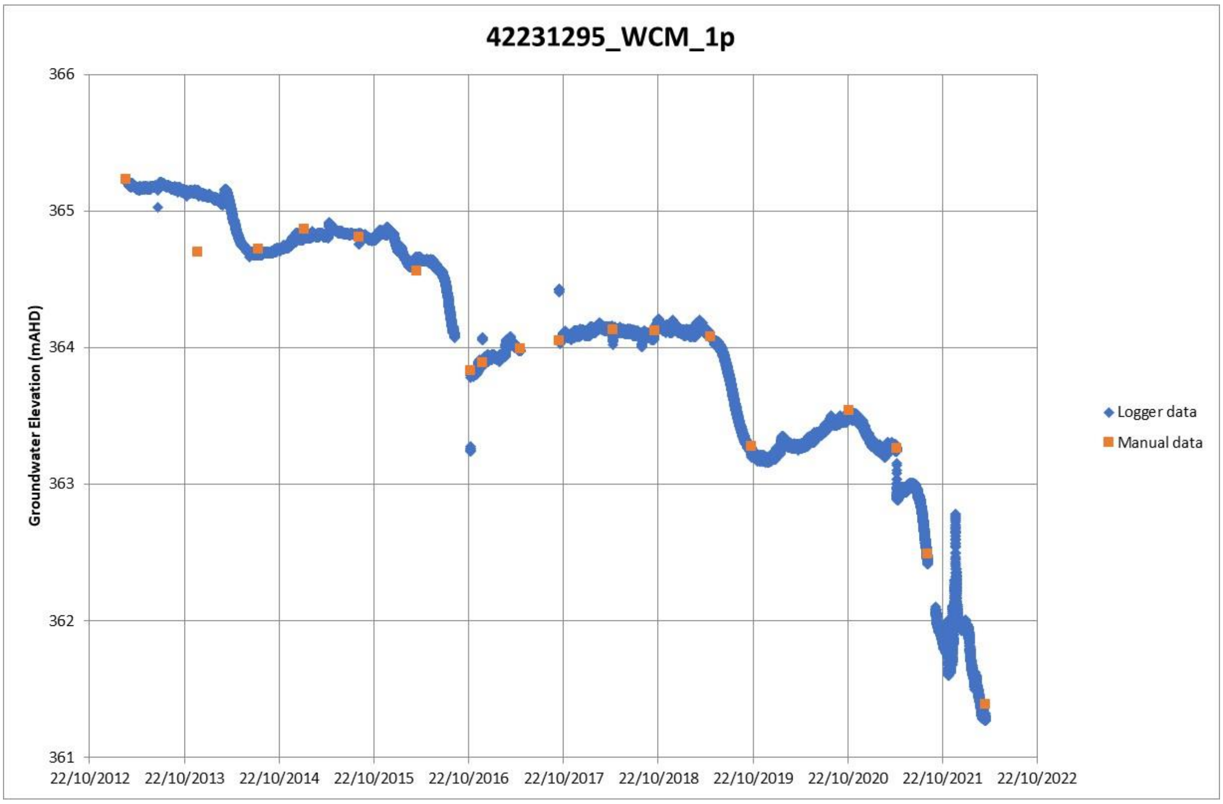
Appendix A – Groundwater Level Monitoring Bores Hydrographs

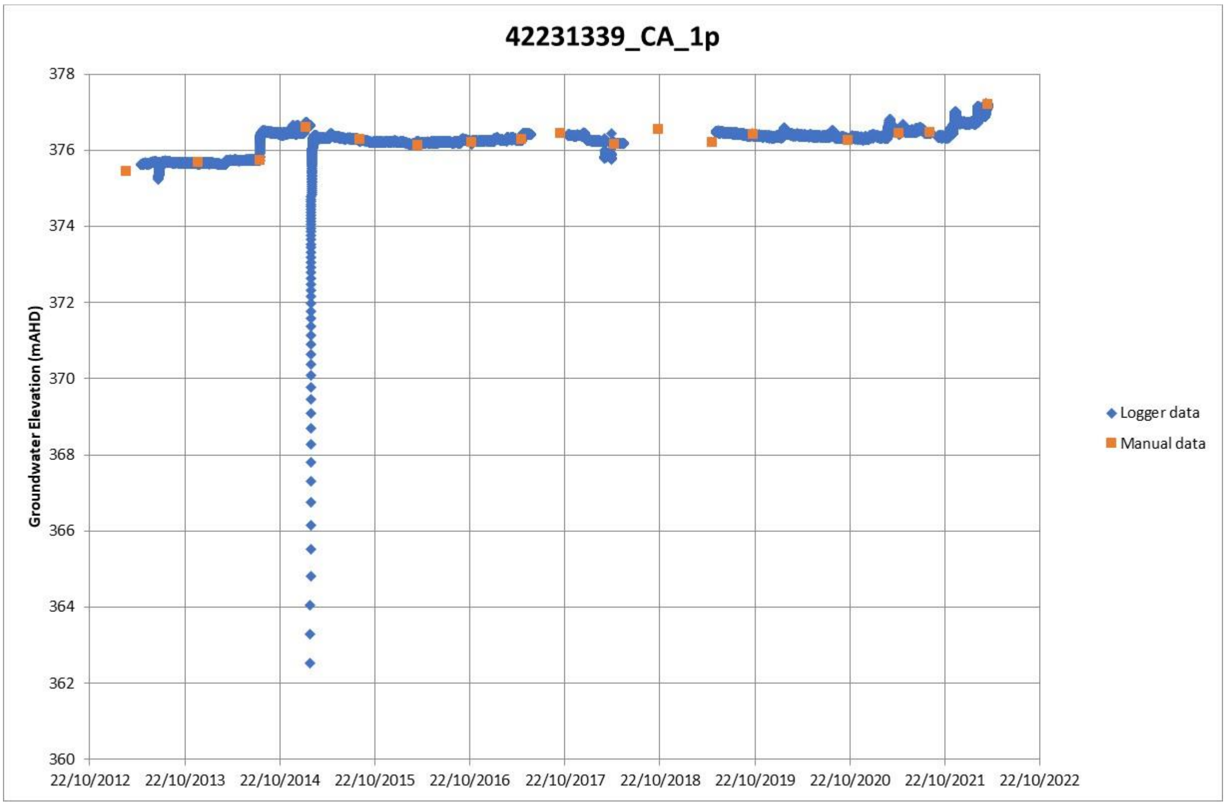

42230209 - Condamine Alluvium (42230209_CA_1p)
Groundwater Elevation (mAHD)
295
294
293
292
291
290
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

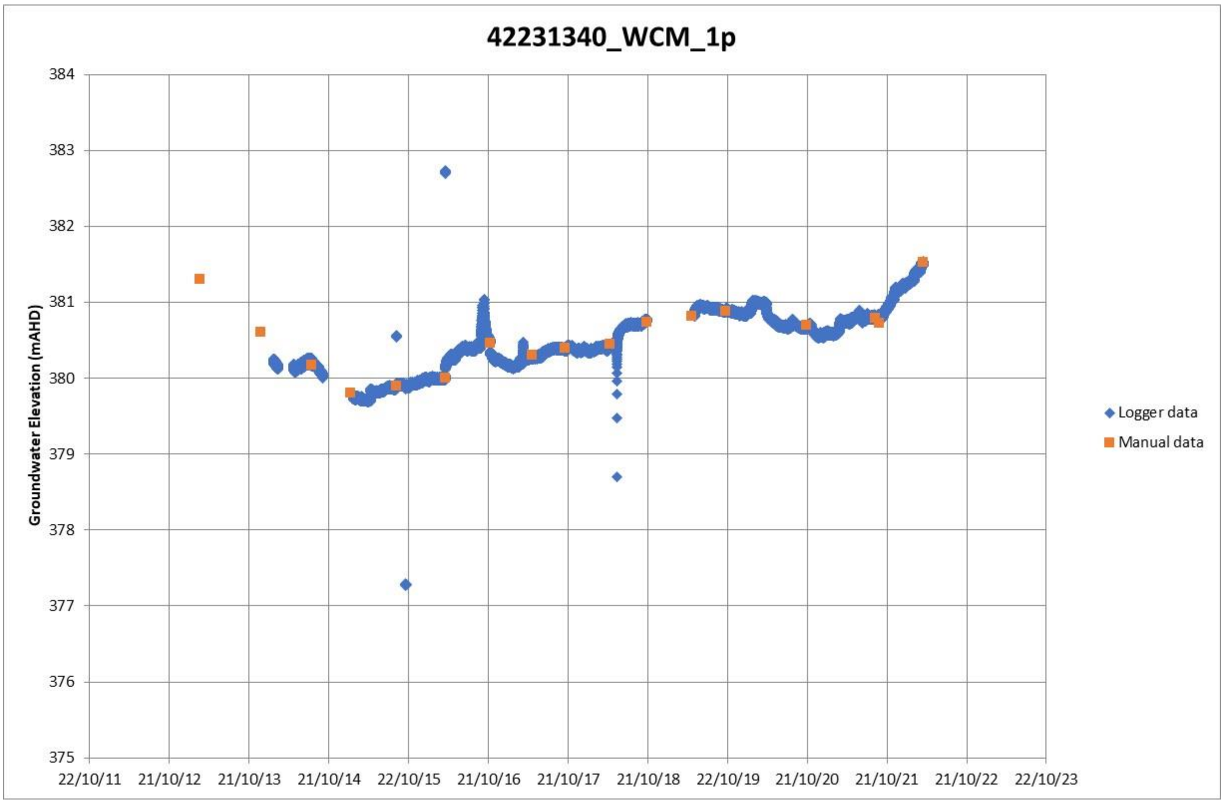

41620043 - Upper Juandah CM (41620043_SS_1p)
Groundwater Elevation (mAHD)
405.0
404.5
404.0
403.5
403.0
402.5
402.0
401.5
401.0
400.5
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

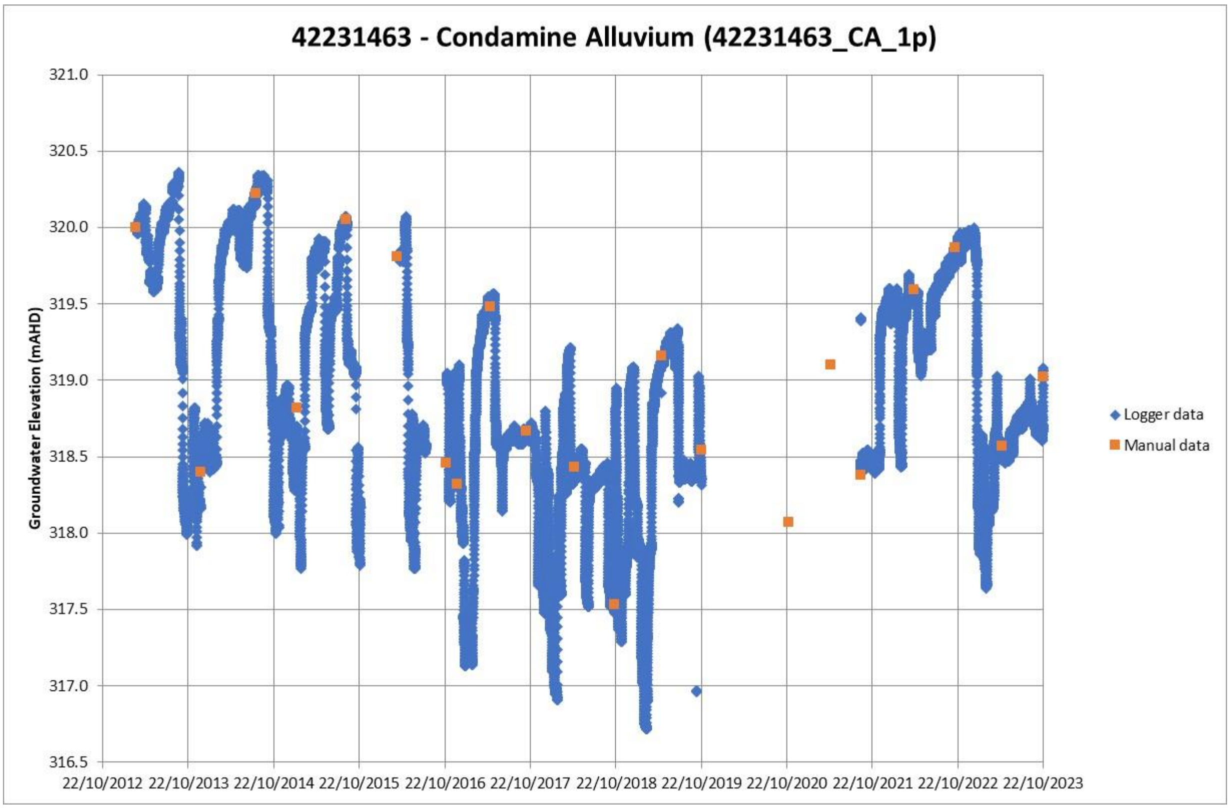

42230088_CA_1p
Groundwater Elevation (mAHD)
345
344
343
342
341
340
339
338
337
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
Logger data
Manual data

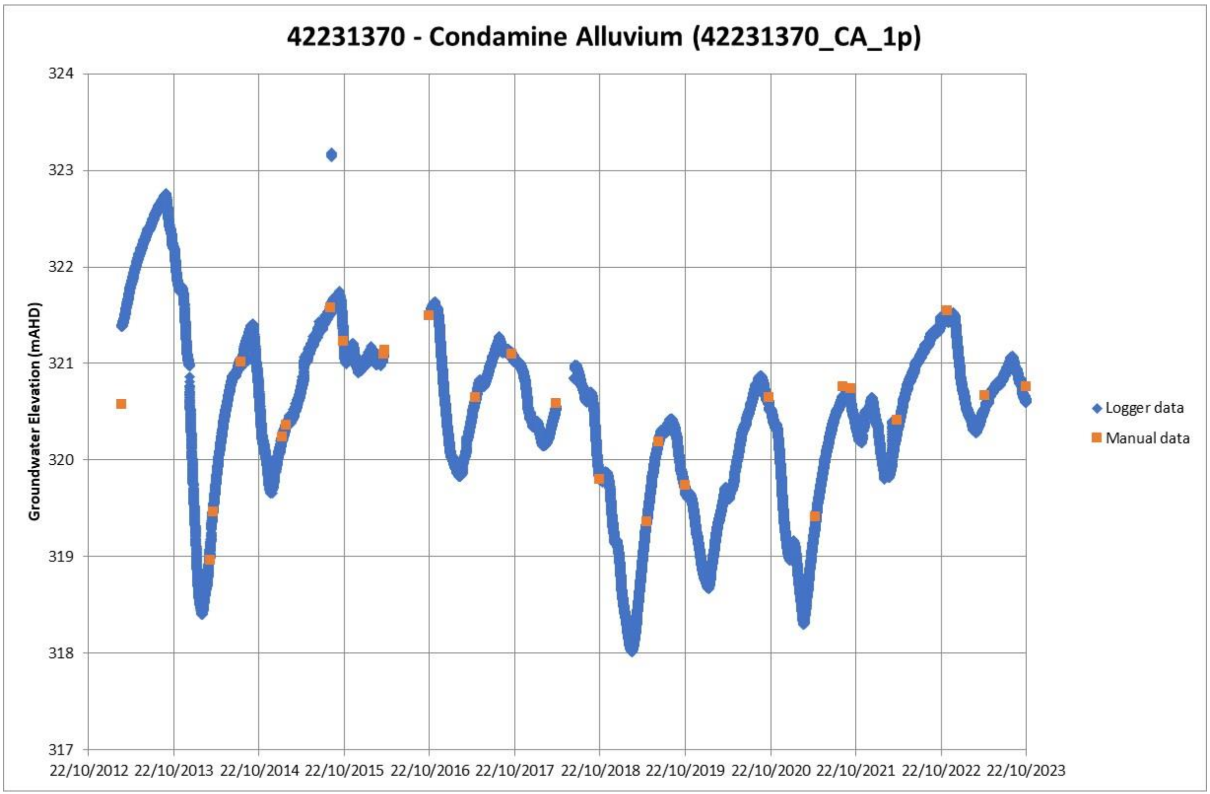

42231294_CA_1p
Groundwater Elevation (mAHD)
372
370
368
366
364
362
360
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
Logger data
Manual data

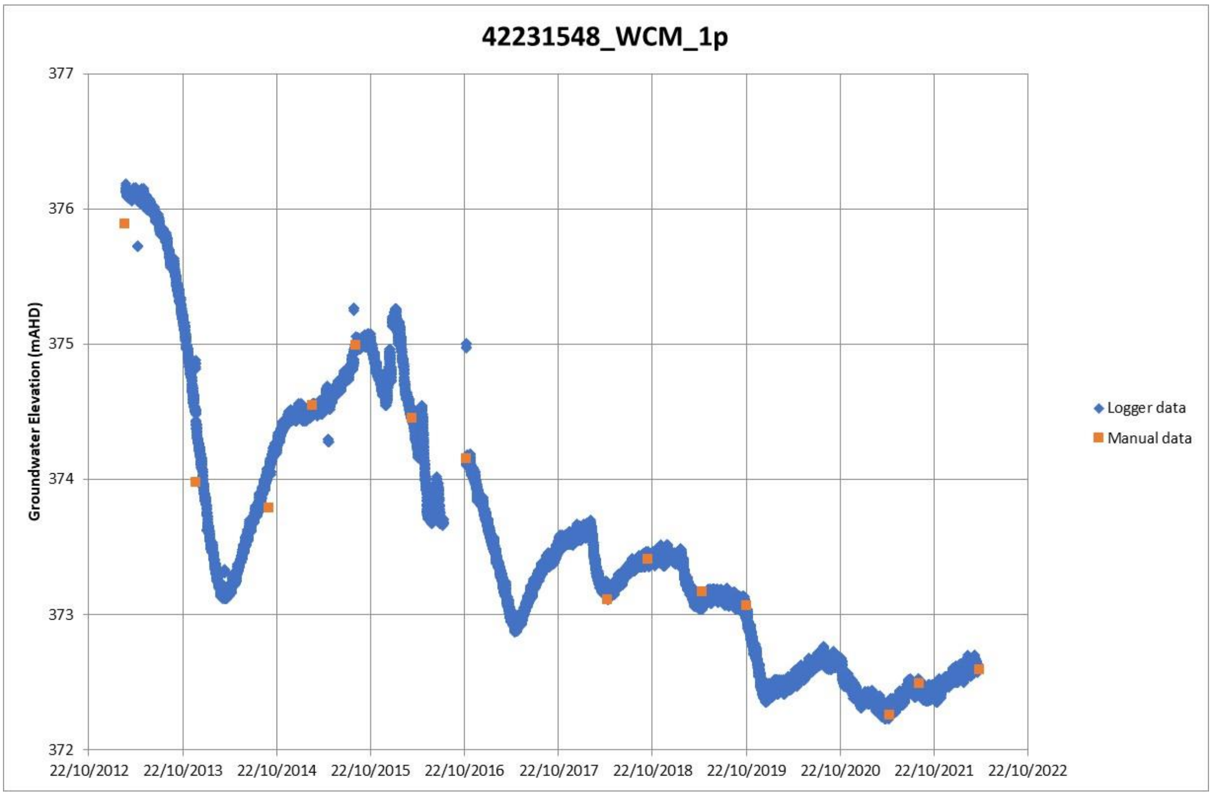

42231295_WCM_1p
Groundwater Elevation (mAHD)
366
365
364
363
362
361
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
Logger data
Manual data

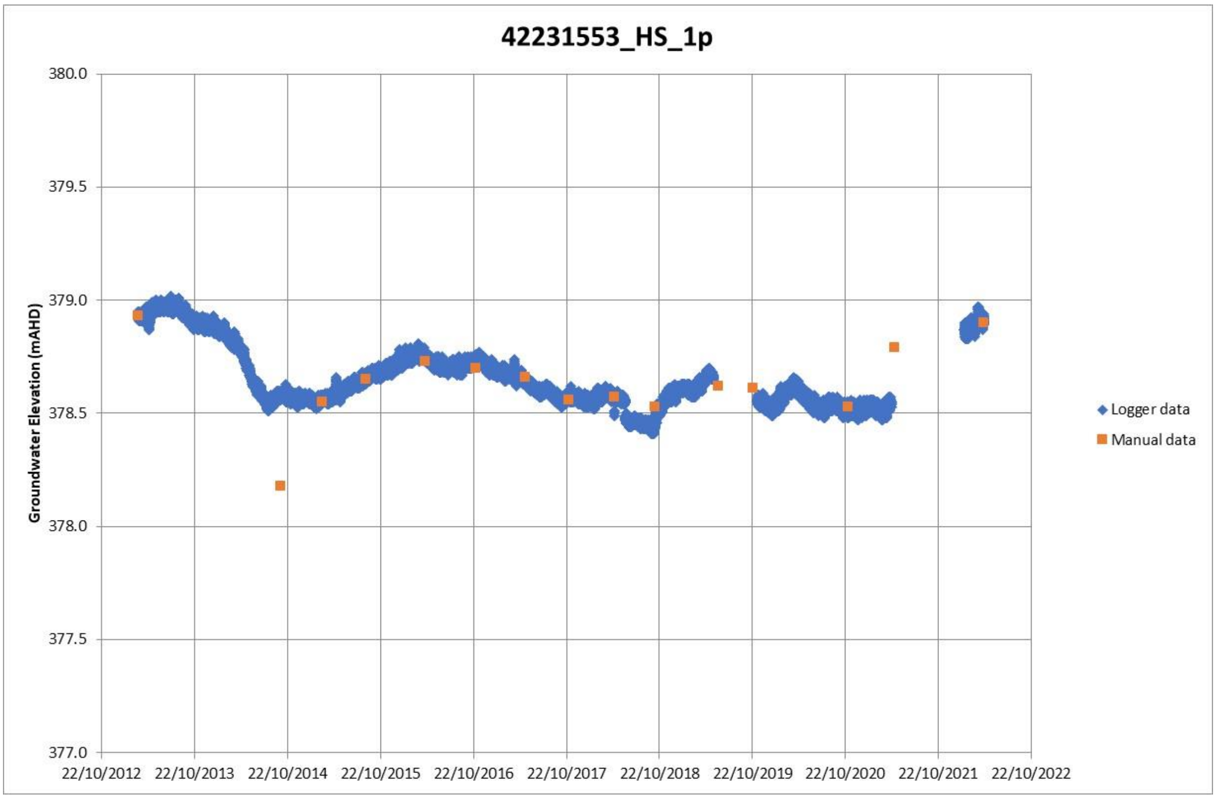

42231339_CA_1p
Groundwater Elevation (mAHD)
378
376
374
372
370
368
366
364
362
360
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
Logger data
Manual data

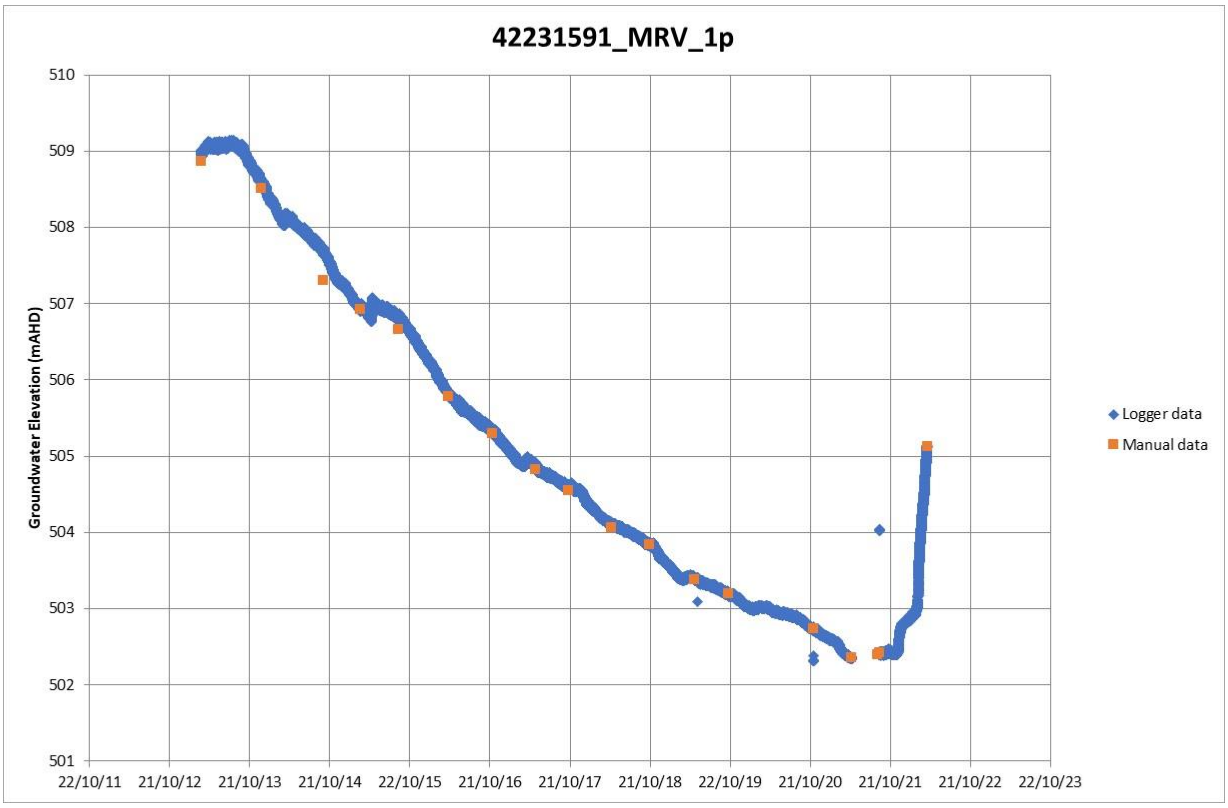

42231340_WCM_1p
Groundwater Elevation (mAHD)
384
383
382
381
380
379
378
377
376
375
22/10/11
21/10/12
21/10/13
21/10/14
22/10/15
21/10/16
21/10/17
21/10/18
22/10/19
21/10/20
21/10/21
21/10/22
22/10/23
Logger data
Manual data

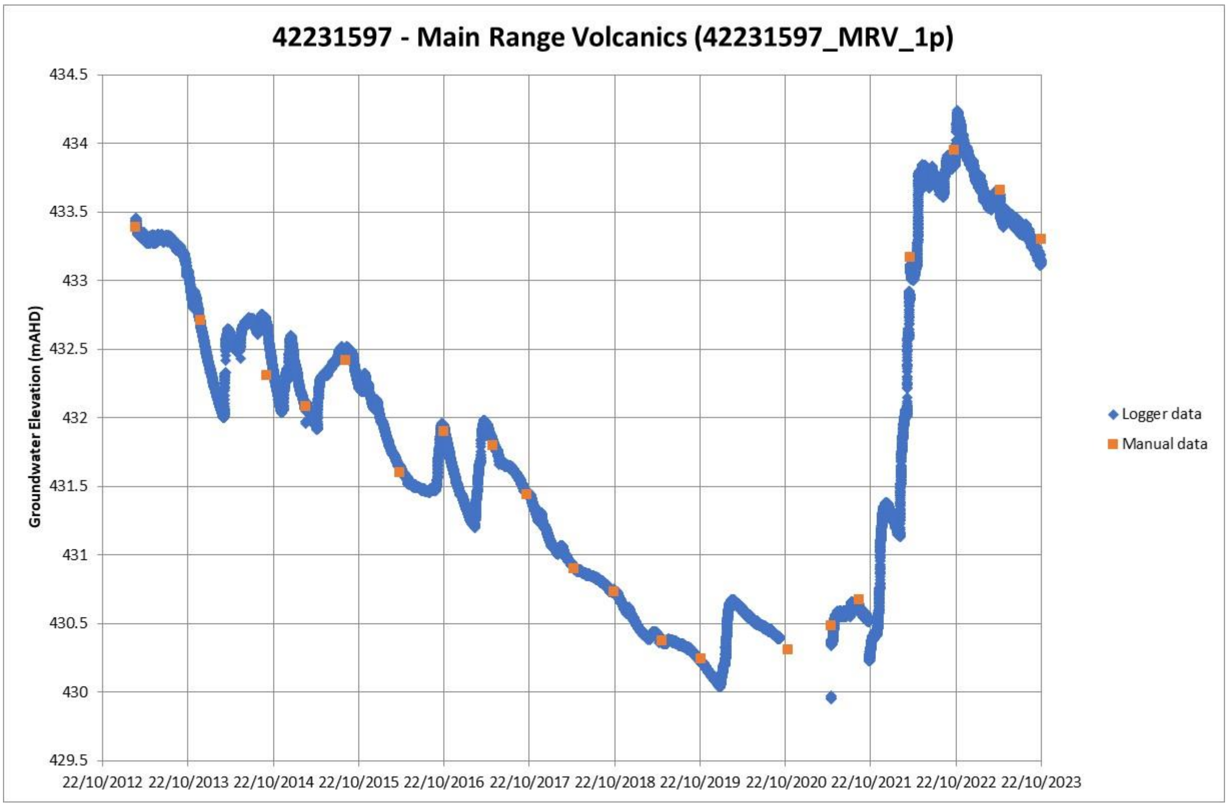

42231463 - Condamine Alluvium (42231463_CA_1p)
Groundwater Elevation (mAHD)
321.0
320.5
320.0
319.5
319.0
318.5
318.0
317.5
317.0
316.5
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

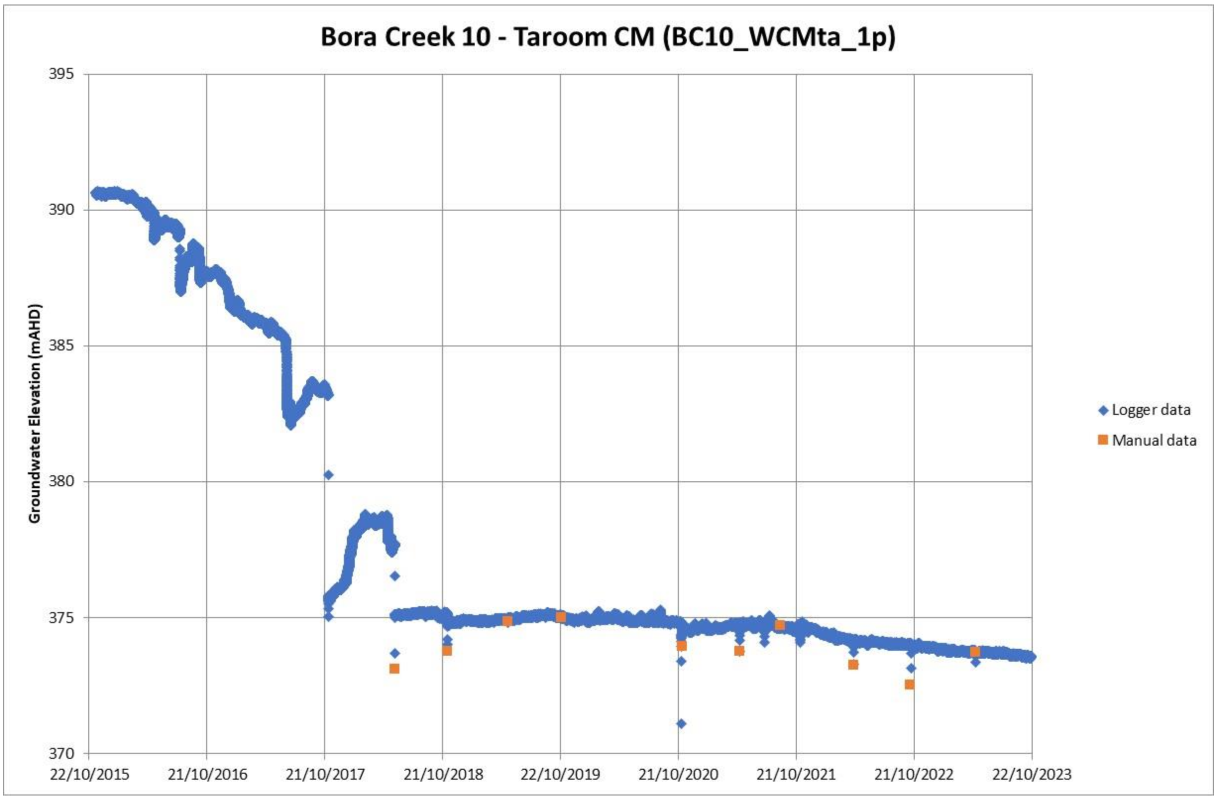

42231370 - Condamine Alluvium (42231370_CA_1p)
Groundwater Elevation (mAHD)
324
323
322
321
320
319
318
317
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

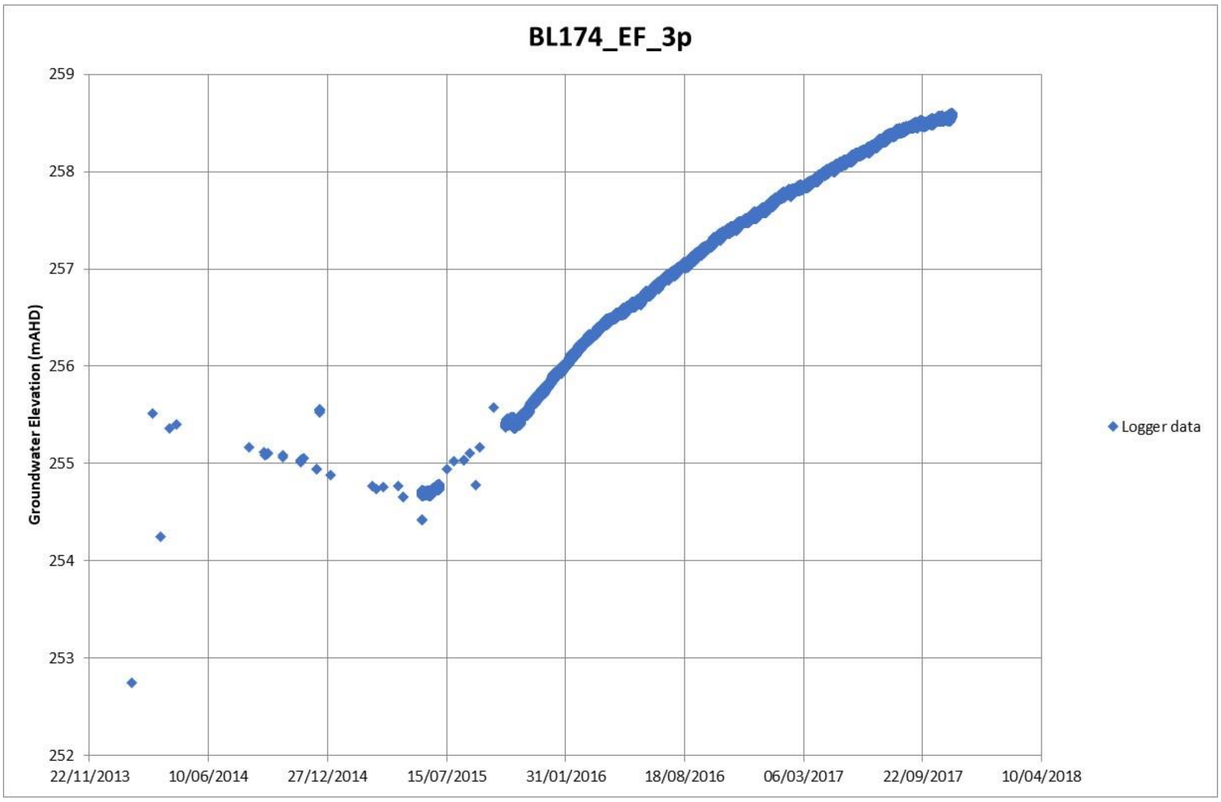

42231548_WCM_1p
Groundwater Elevation (mAHD)
377
376
375
374
373
372
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022
Logger data
Manual data

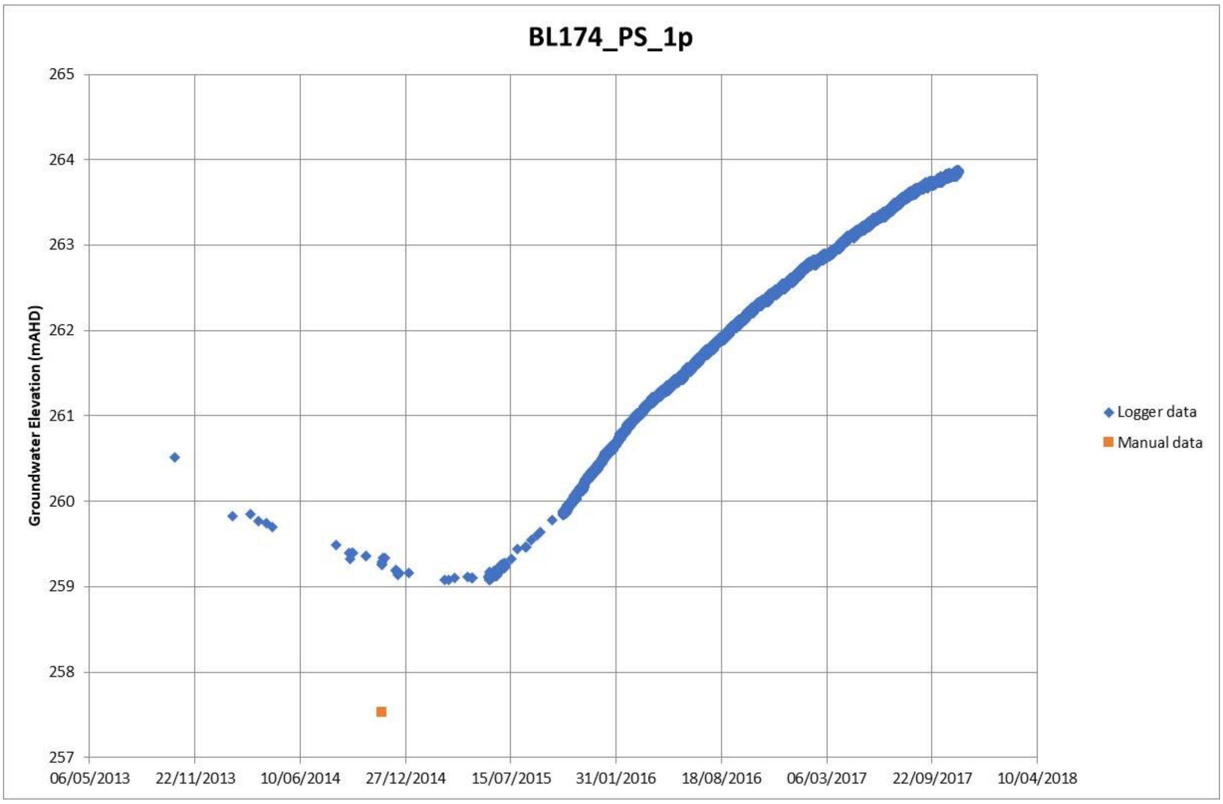

42231553_HS_1p
Groundwater Elevation (mAHD)
380.0
379.5
379.0
378.5
378.0
377.5
377.0
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022
Logger data
Manual data

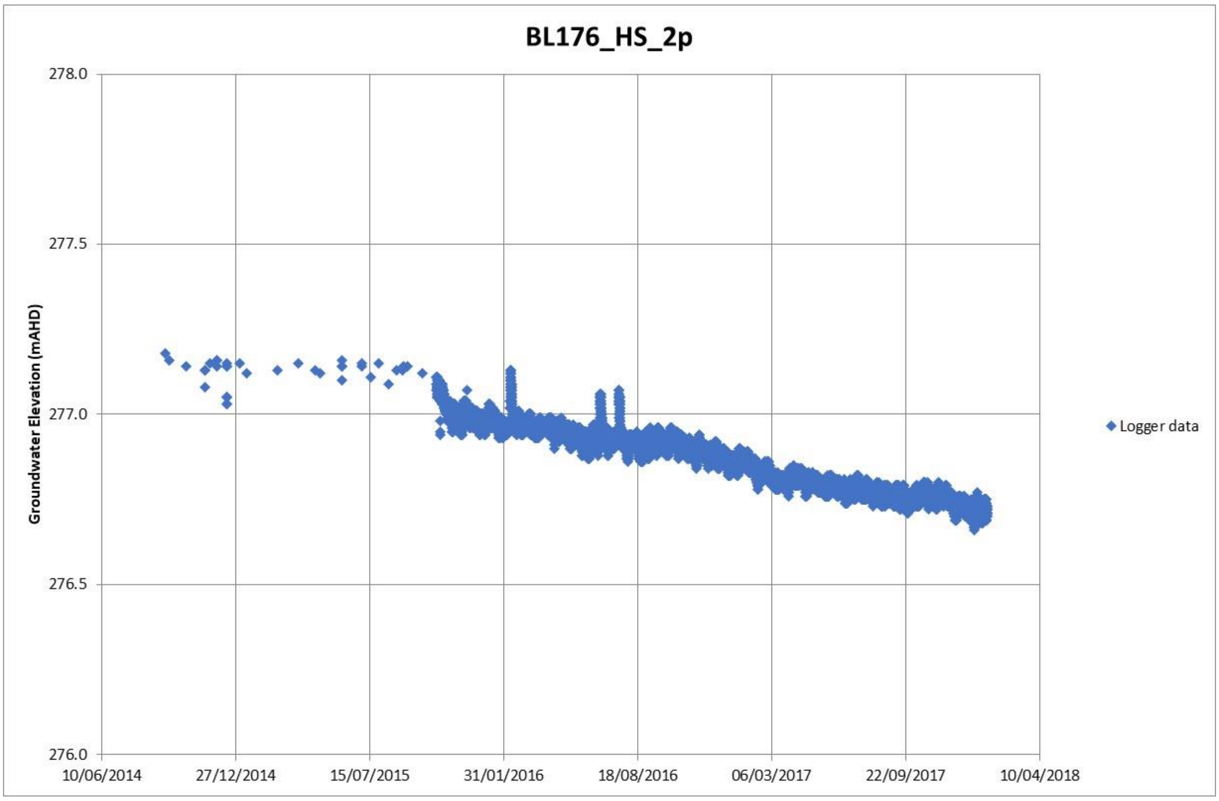

42231591_MRV_1p
Groundwater Elevation (mAHD)
510
509
508
507
506
505
504
503
502
501
22/10/11 21/10/12 21/10/13 21/10/14 22/10/15 21/10/16 21/10/17 21/10/18 22/10/19 21/10/20 21/10/21 21/10/22 22/10/23
Logger data
Manual data

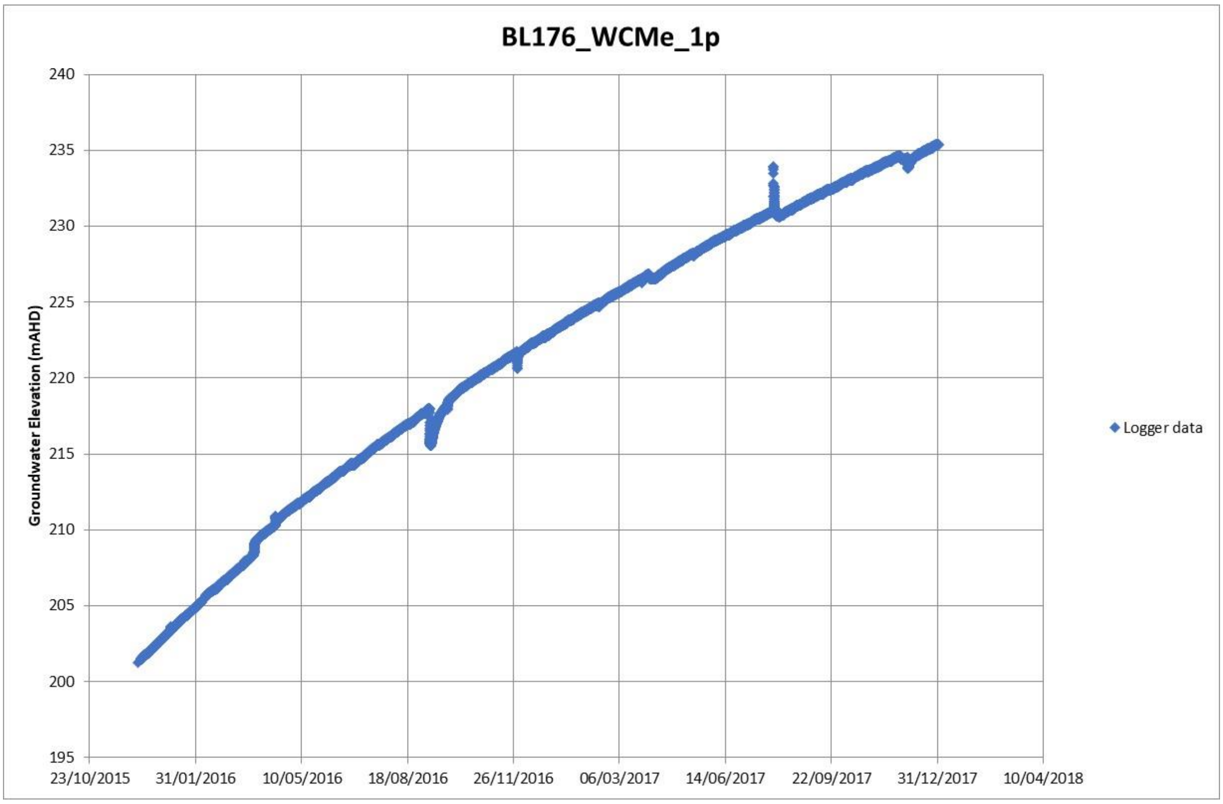

42231597 - Main Range Volcanics (42231597_MRV_1p)
Groundwater Elevation (mAHD)
434.5
434
433.5
433
432.5
432
431.5
431
430.5
430
429.5
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

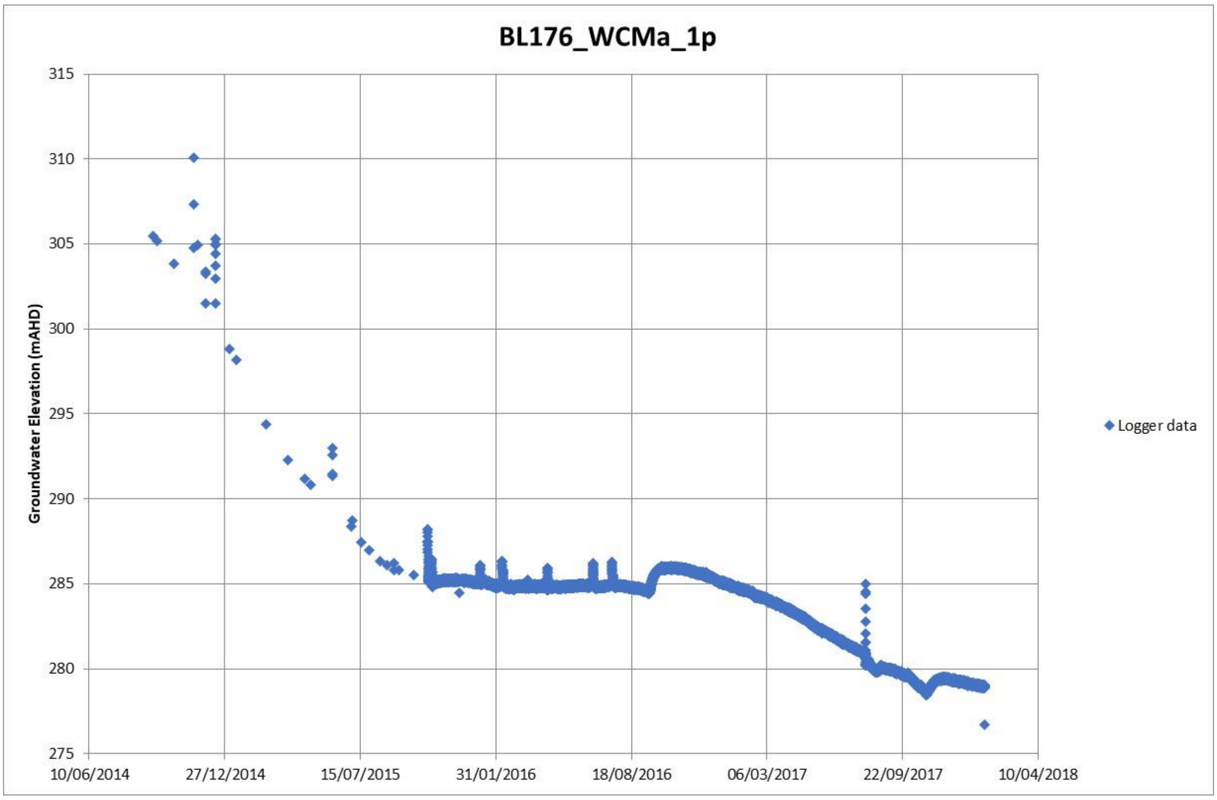

Bora Creek 10 - Taroom CM (BC10_WCMta_1p)
Groundwater Elevation (mAHD)
395
390
385
380
375
370
22/10/2015 21/10/2016 21/10/2017 21/10/2018 22/10/2019 21/10/2020 21/10/2021 21/10/2022 22/10/2023
Logger data
Manual data

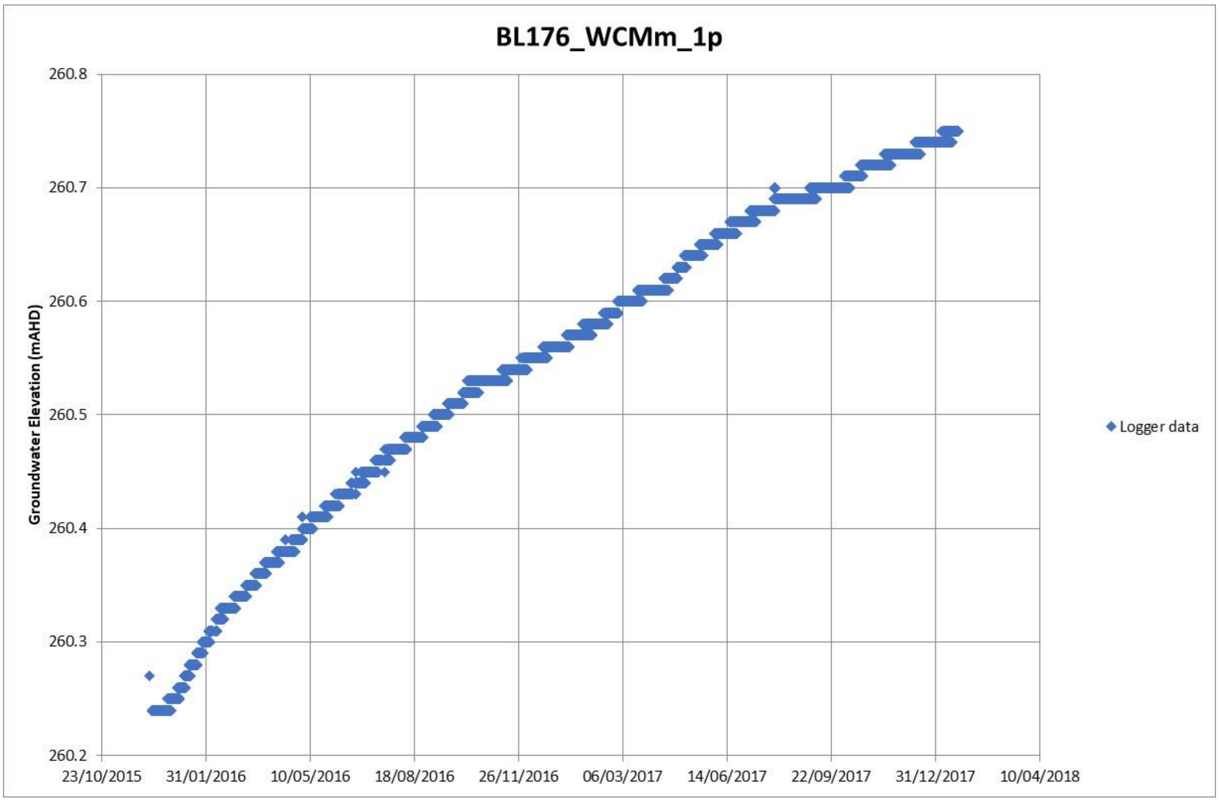

BL174_EF_3p
Groundwater Elevation (mAHD)
259
258
257
256
255
254
253
252
22/11/2013
10/06/2014
27/12/2014
15/07/2015
31/01/2016
18/08/2016
06/03/2017
22/09/2017
10/04/2018
Logger data

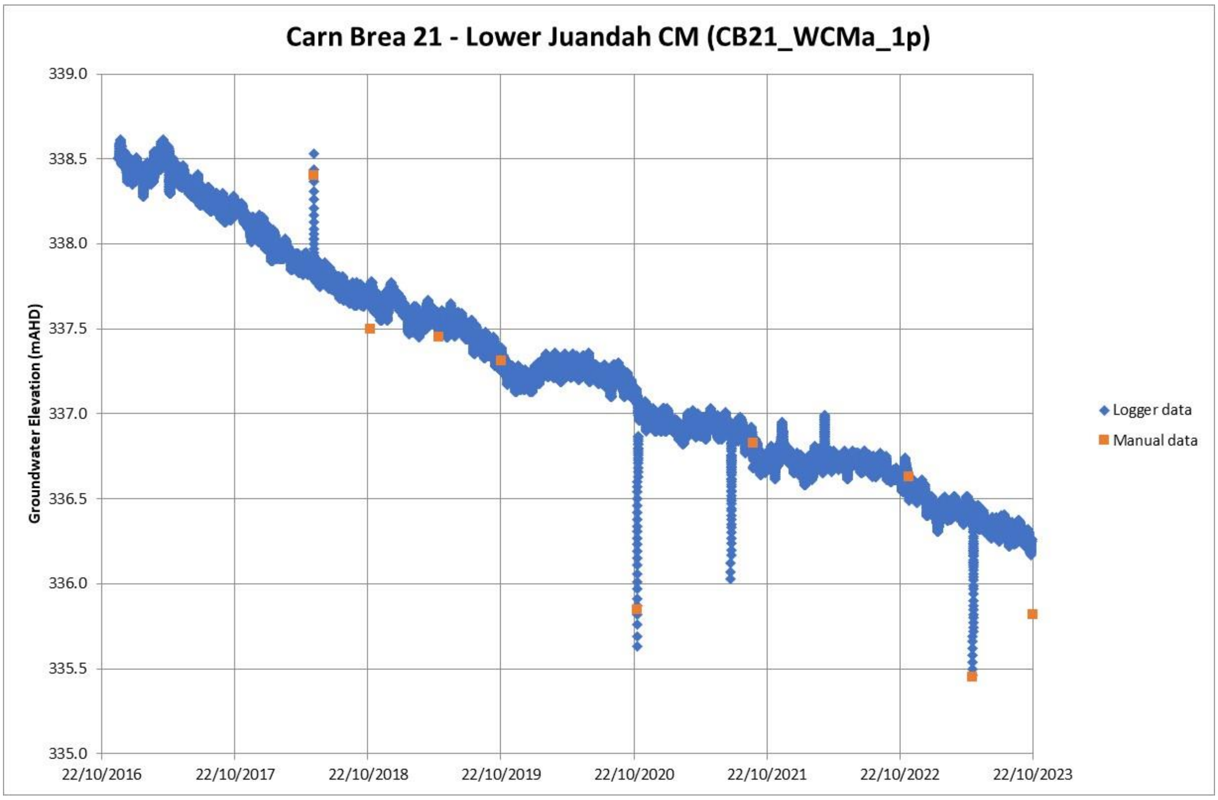

BL174_PS_1p
Groundwater Elevation (mAHD)
265
264
263
262
261
260
259
258
257
06/05/2013
22/11/2013
10/06/2014
27/12/2014
15/07/2015
31/01/2016
18/08/2016
06/03/2017
22/09/2017
10/04/2018
Logger data
Manual data

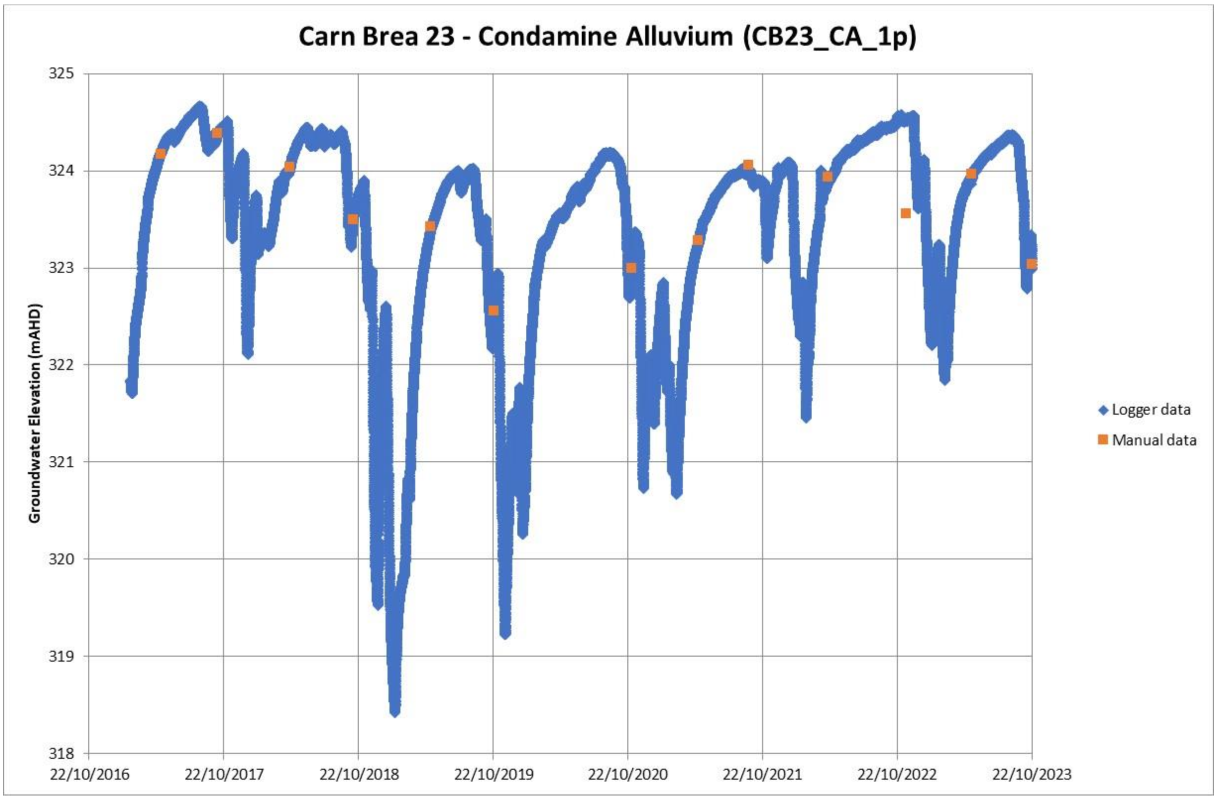

BL176_HS_2p
Groundwater Elevation (mAHD)
278.0
277.5
277.0
276.5
276.0
10/06/2014
27/12/2014
15/07/2015
31/01/2016
18/08/2016
06/03/2017
22/09/2017
10/04/2018
Logger data

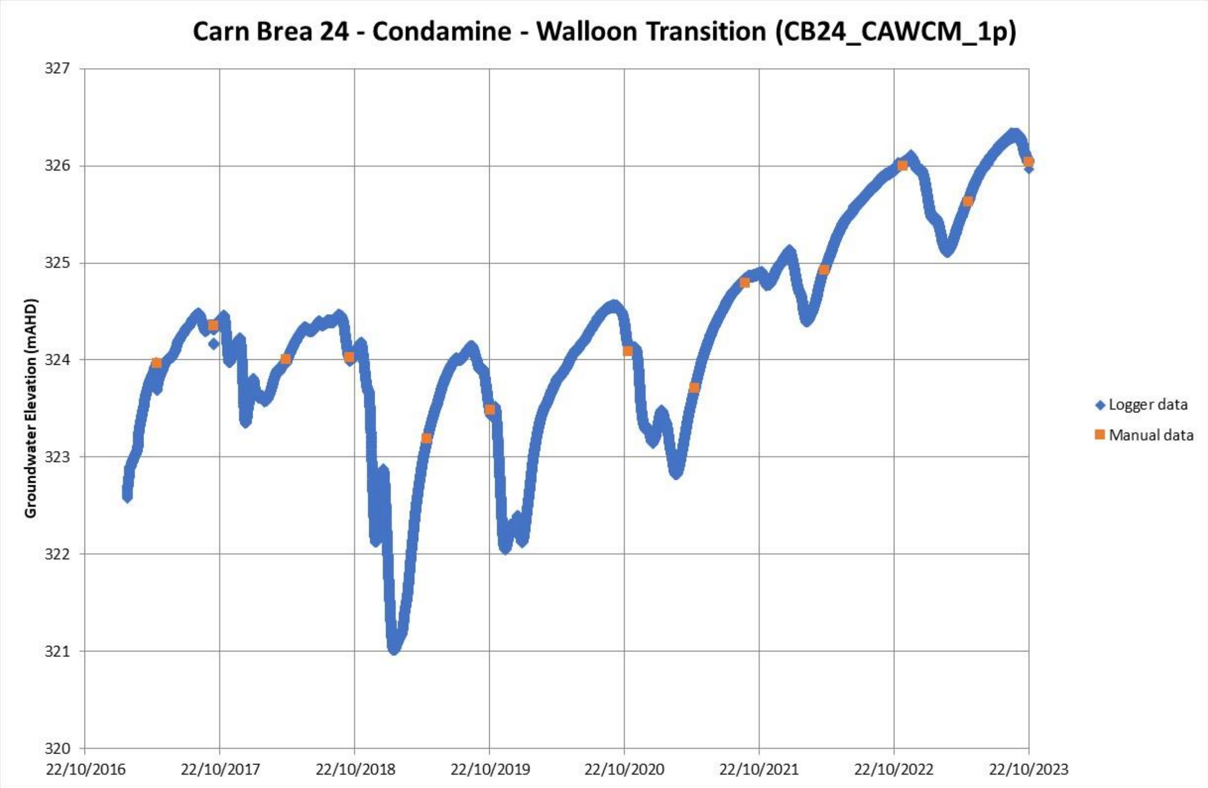

BL176_WCMe_1p
Groundwater Elevation (mAHD)
240
235
230
225
220
215
210
205
200
195
23/10/2015
31/01/2016
10/05/2016
18/08/2016
26/11/2016
06/03/2017
14/06/2017
22/09/2017
31/12/2017
10/04/2018
Logger data

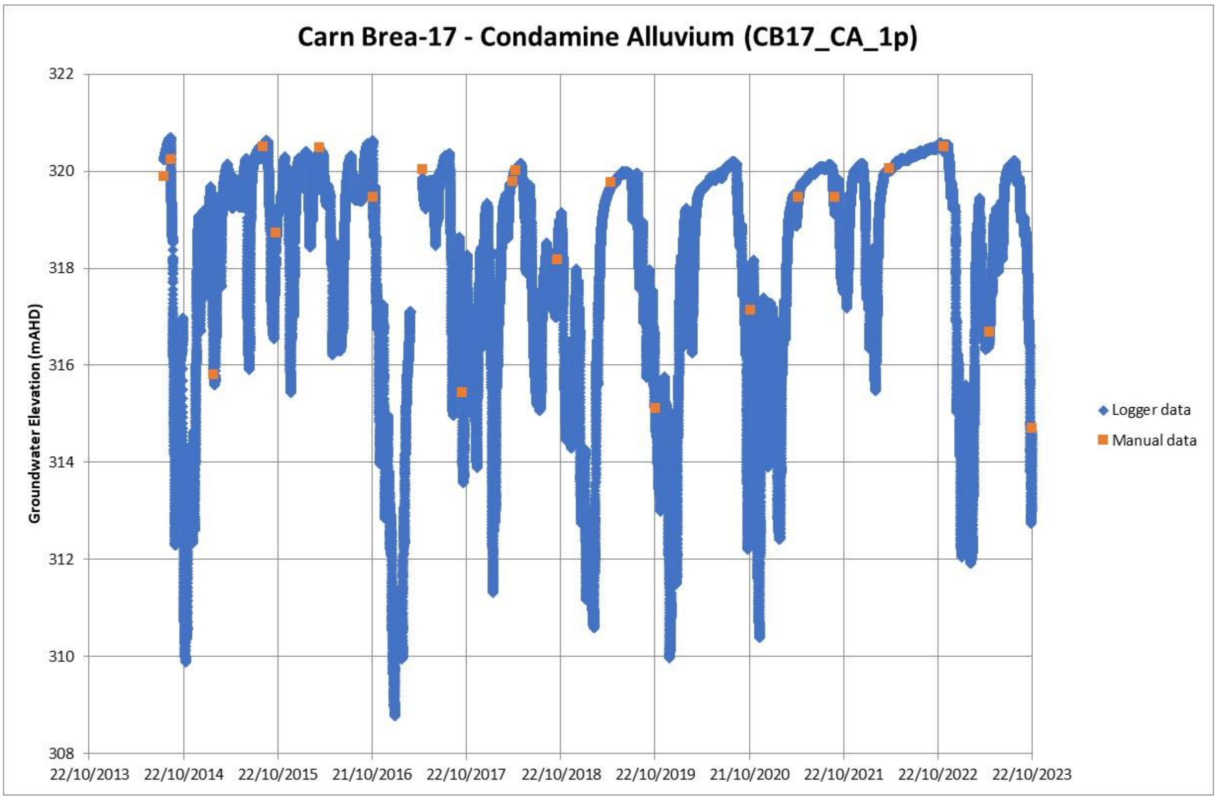

BL176_WCMa_1p
Groundwater Elevation (mAHD)
315
310
305
300
295
290
285
280
275
10/06/2014
27/12/2014
15/07/2015
31/01/2016
18/08/2016
06/03/2017
22/09/2017
10/04/2018
Logger data

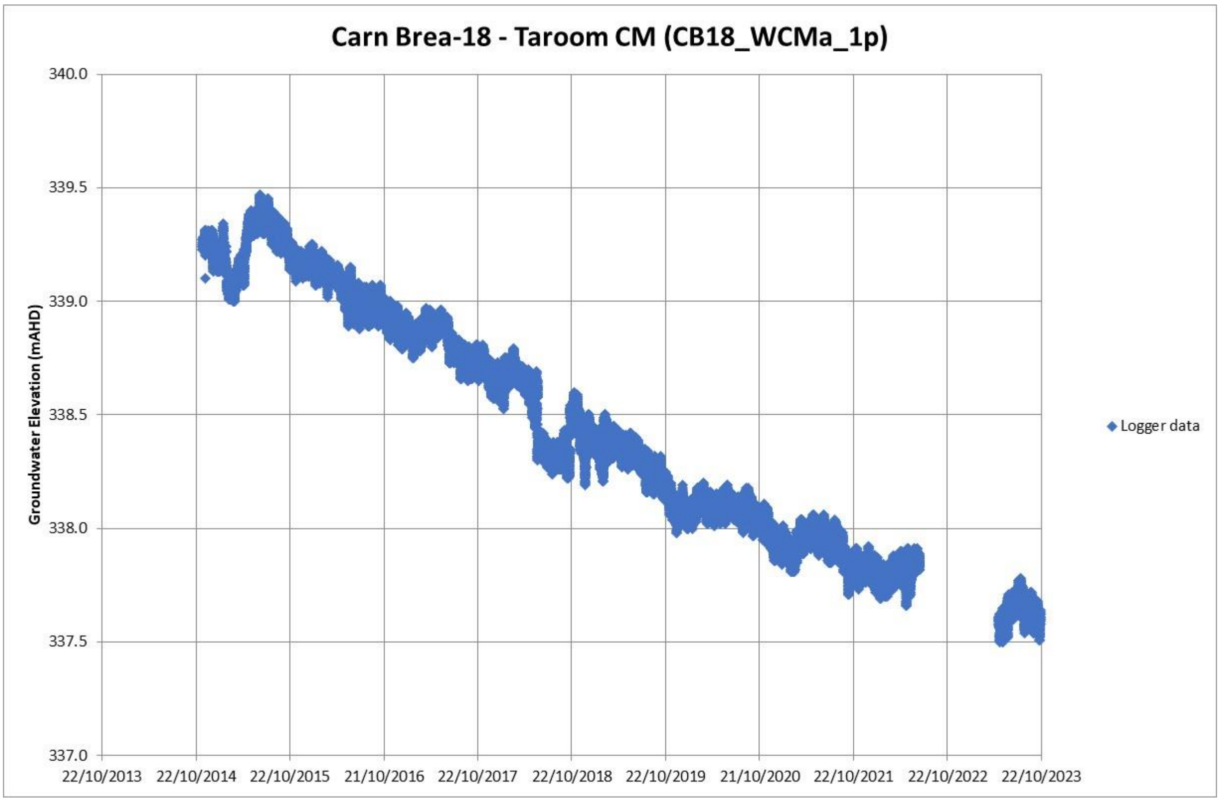

BL176_WCMm_1p
Groundwater Elevation (mAHD)
260.8
260.7
260.6
260.5
260.4
260.3
260.2
23/10/2015
31/01/2016
10/05/2016
18/08/2016
26/11/2016
06/03/2017
14/06/2017
22/09/2017
31/12/2017
10/04/2018
Logger data


Carn Brea 21 - Lower Juandah CM (CB21_WCMa_1p)
Groundwater Elevation (mAHD)
339.0
338.5
338.0
337.5
337.0
336.5
336.0
335.5
335.0
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

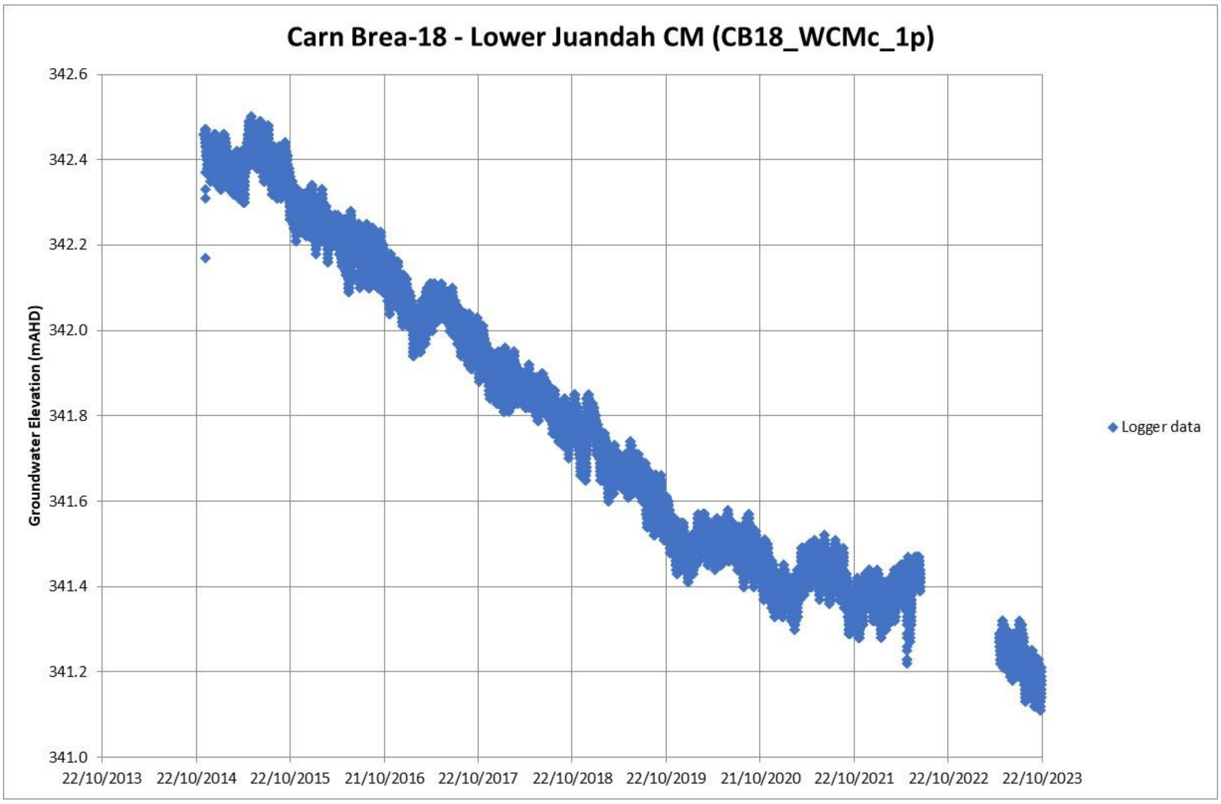

Carn Brea 23 - Condamine Alluvium (CB23_CA_1p)
Groundwater Elevation (mAHD)
325
324
323
322
321
320
319
318
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data


Carn Brea 24 - Condamine - Walloon Transition (CB24_CAWCM_1p)
Groundwater Elevation (mAHD)
327
326
325
324
323
322
321
320
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

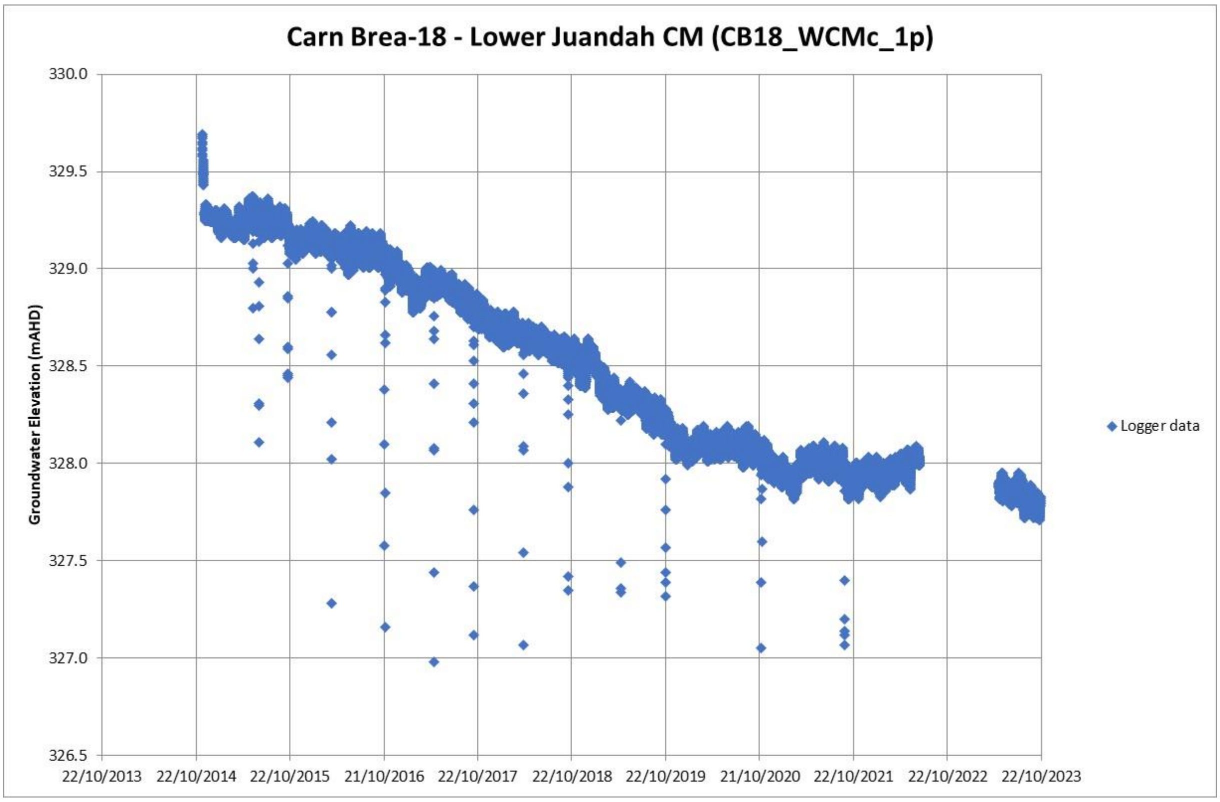

Carn Brea-17 - Condamine Alluvium (CB17_CA_1p)
Groundwater Elevation (mAHD)
322
320
318
316
314
312
310
308
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

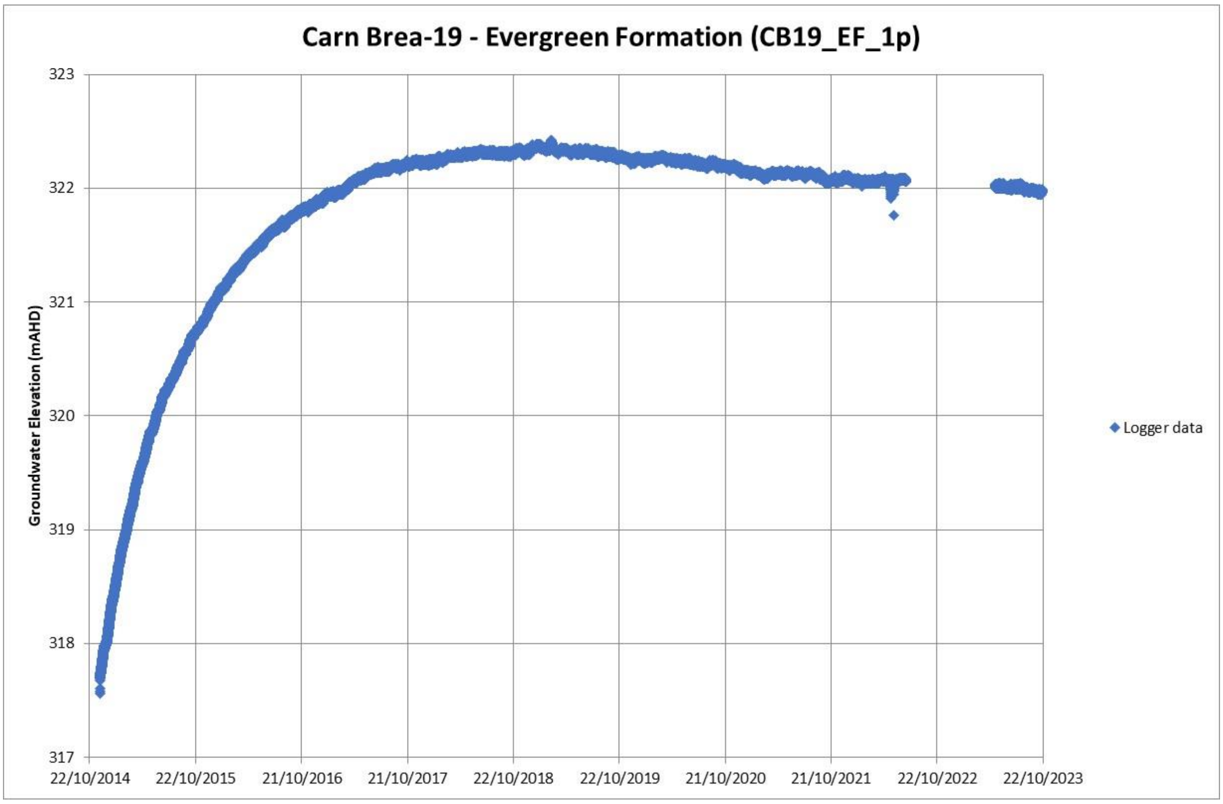


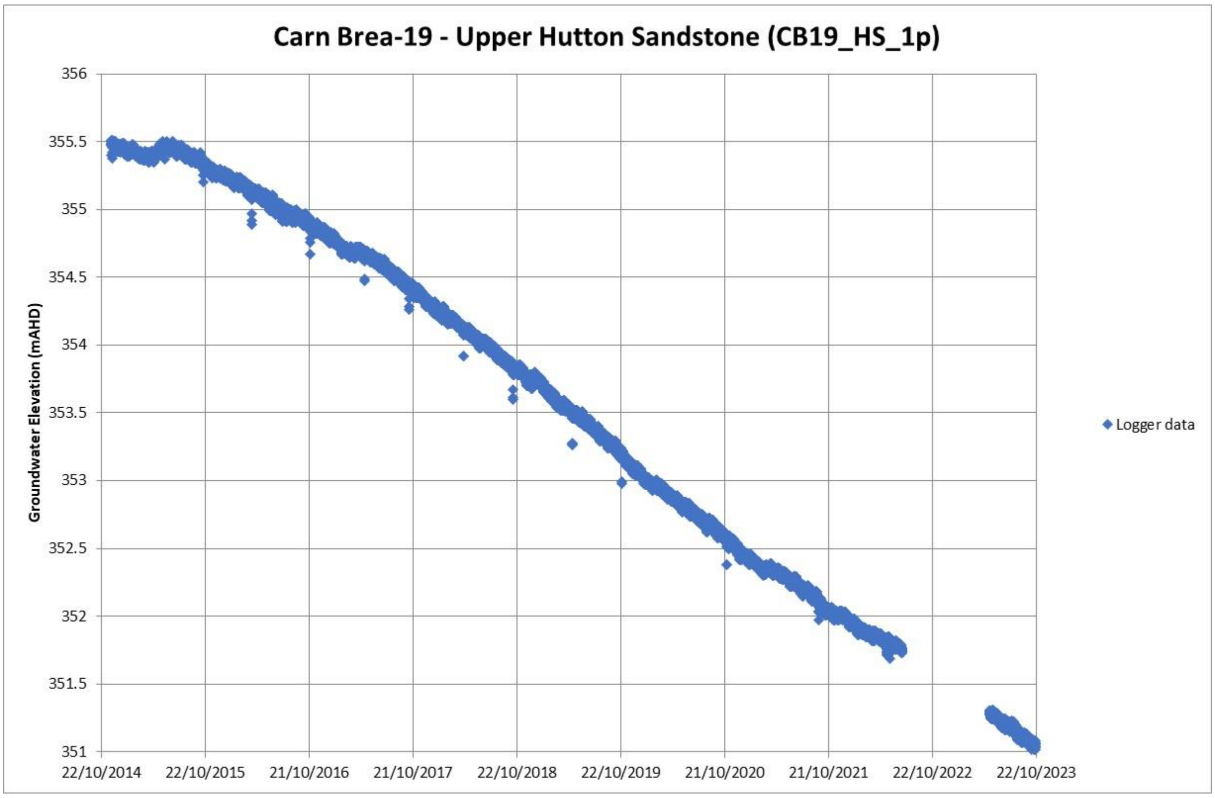
Carn Brea-18 - Taroom CM (CB18_WCMa_1p)
Groundwater Elevation (mAHD)
340.0
339.5
339.0
338.5
338.0
337.5
337.0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

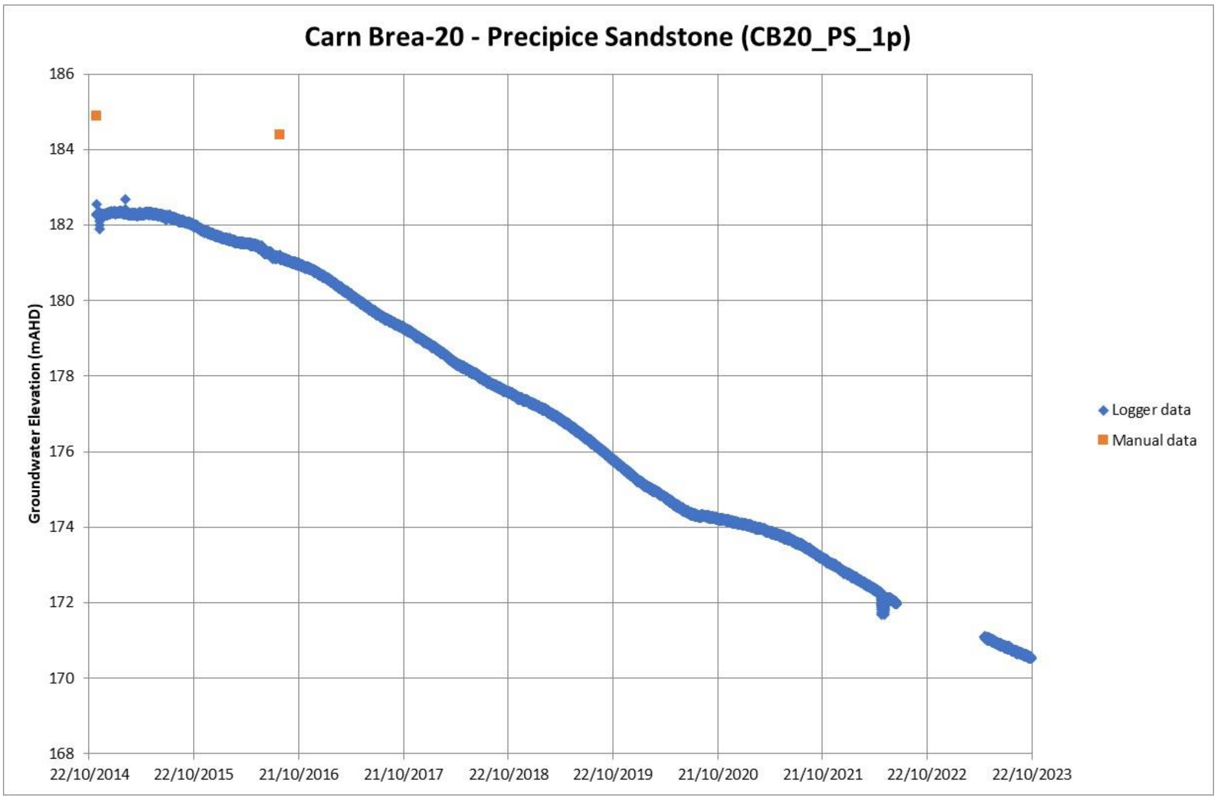


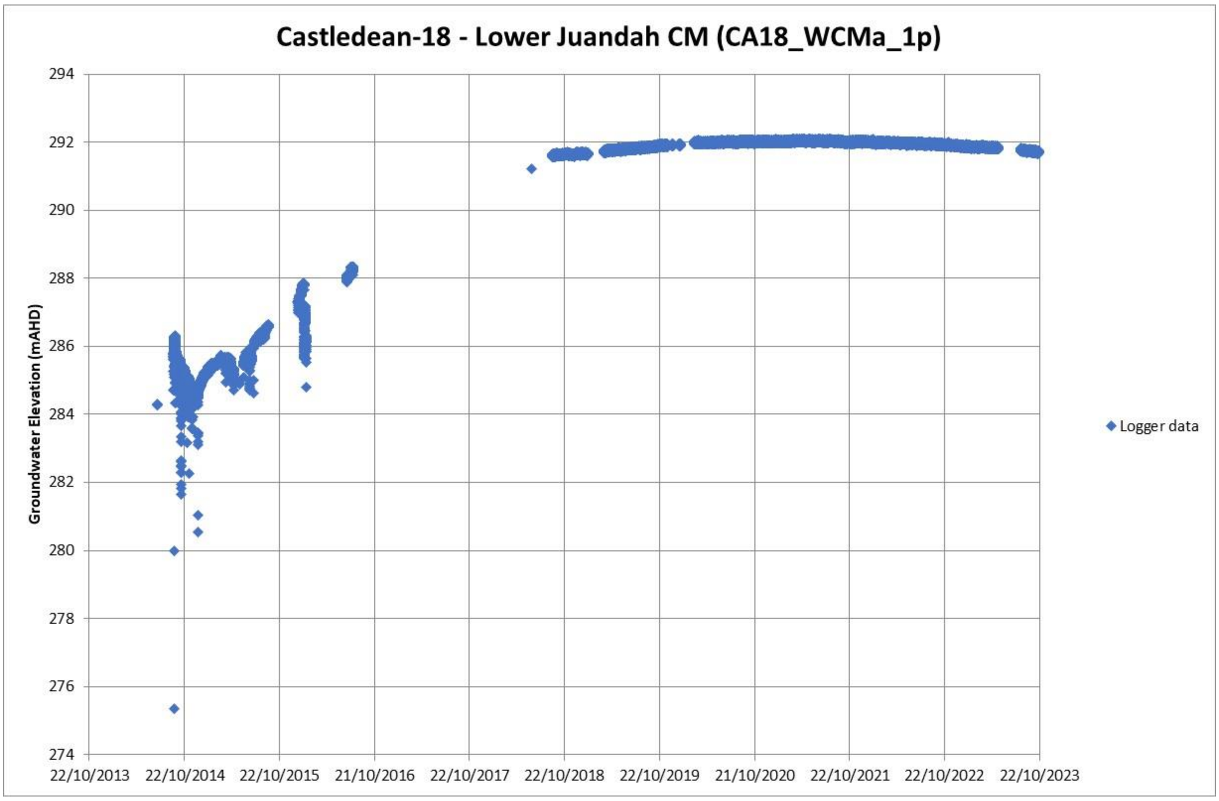
Carn Brea-18 - Lower Juandah CM (CB18_WCMc_1p)
Groundwater Elevation (mAHD)
342.6
342.4
342.2
342.0
341.8
341.6
341.4
341.2
341.0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

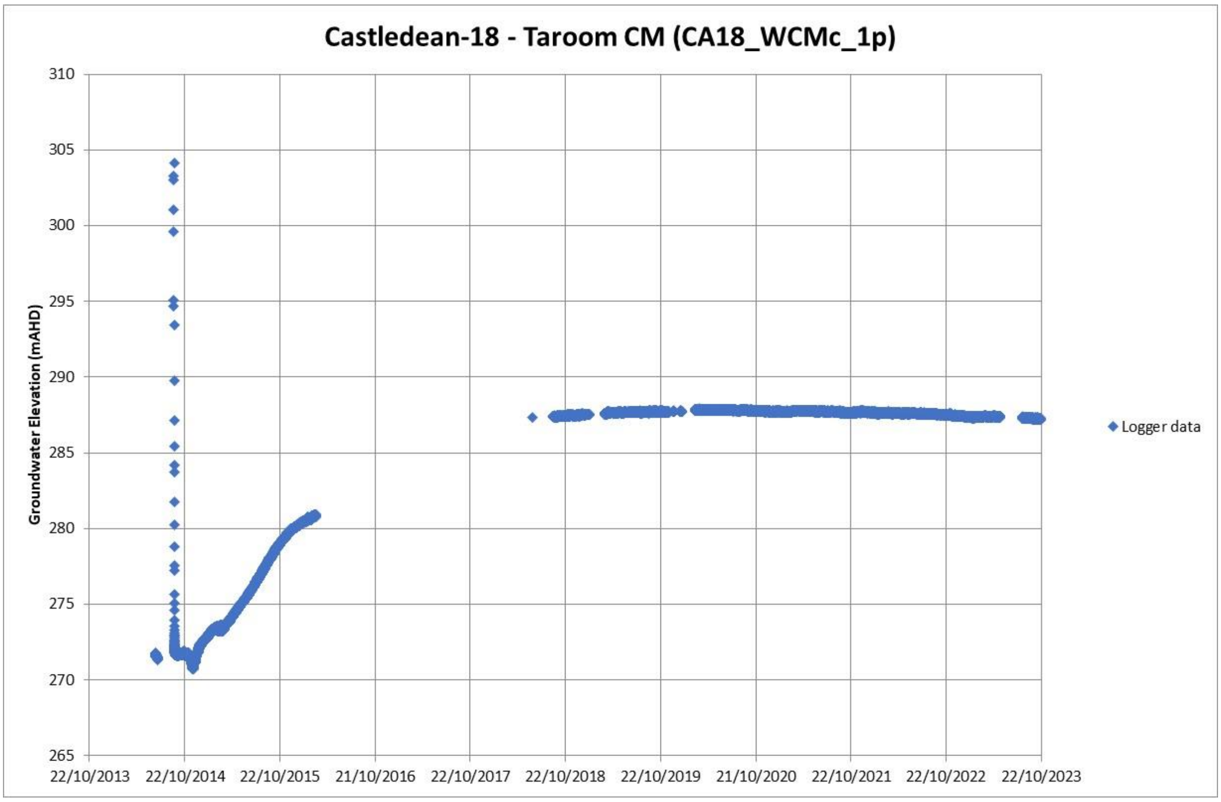

Carn Brea-18 - Lower Juandah CM (CB18_WCMc_1p)
Groundwater Elevation (mAHD)
330.0
329.5
329.0
328.5
328.0
327.5
327.0
326.5
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

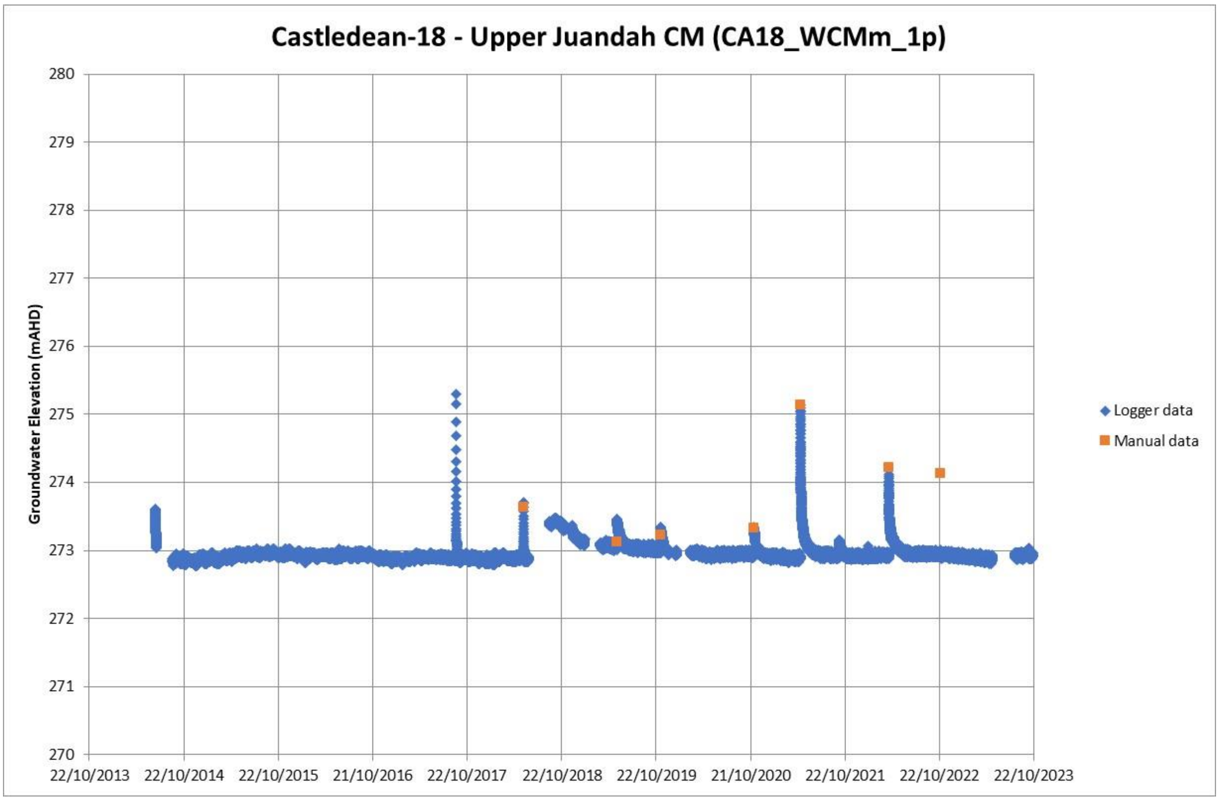

Carn Brea-19 - Evergreen Formation (CB19_EF_1p)
Groundwater Elevation (mAHD)
323
322
321
320
319
318
317
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data


Carn Brea-19 - Upper Hutton Sandstone (CB19_HS_1p)
Groundwater Elevation (mAHD)
356
355.5
355
354.5
354
353.5
353
352.5
352
351.5
351
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

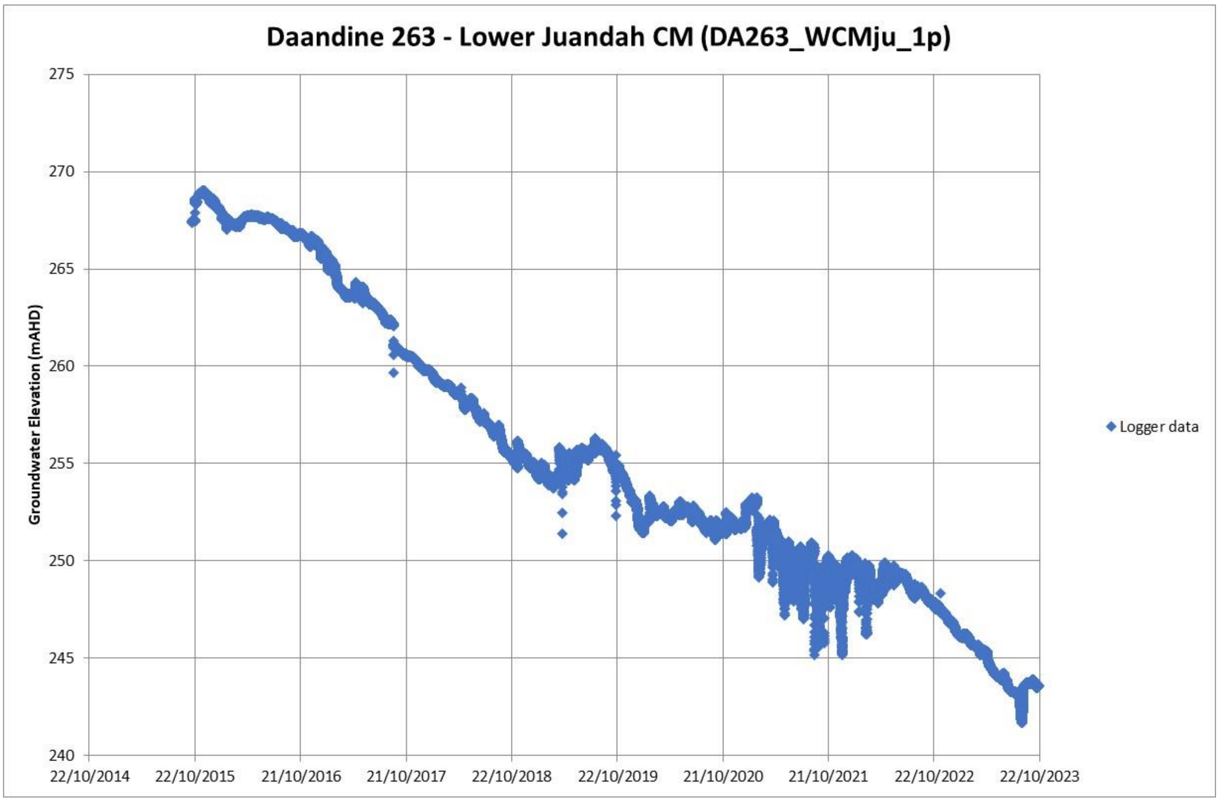

Carn Brea-20 - Precipice Sandstone (CB20_PS_1p)
Groundwater Elevation (mAHD)
186
184
182
180
178
176
174
172
170
168
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data


Castledean-18 - Lower Juandah CM (CA18_WCMa_1p)
Groundwater Elevation (mAHD)
294
292
290
288
286
284
282
280
278
276
274
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

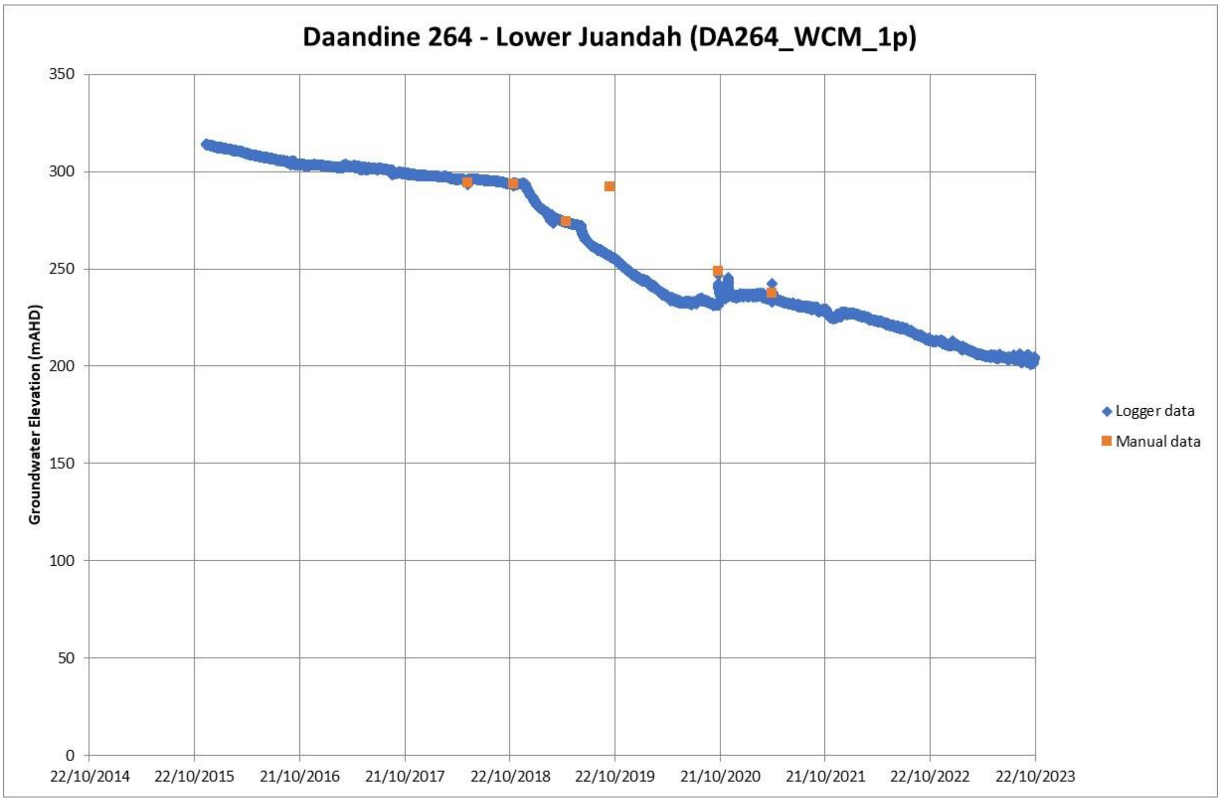

Castledean-18 - Taroom CM (CA18_WCMc_1p)
Groundwater Elevation (mAHD)
310
305
300
295
290
285
280
275
270
265
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

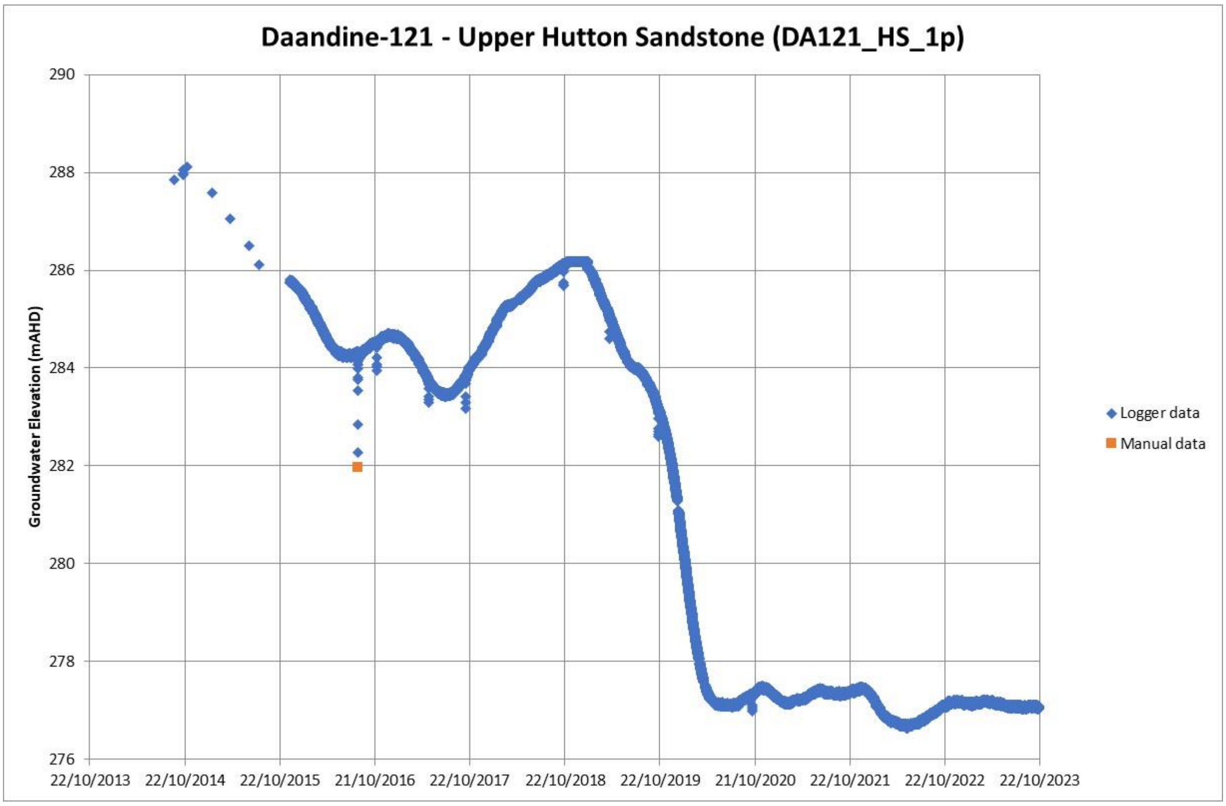


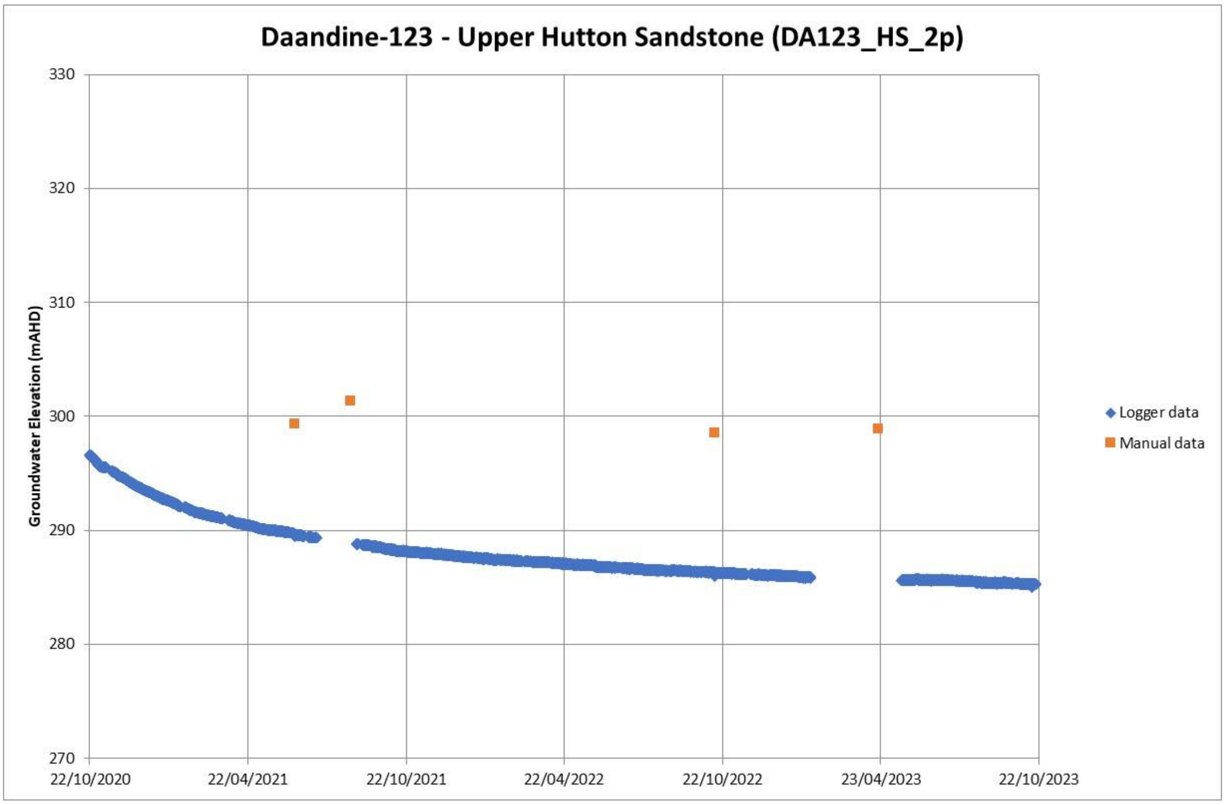
Castledean-18 - Upper Juandah CM (CA18_WCMm_1p)
Groundwater Elevation (mAHD)
280
279
278
277
276
275
274
273
272
271
270
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

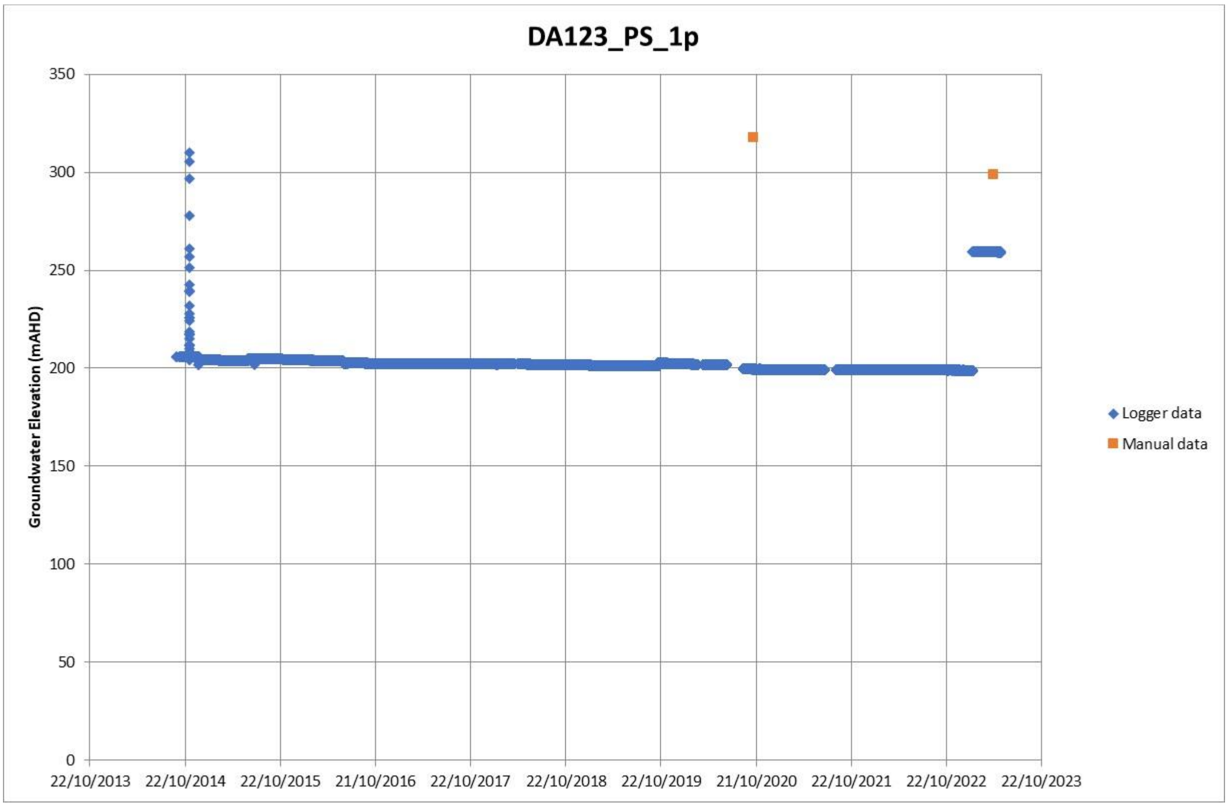


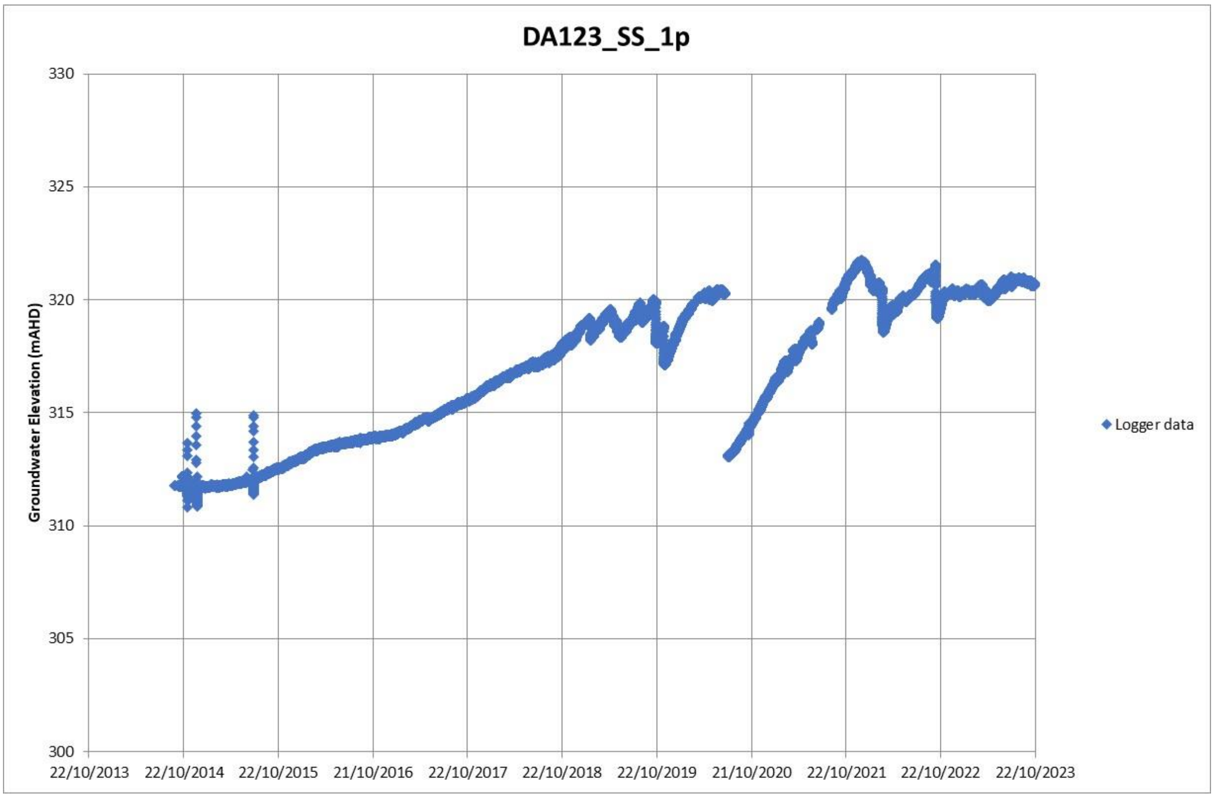
Daandine 263 - Lower Juandah CM (DA263_WCMju_1p)
Groundwater Elevation (mAHD)
275
270
265
260
255
250
245
240
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

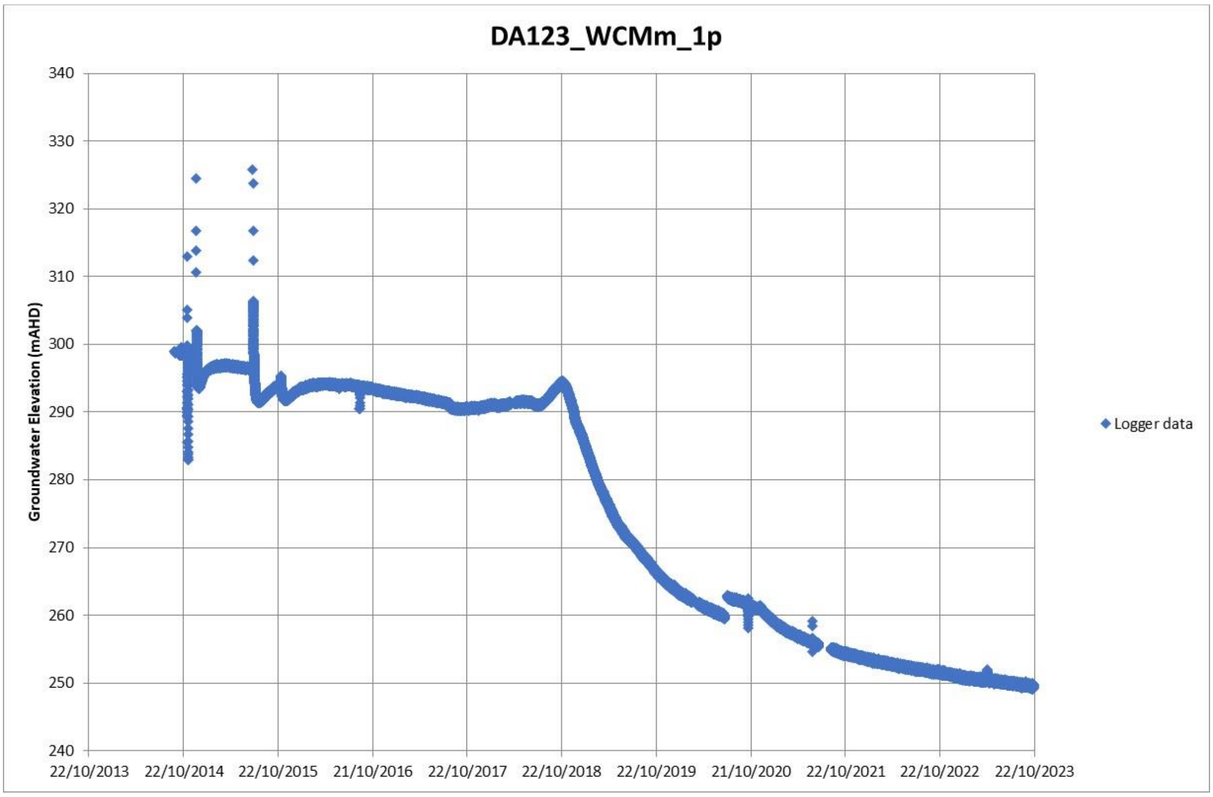

Daandine 264 - Lower Juandah (DA264_WCM_1p)
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

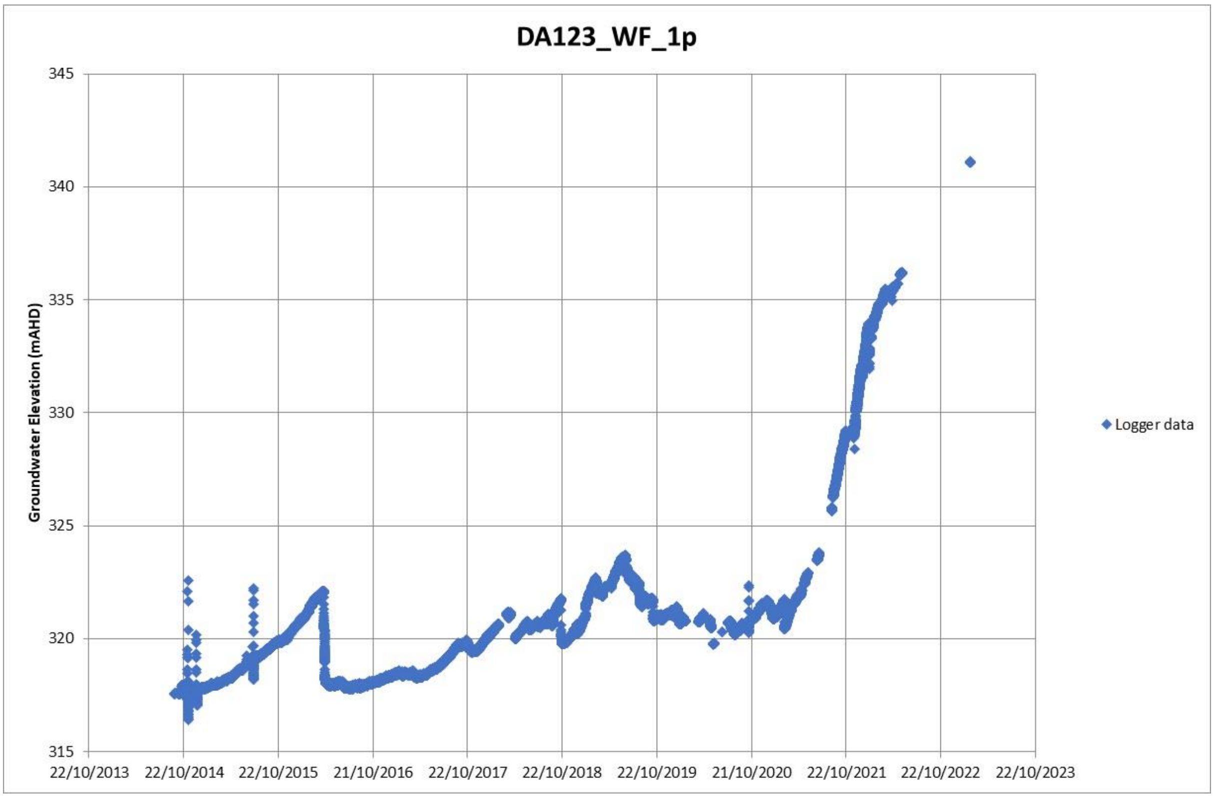

Daandine-121 - Upper Hutton Sandstone (DA121_HS_1p)
Groundwater Elevation (mAHD)
290
288
286
284
282
280
278
276
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

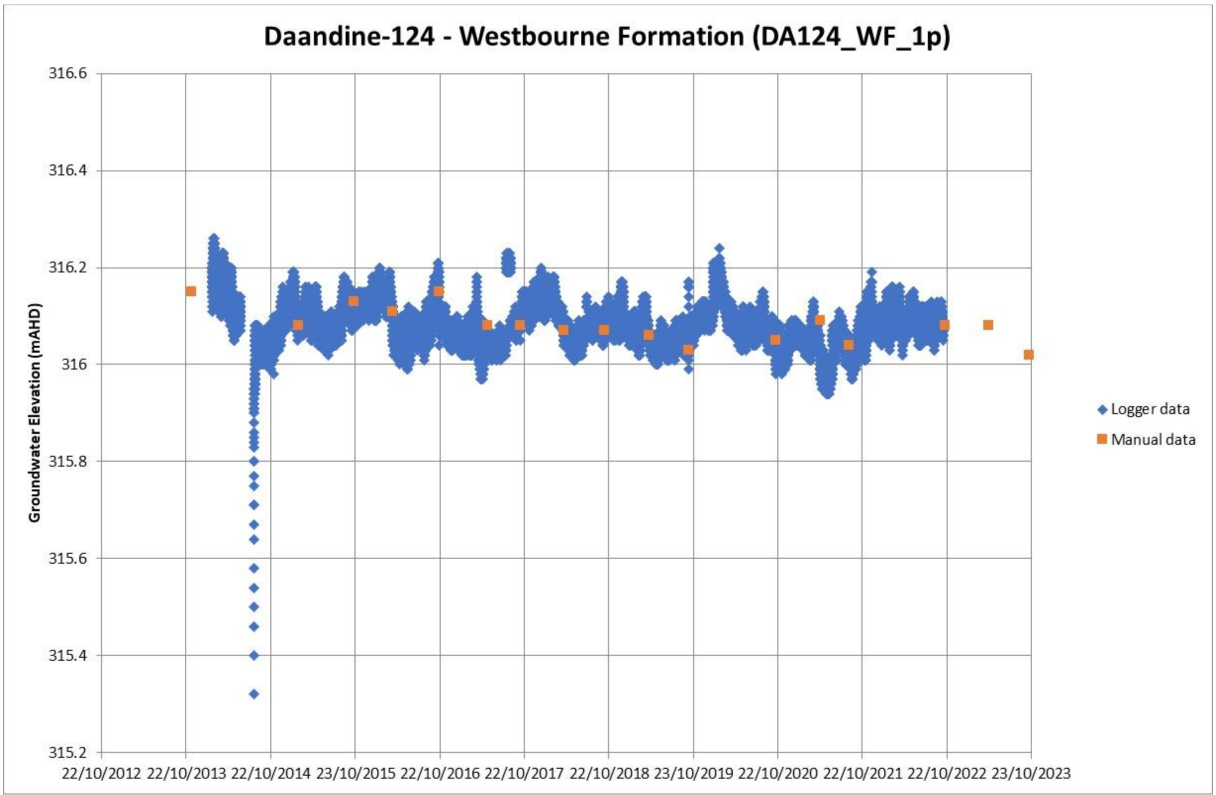

Daandine-123 - Upper Hutton Sandstone (DA123_HS_2p)
Groundwater Elevation (mAHD)
330
320
310
300
290
280
270
22/10/2020
22/04/2021
22/10/2021
22/04/2022
22/10/2022
23/04/2023
22/10/2023
Logger data
Manual data

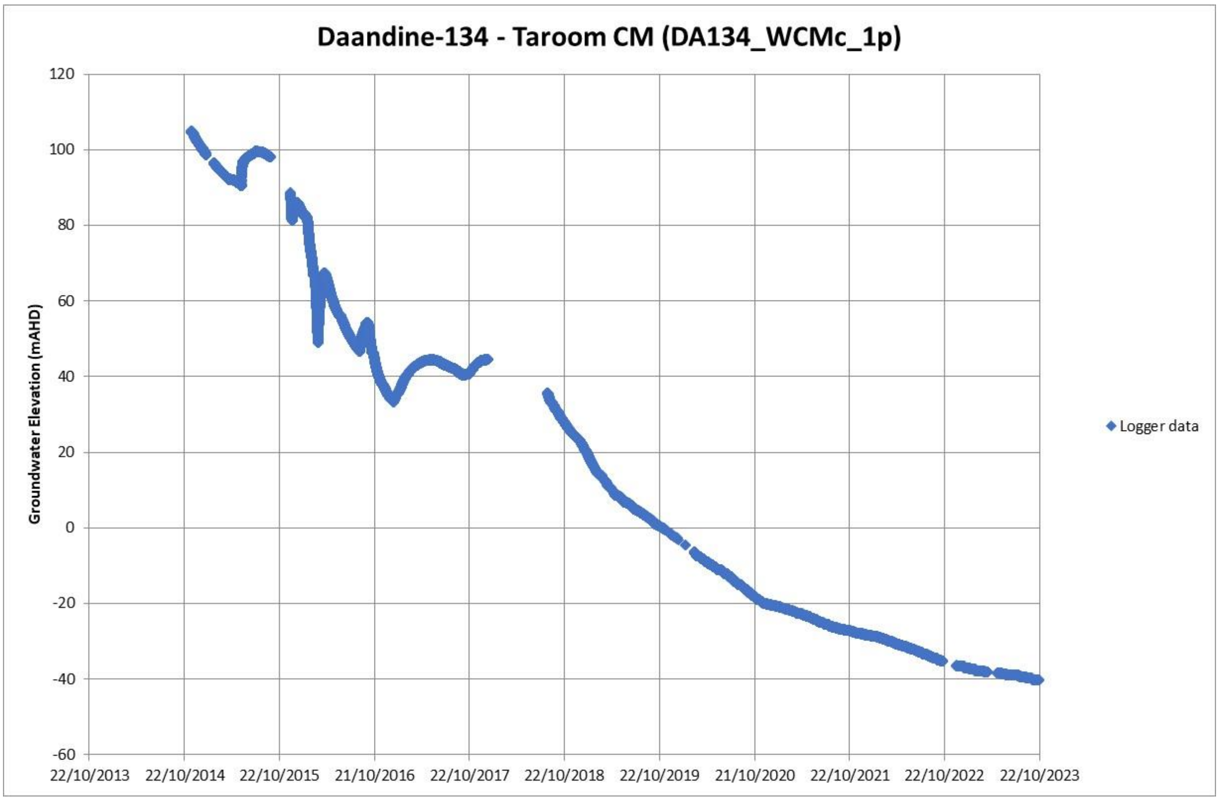

DA123_PS_1p
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

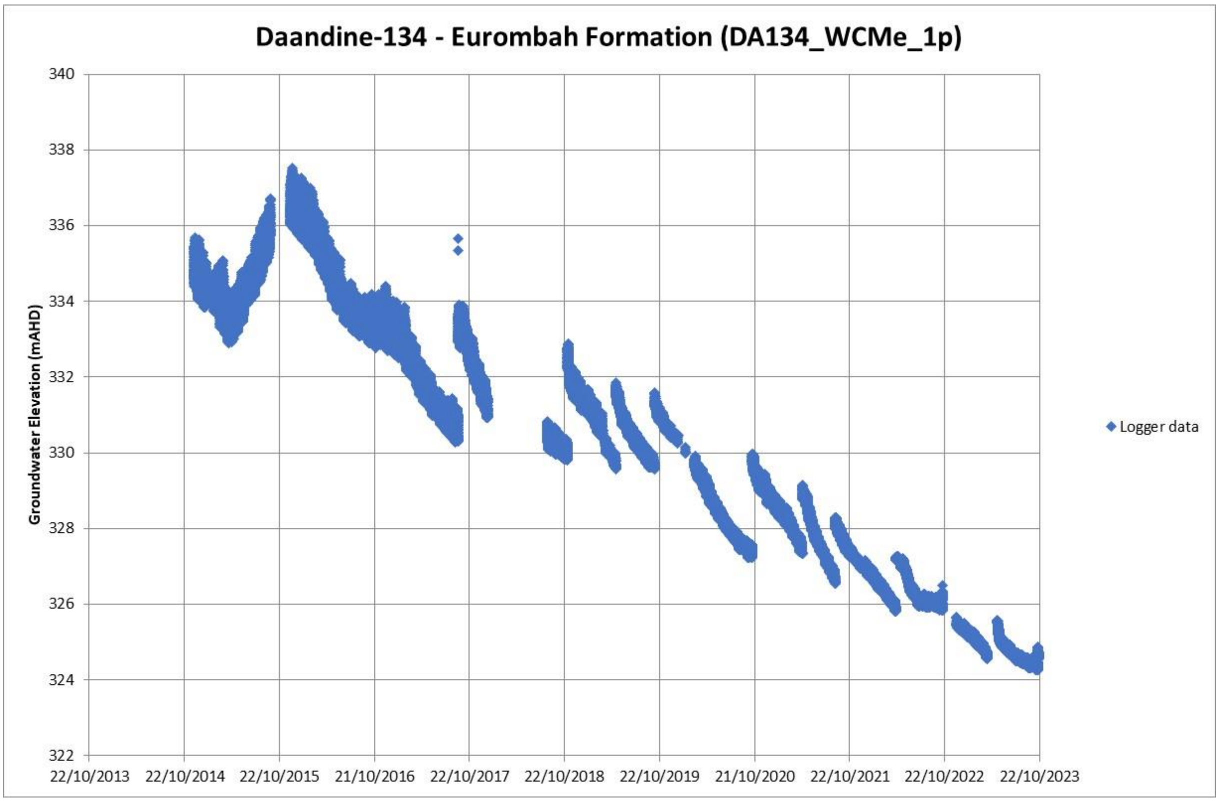

DA123_SS_1p
Groundwater Elevation (mAHD)
330
325
320
315
310
305
300
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

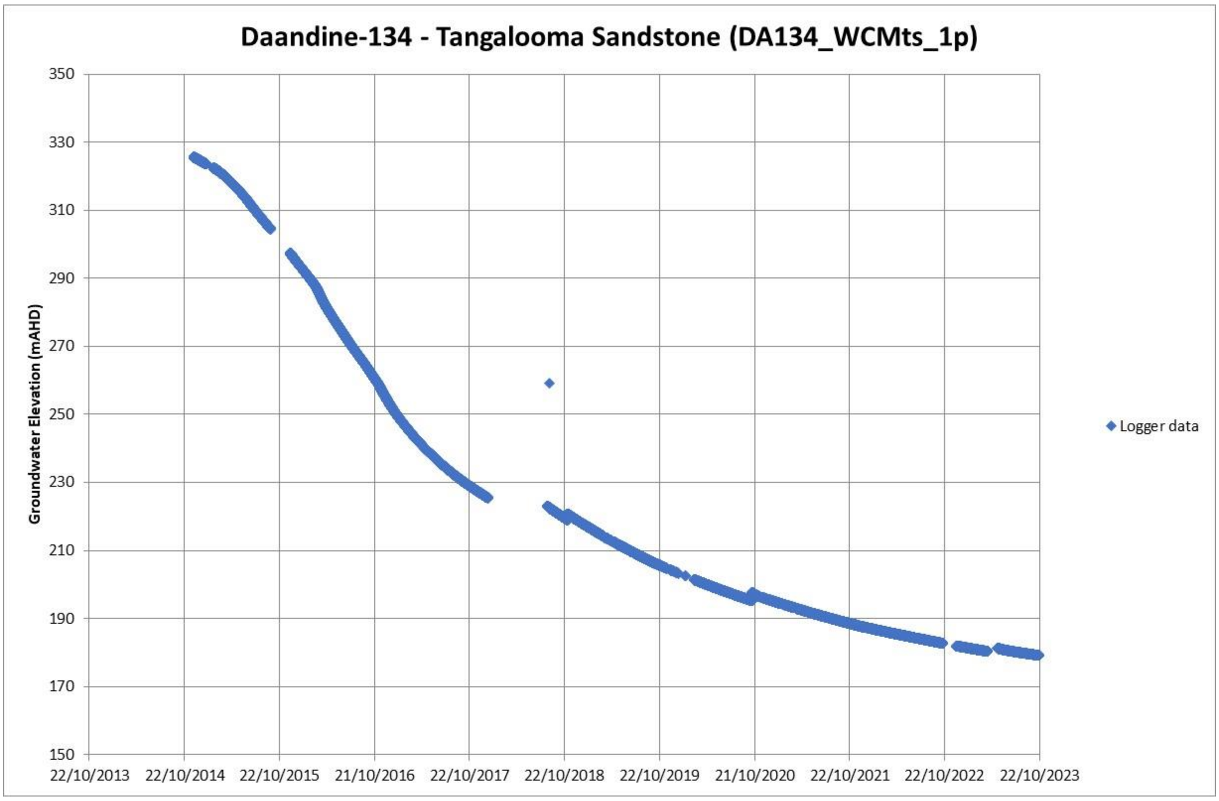

DA123_WCMm_1p
Groundwater Elevation (mAHD)
340
330
320
310
300
290
280
270
260
250
240
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

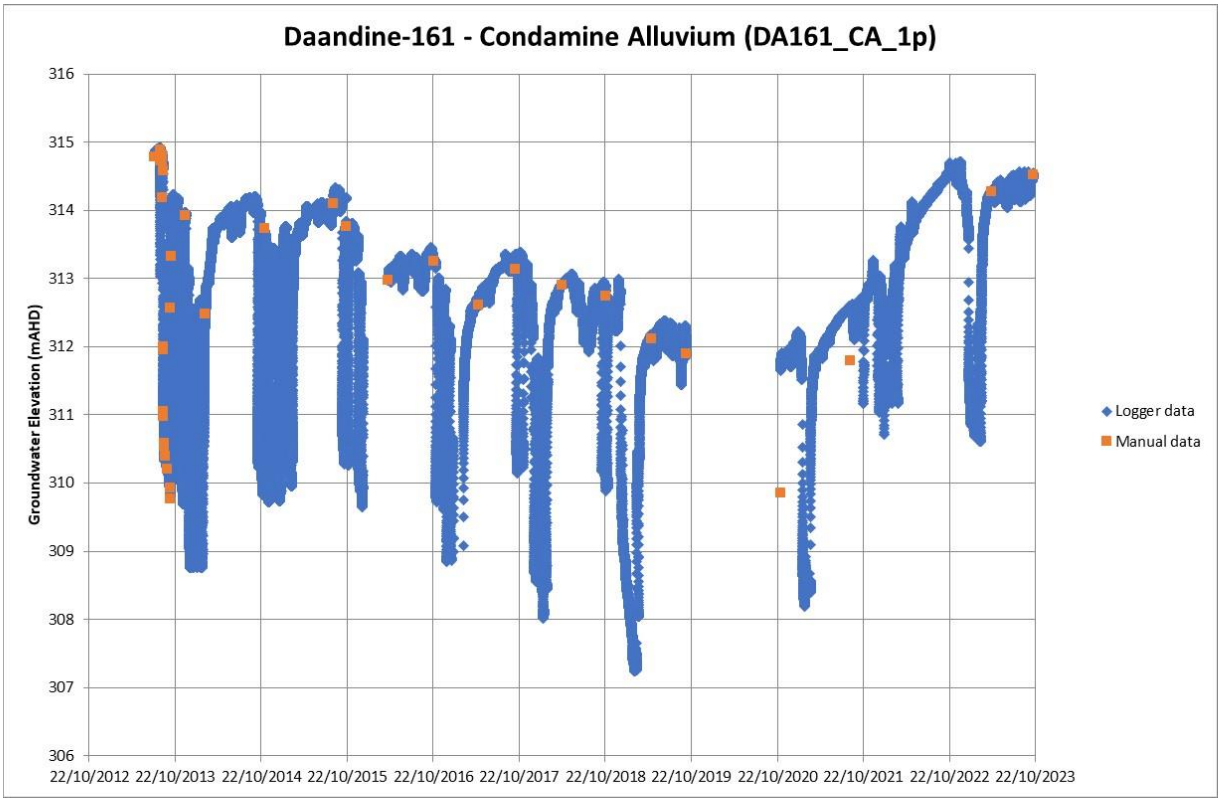

DA123_WF_1p
Groundwater Elevation (mAHD)
345
340
335
330
325
320
315
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

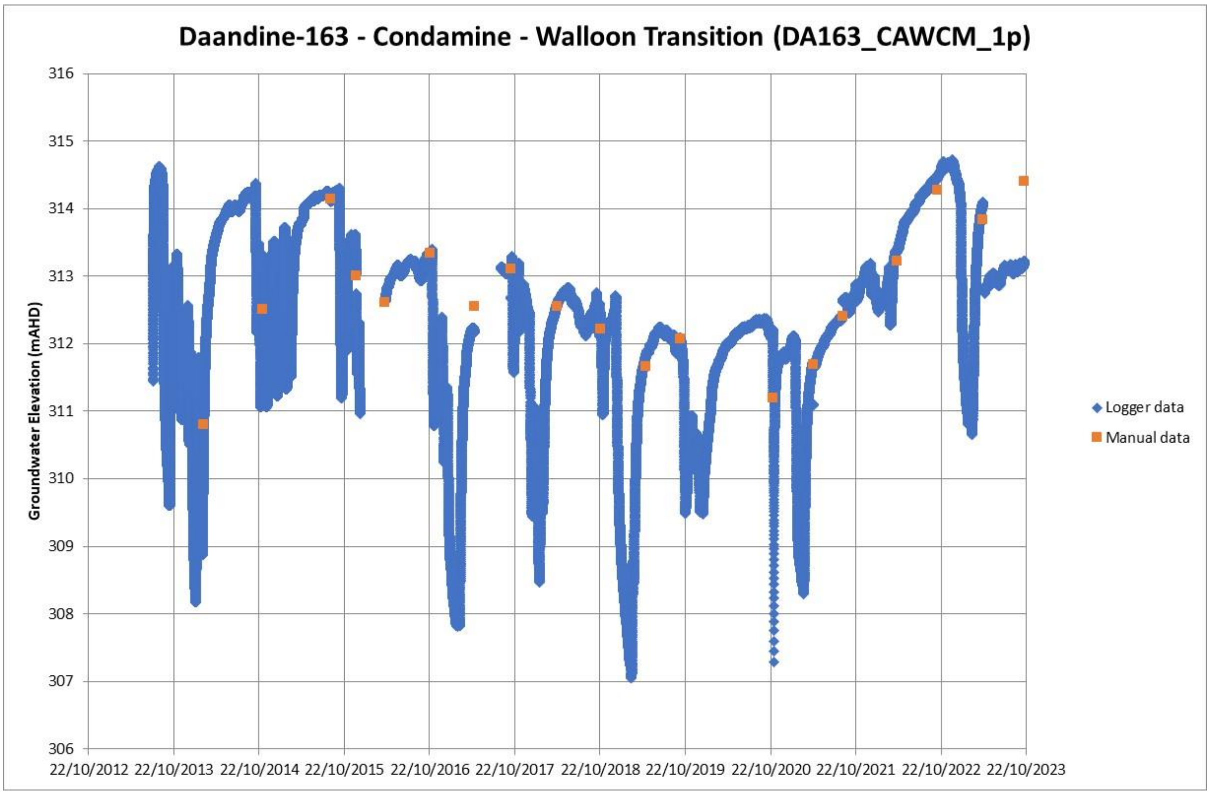

Daandine-124 - Westbourne Formation (DA124_WF_1p)
Groundwater Elevation (mAHD)
316.6
316.4
316.2
316
315.8
315.6
315.4
315.2
22/10/2012
22/10/2013
22/10/2014
23/10/2015
22/10/2016
22/10/2017
22/10/2018
23/10/2019
22/10/2020
22/10/2021
22/10/2022
23/10/2023
Logger data
Manual data

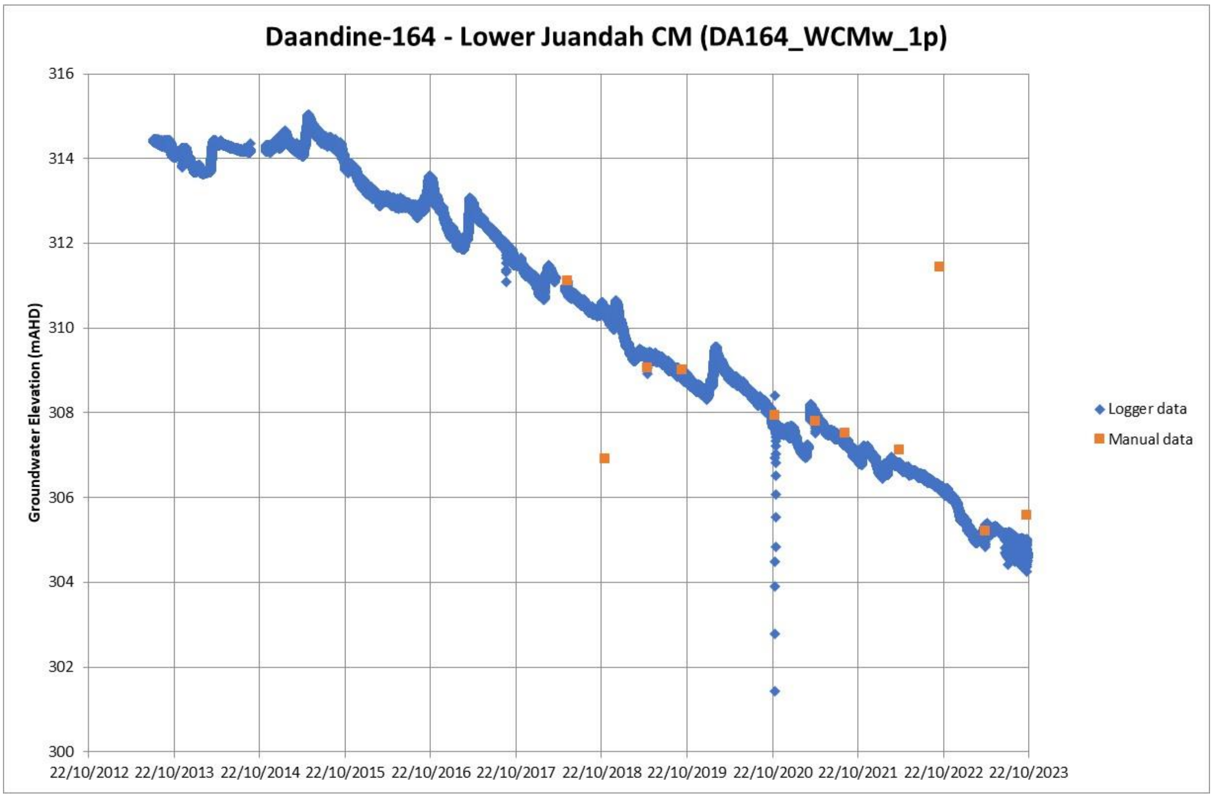

Daandine-134 - Taroom CM (DA134_WCMc_1p)
Groundwater Elevation (mAHD)
120
100
80
60
40
20
0
-20
-40
-60
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

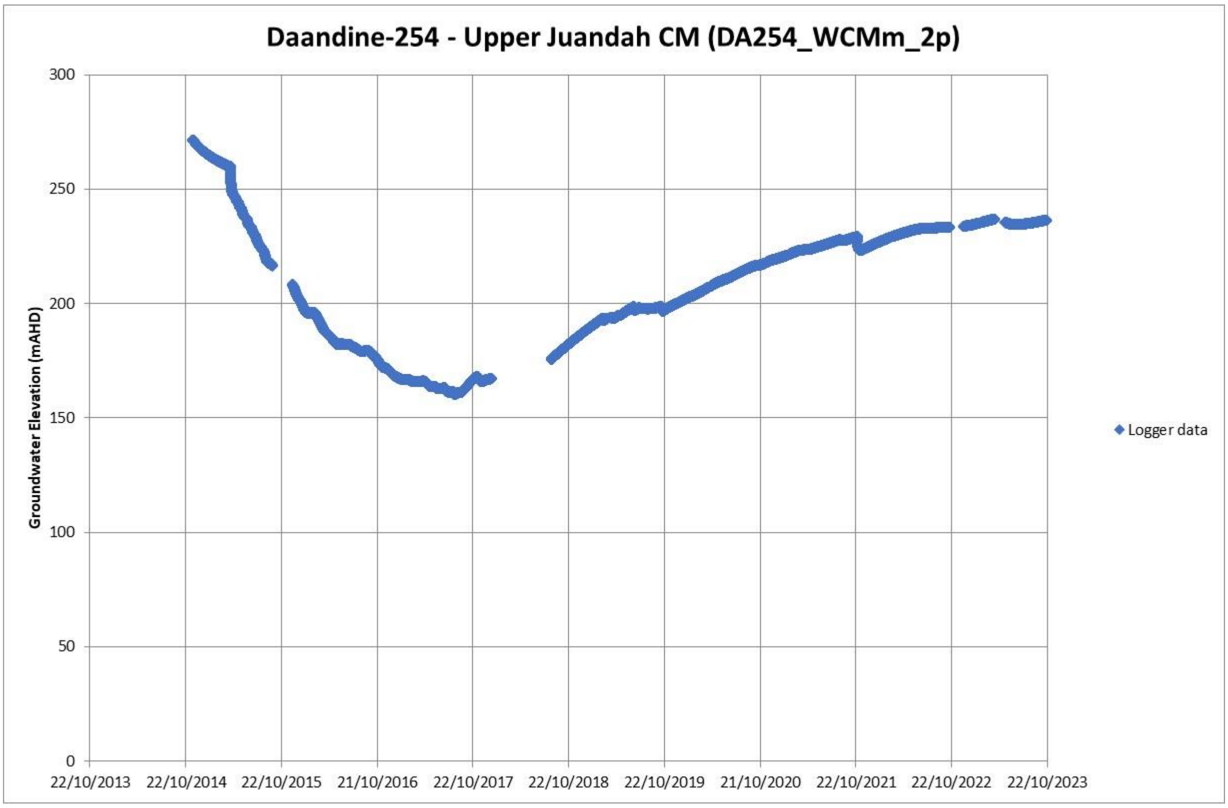

Daandine-134 - Eurombah Formation (DA134_WCMe_1p)
Groundwater Elevation (mAHD)
340
338
336
334
332
330
328
326
324
322
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

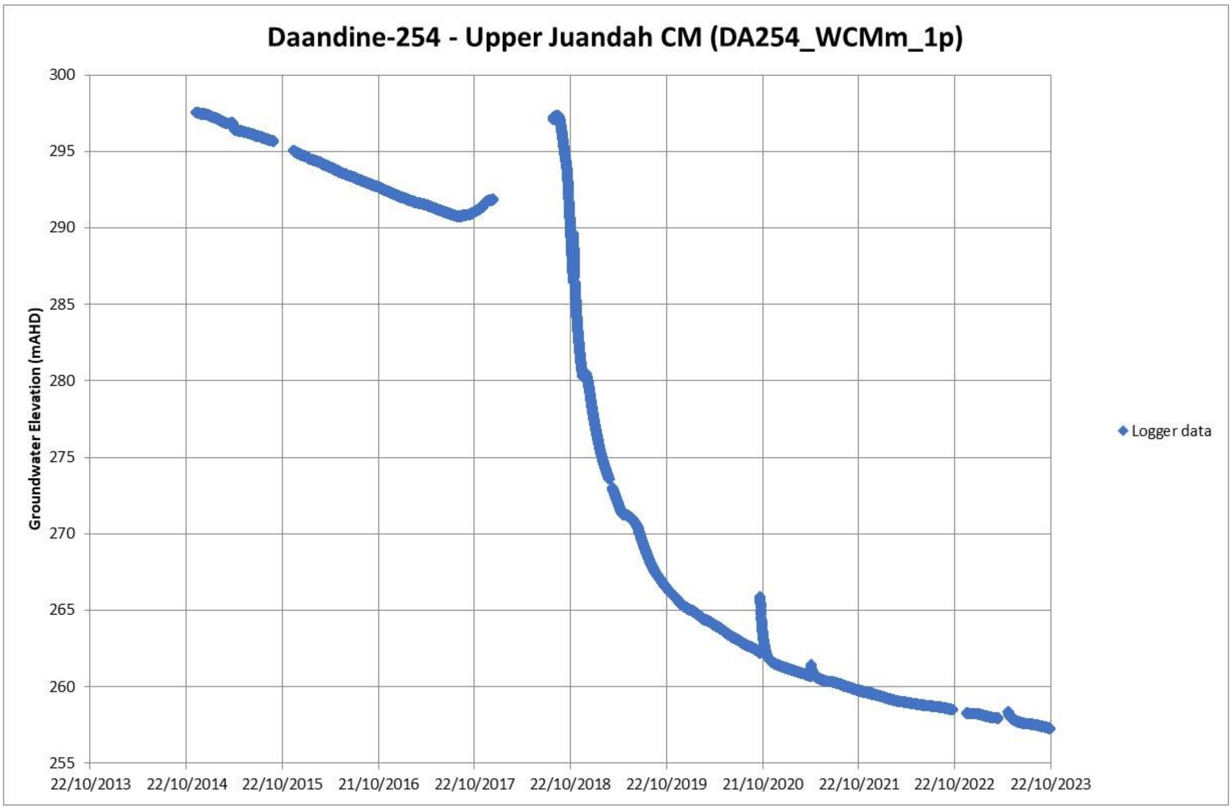

Daandine-134 - Tangalooma Sandstone (DA134_WCMts_1p)
Groundwater Elevation (mAHD)
350
330
310
290
270
250
230
210
190
170
150
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

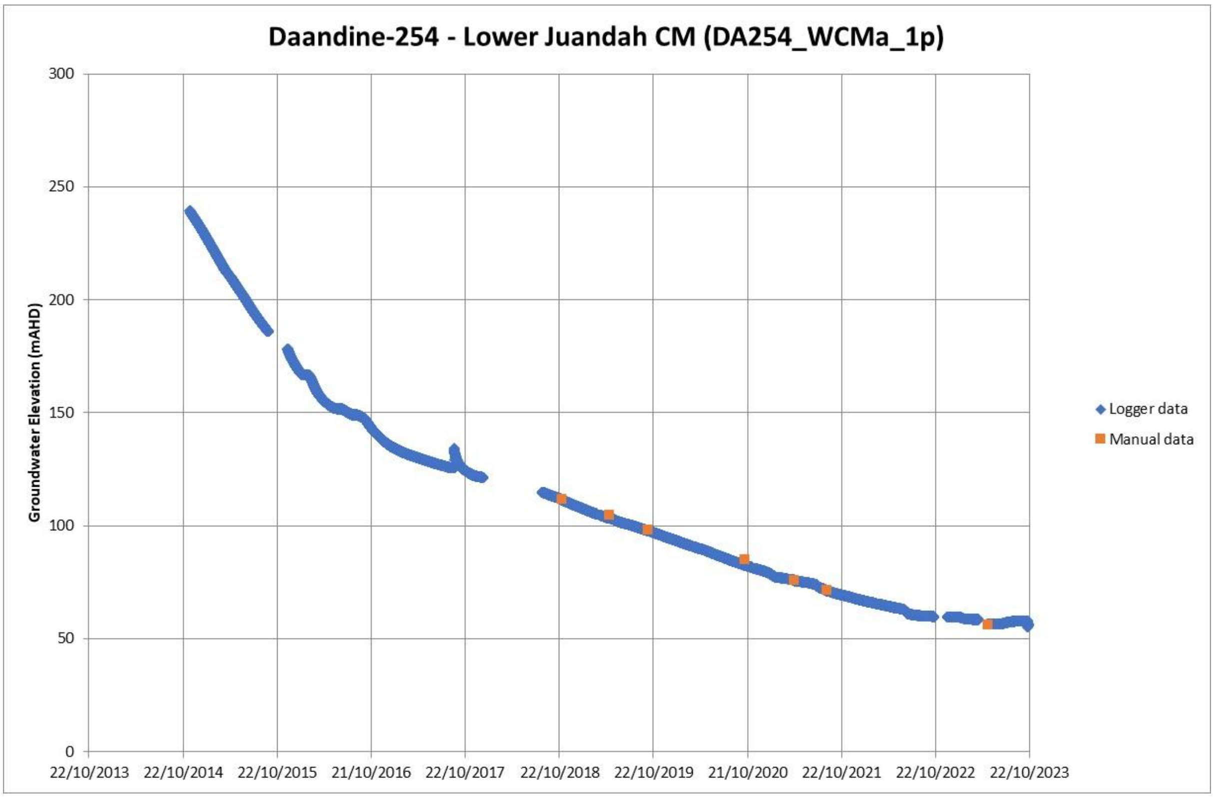

Daandine-161 - Condamine Alluvium (DA161_CA_1p)
Groundwater Elevation (mAHD)
316
315
314
313
312
311
310
309
308
307
306
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

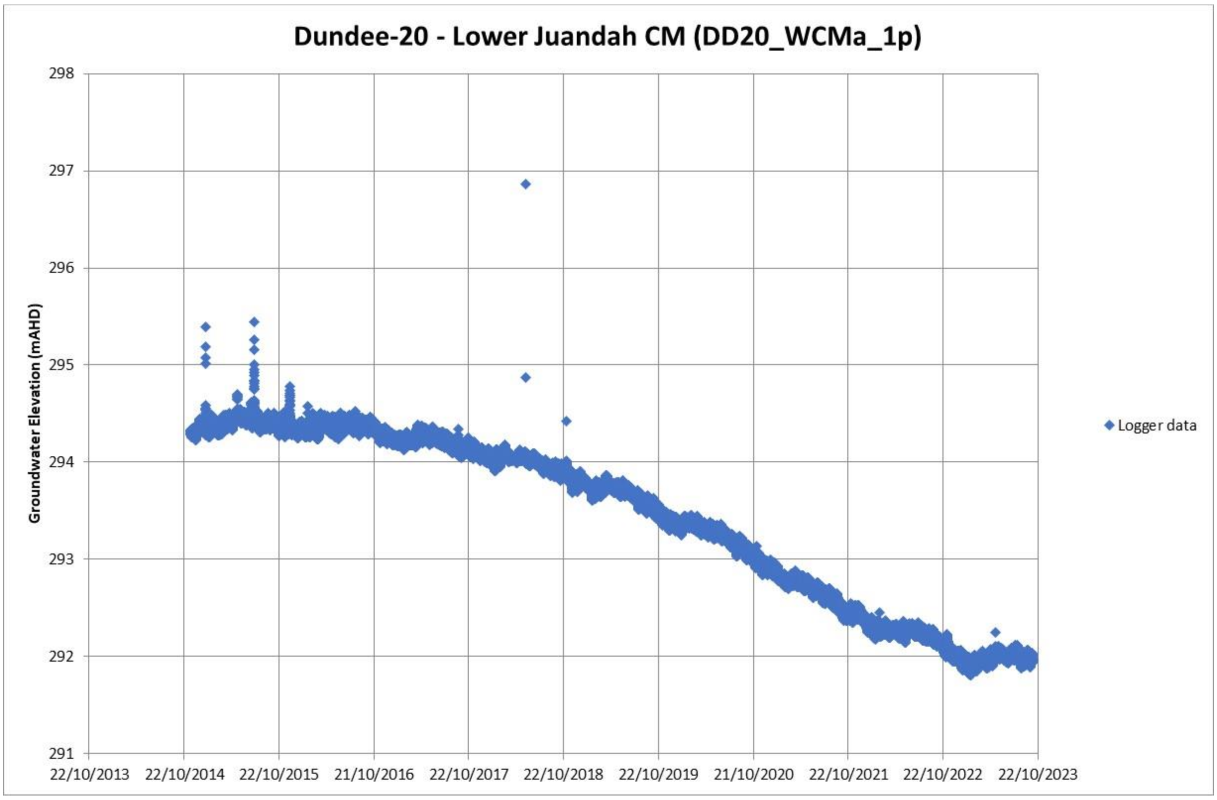

Daandine-163 - Condamine - Walloon Transition (DA163_CAWCM_1p)
Groundwater Elevation (mAHD)
316
315
314
313
312
311
310
309
308
307
306
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

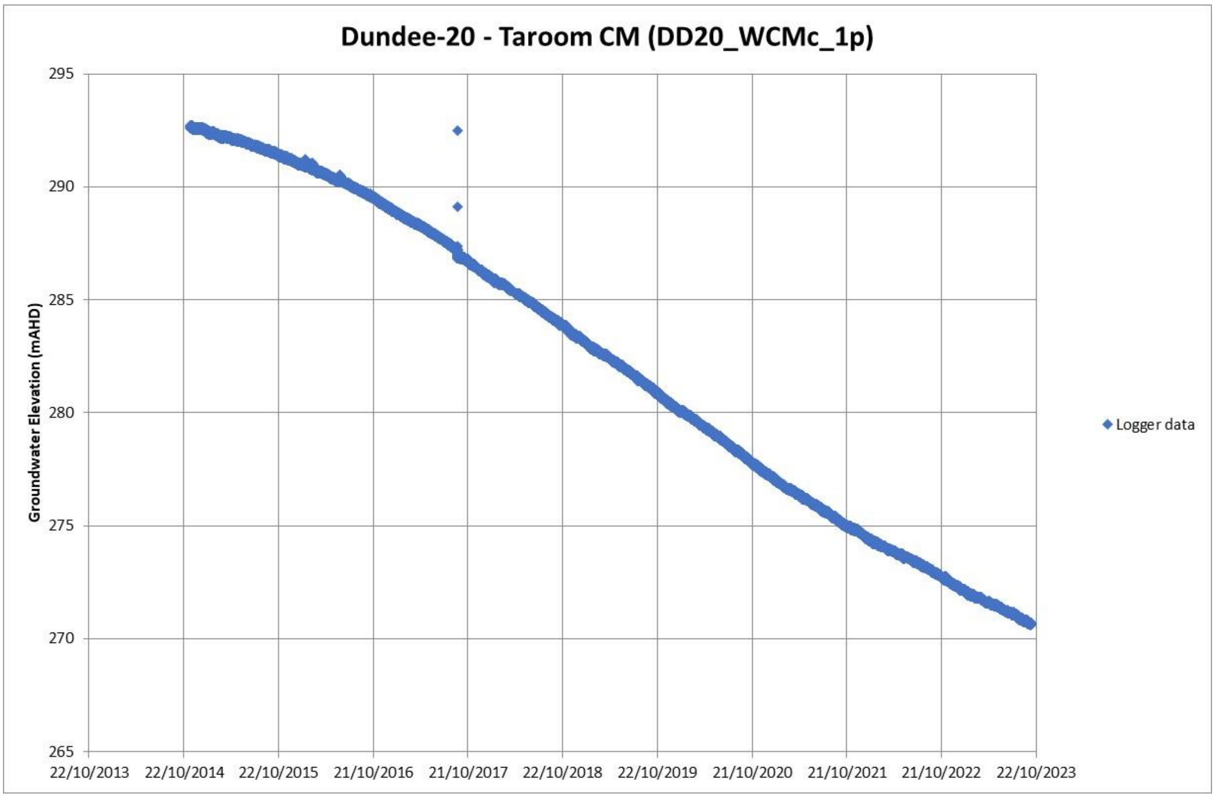

Daandine-164 - Lower Juandah CM (DA164_WCMw_1p)
Groundwater Elevation (mAHD)
316
314
312
310
308
306
304
302
300
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data


Daandine-254 - Upper Juandah CM (DA254_WCMm_2p)
Groundwater Elevation (mAHD)
300
250
200
150
100
50
0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

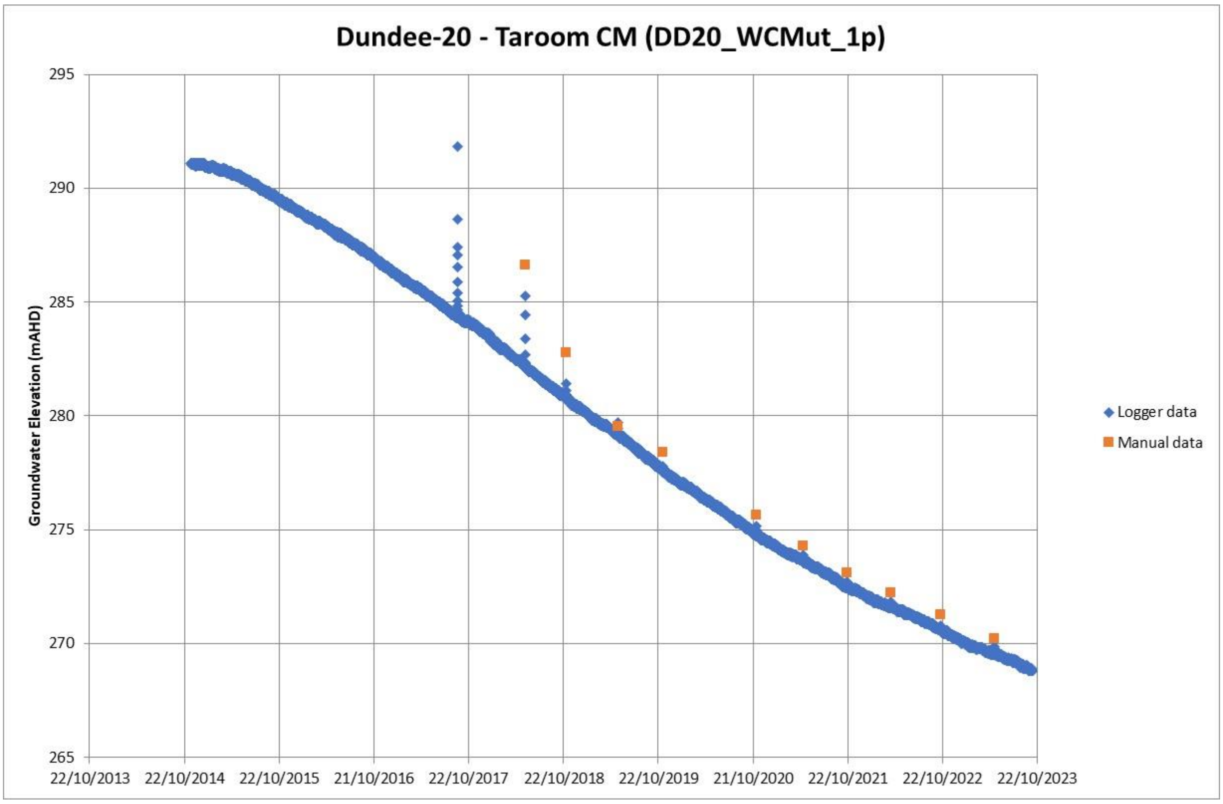

Daandine-254 - Upper Juandah CM (DA254_WCMm_1p)
Groundwater Elevation (mAHD)
300
295
290
285
280
275
270
265
260
255
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data


Daandine-254 - Lower Juandah CM (DA254_WCMa_1p)
Groundwater Elevation (mAHD)
300
250
200
150
100
50
0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

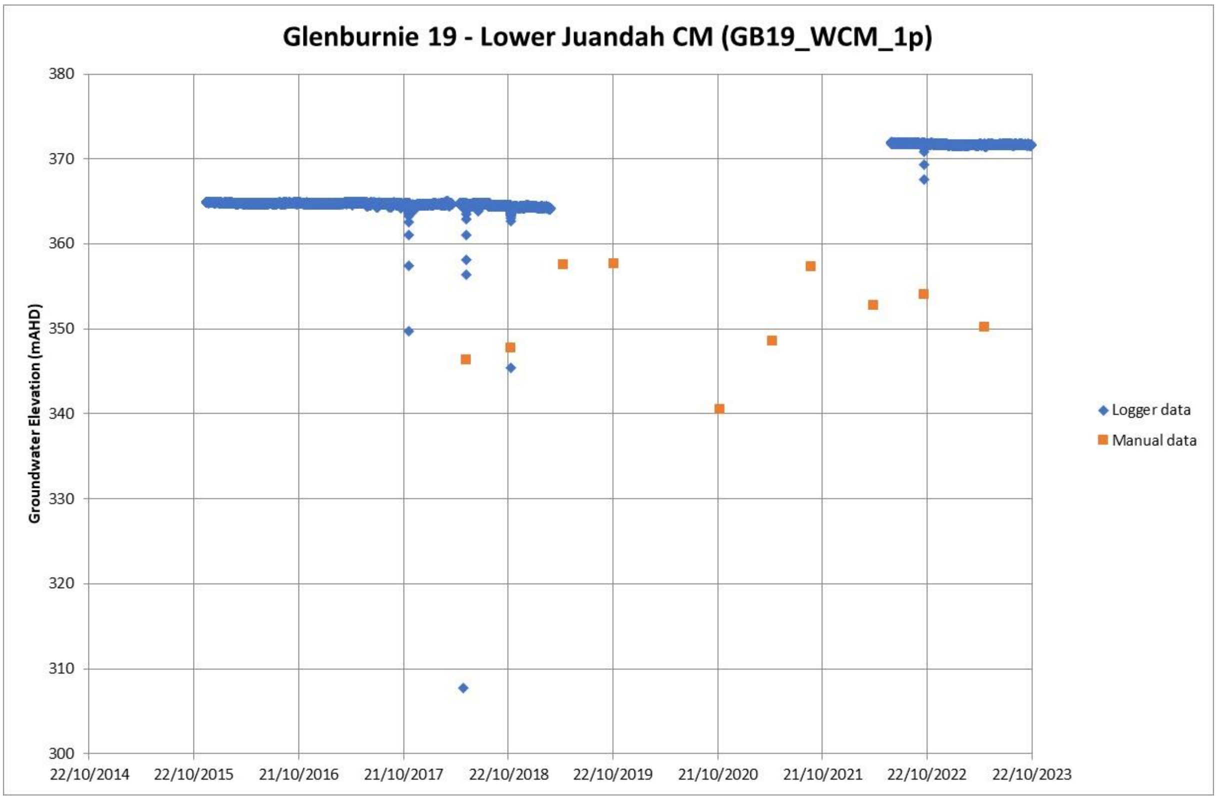

Dundee-20 - Lower Juandah CM (DD20_WCMa_1p)
Groundwater Elevation (mAHD)
298
297
296
295
294
293
292
291
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

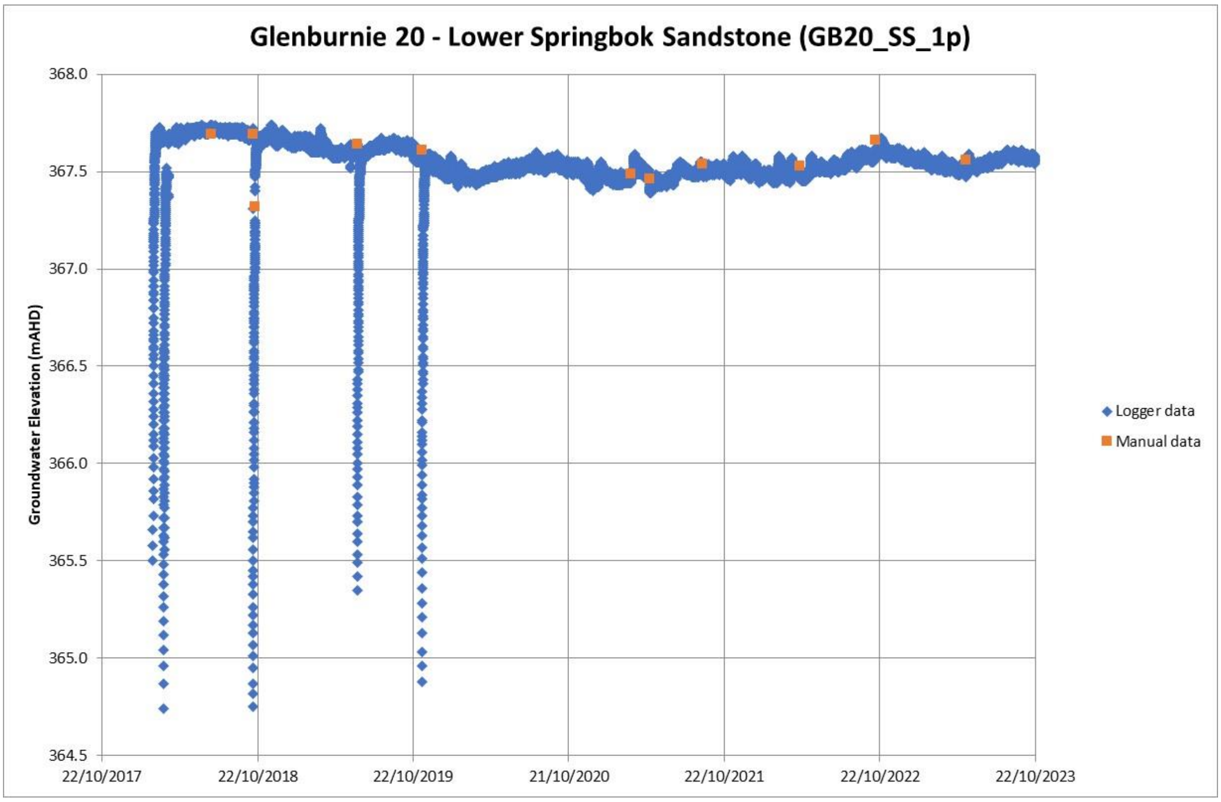


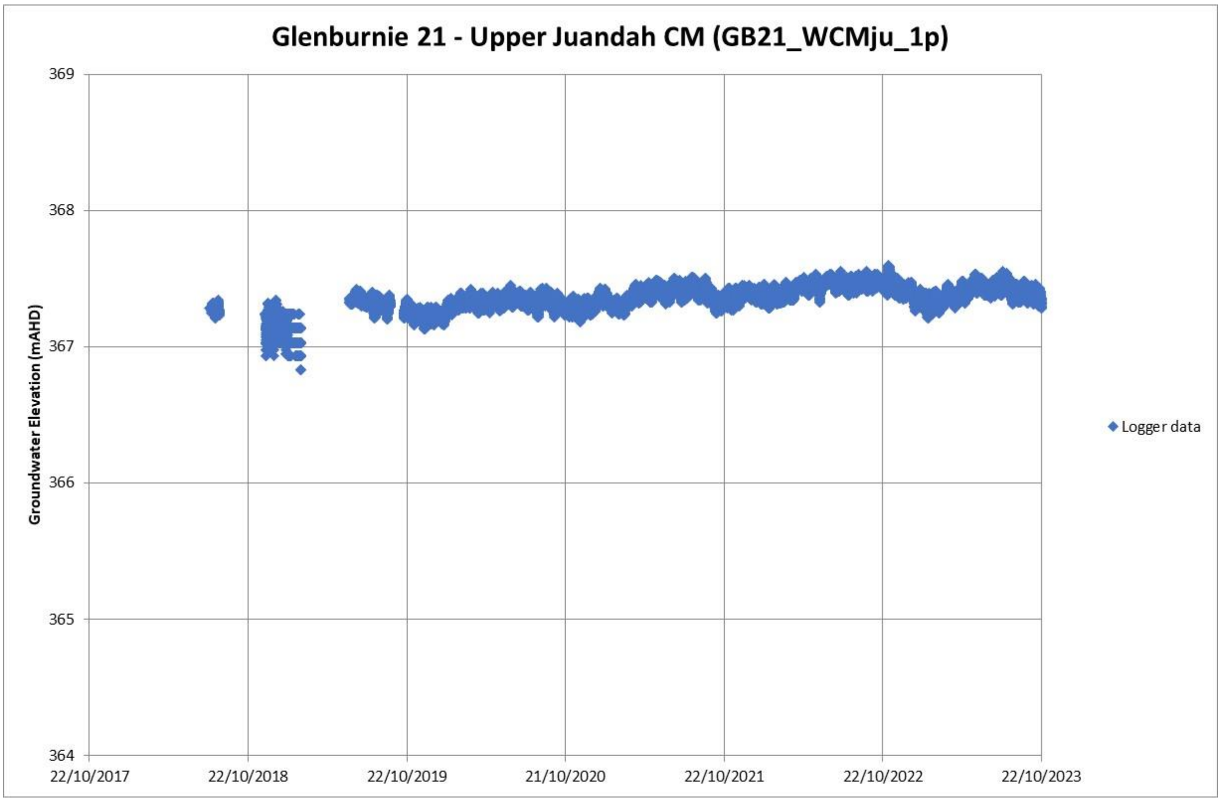
Dundee-20 - Taroom CM (DD20_WCMc_1p)
Groundwater Elevation (mAHD)
295
290
285
280
275
270
265
22/10/2013
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data

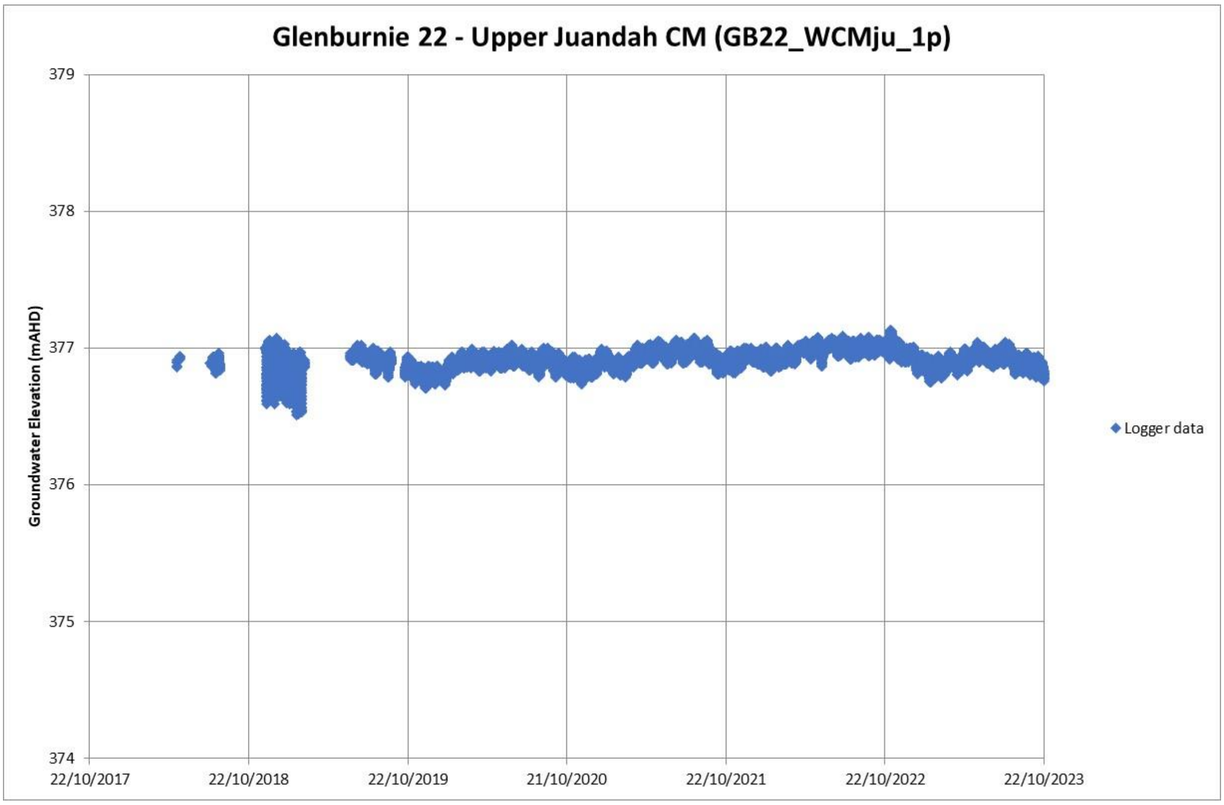


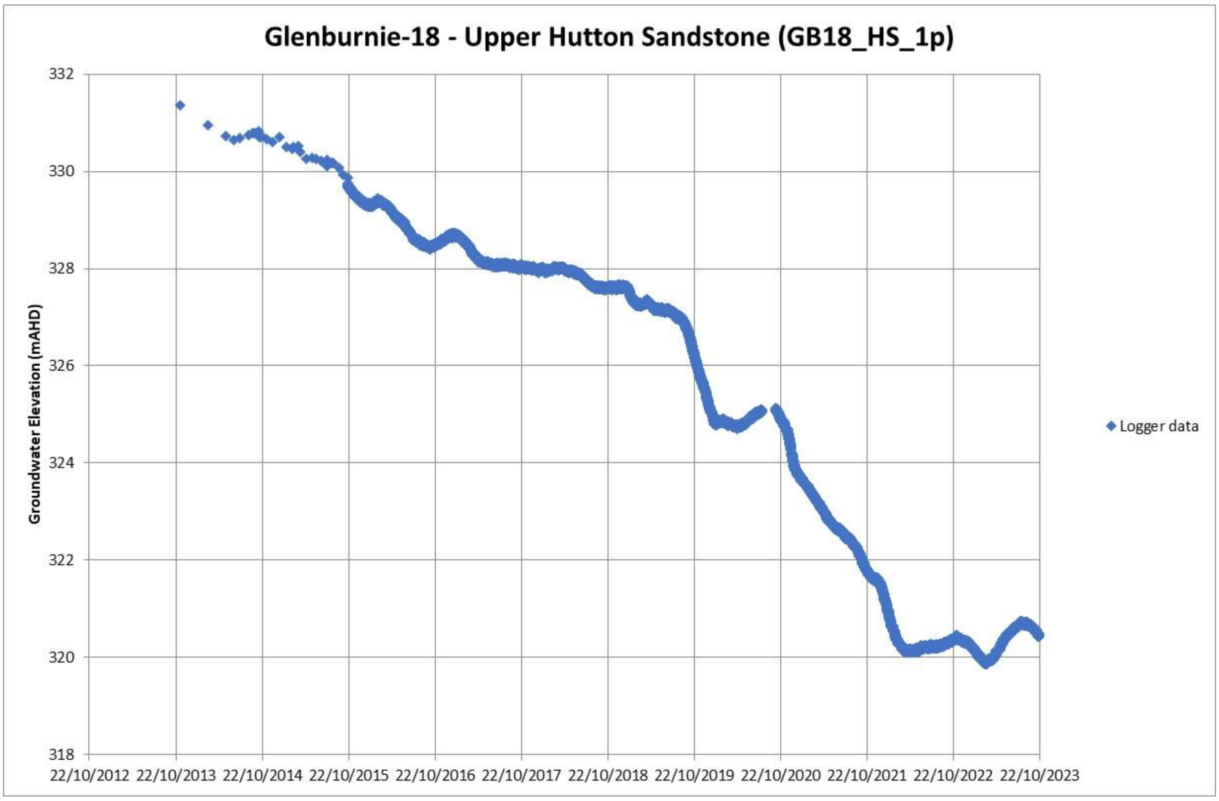
Dundee-20 - Taroom CM (DD20_WCMut_1p)
Groundwater Elevation (mAHD)
295
290
285
280
275
270
265
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

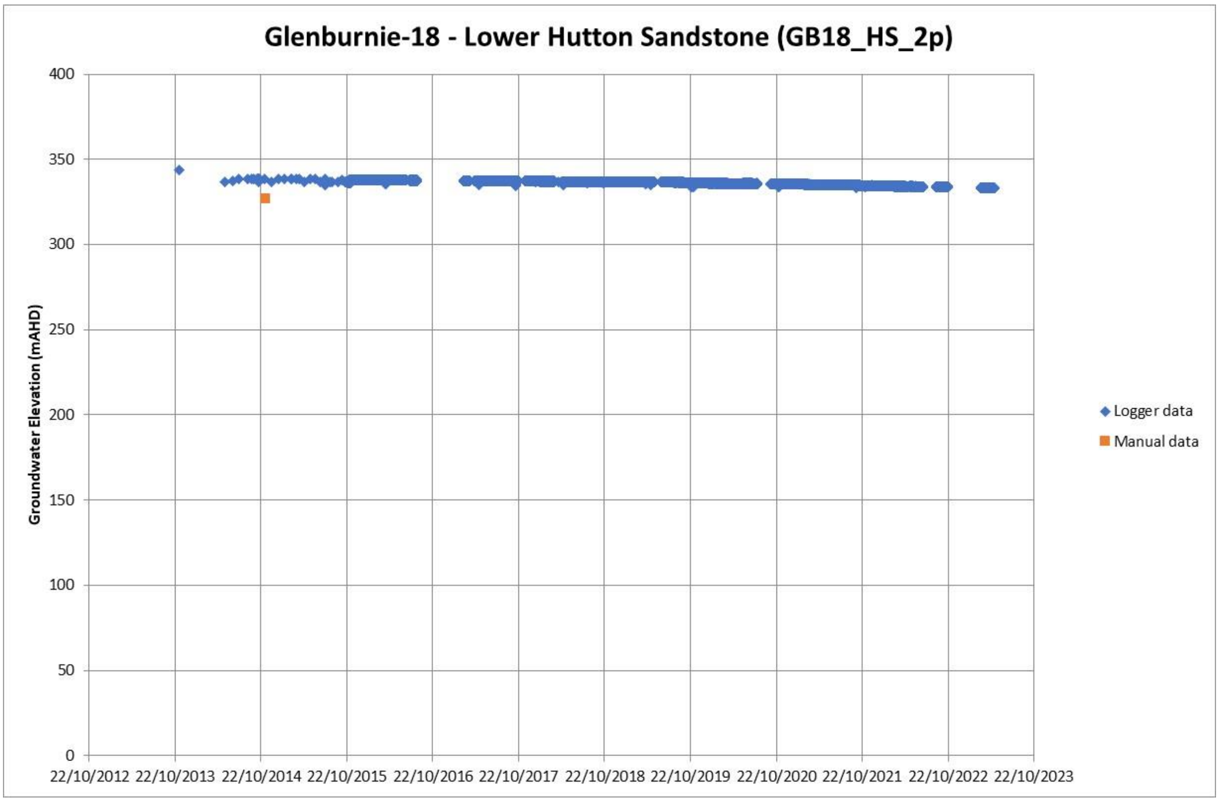

Glenburnie 19 - Lower Juandah CM (GB19_WCM_1p)
Groundwater Elevation (mAHD)
380
370
360
350
340
330
320
310
300
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

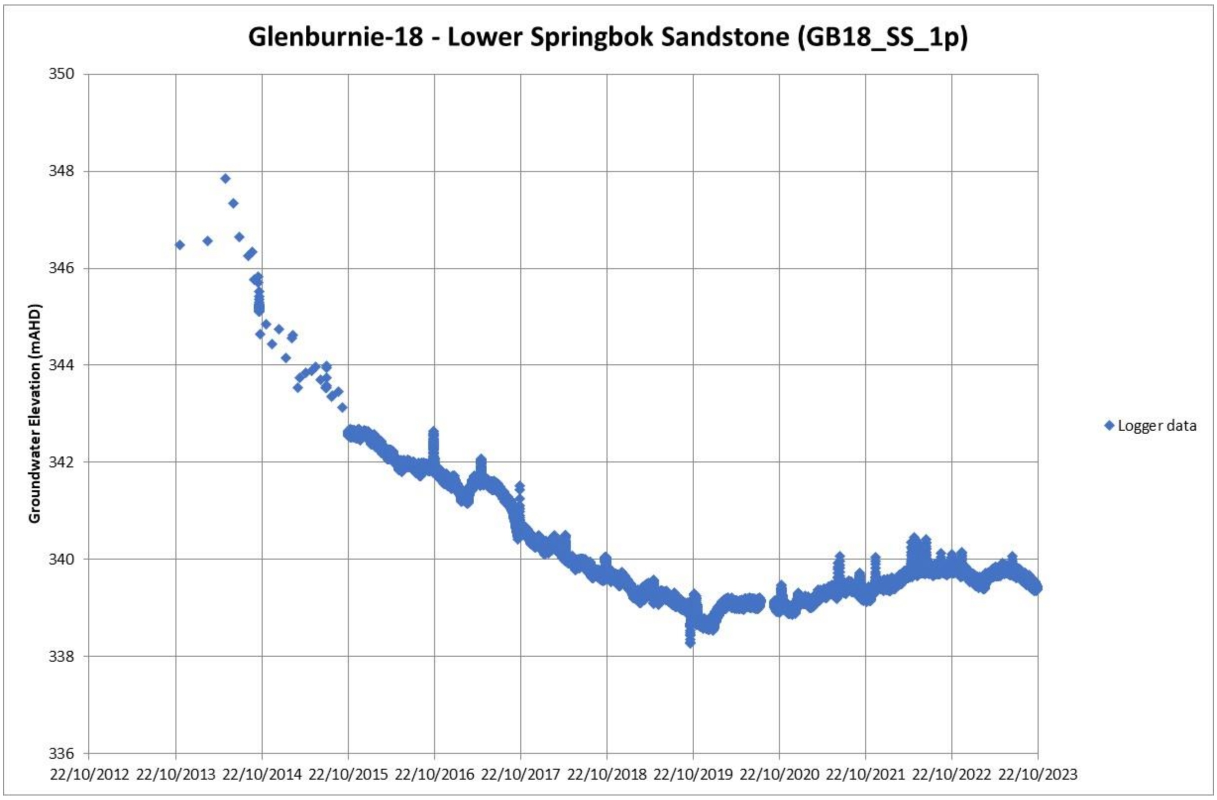

Glenburnie 20 - Lower Springbok Sandstone (GB20_SS_1p)
Groundwater Elevation (mAHD)
368.0
367.5
367.0
366.5
366.0
365.5
365.0
364.5
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

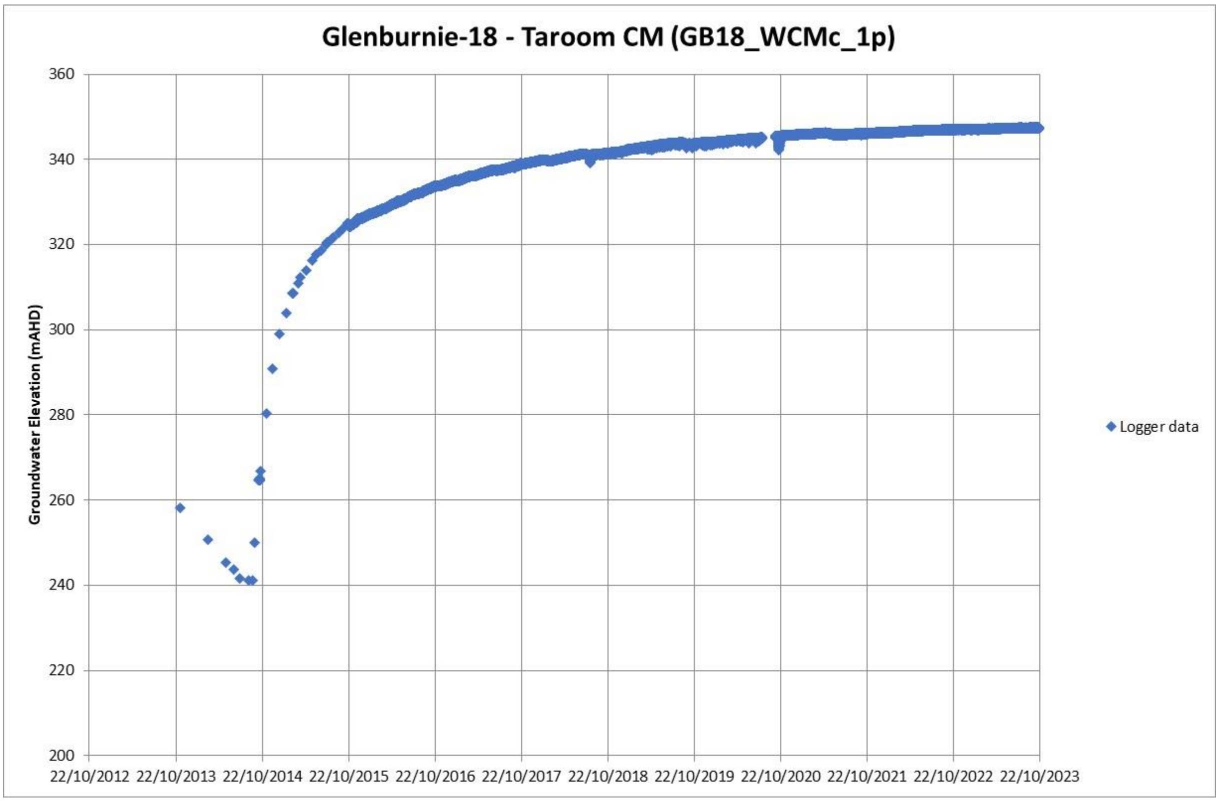

Glenburnie 21 - Upper Juandah CM (GB21_WCMju_1p)
Groundwater Elevation (mAHD)
369
368
367
366
365
364
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

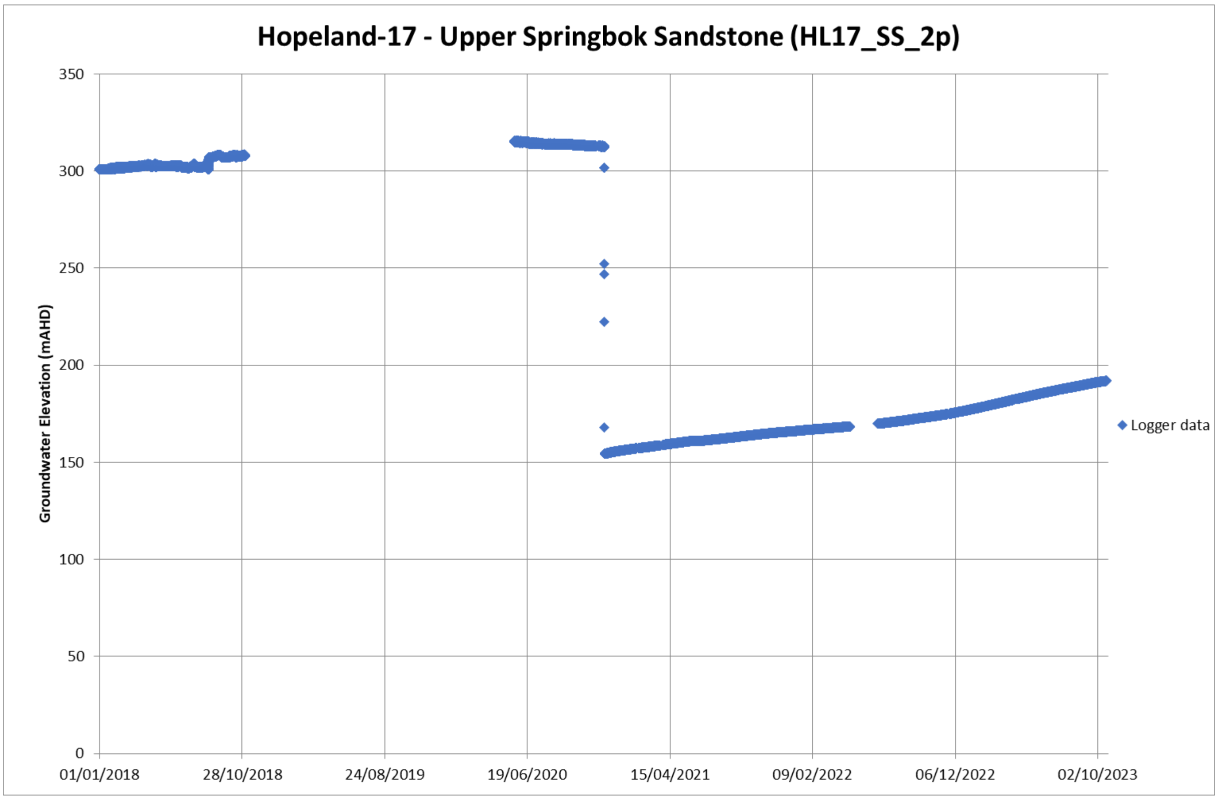

Glenburnie 22 - Upper Juandah CM (GB22_WCMju_1p)
Groundwater Elevation (mAHD)
379
378
377
376
375
374
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

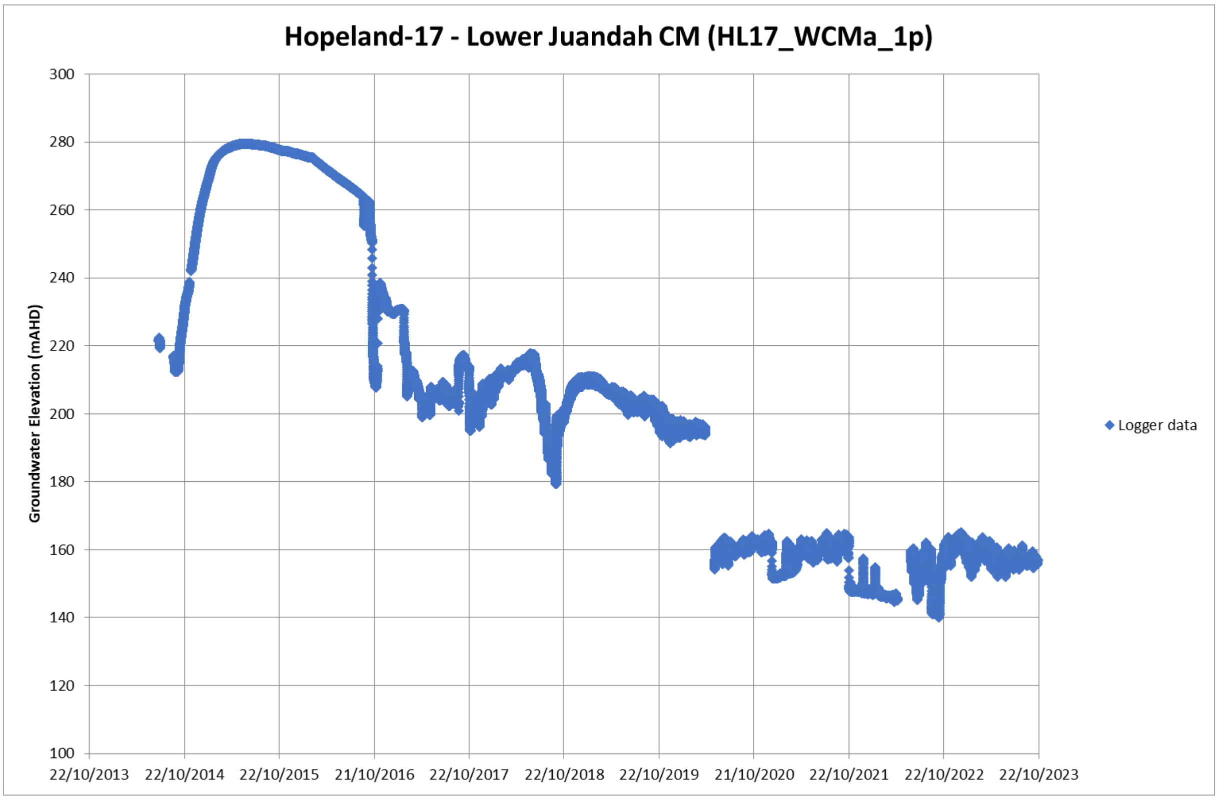

Glenburnie-18 - Upper Hutton Sandstone (GB18_HS_1p)
Groundwater Elevation (mAHD)
332
330
328
326
324
322
320
318
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data

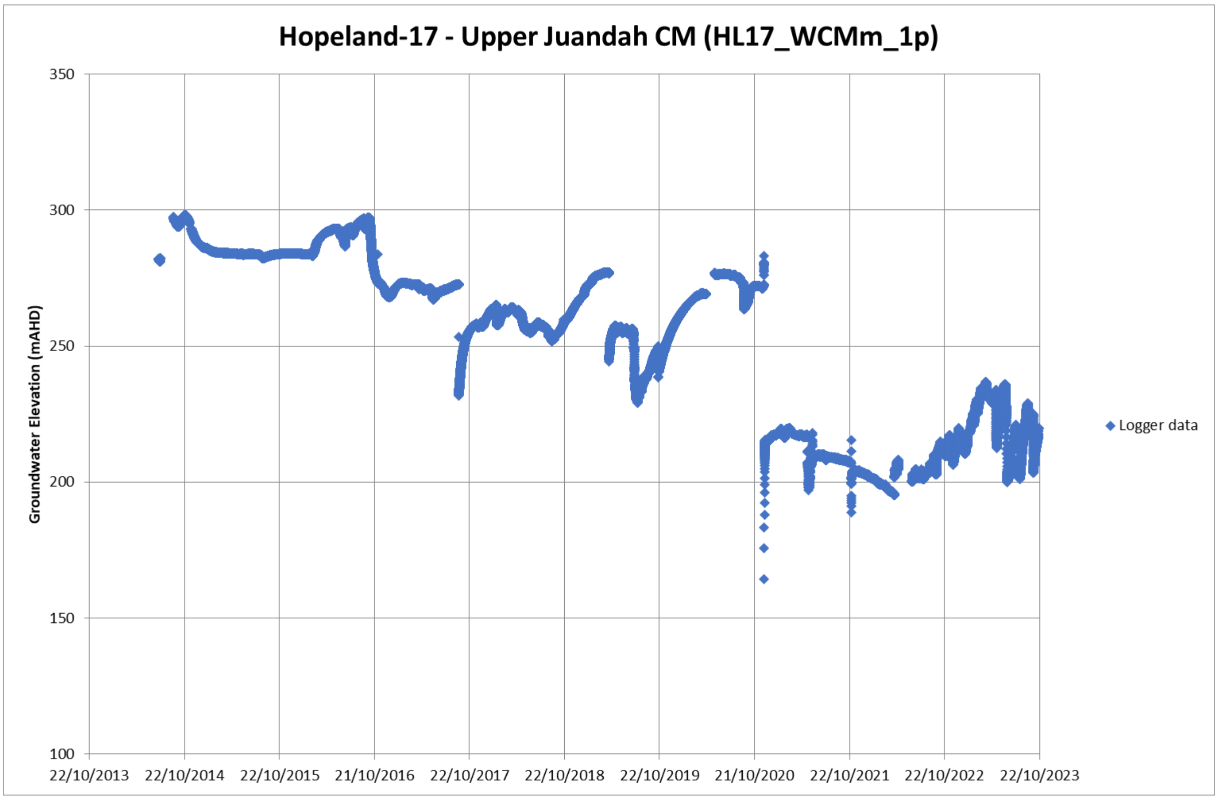

Glenburnie-18 - Lower Hutton Sandstone (GB18_HS_2p)
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

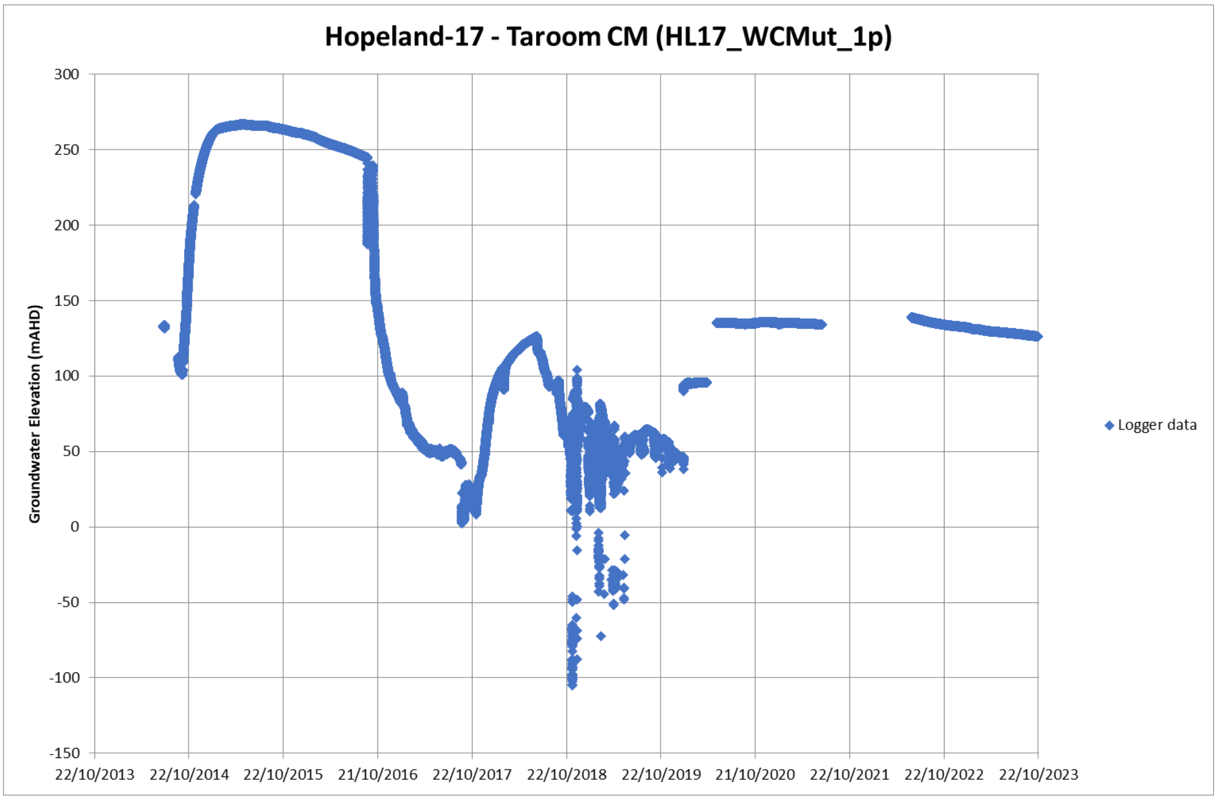

Glenburnie-18 - Lower Springbok Sandstone (GB18_SS_1p)
Groundwater Elevation (mAHD)
350
348
346
344
342
340
338
336
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data

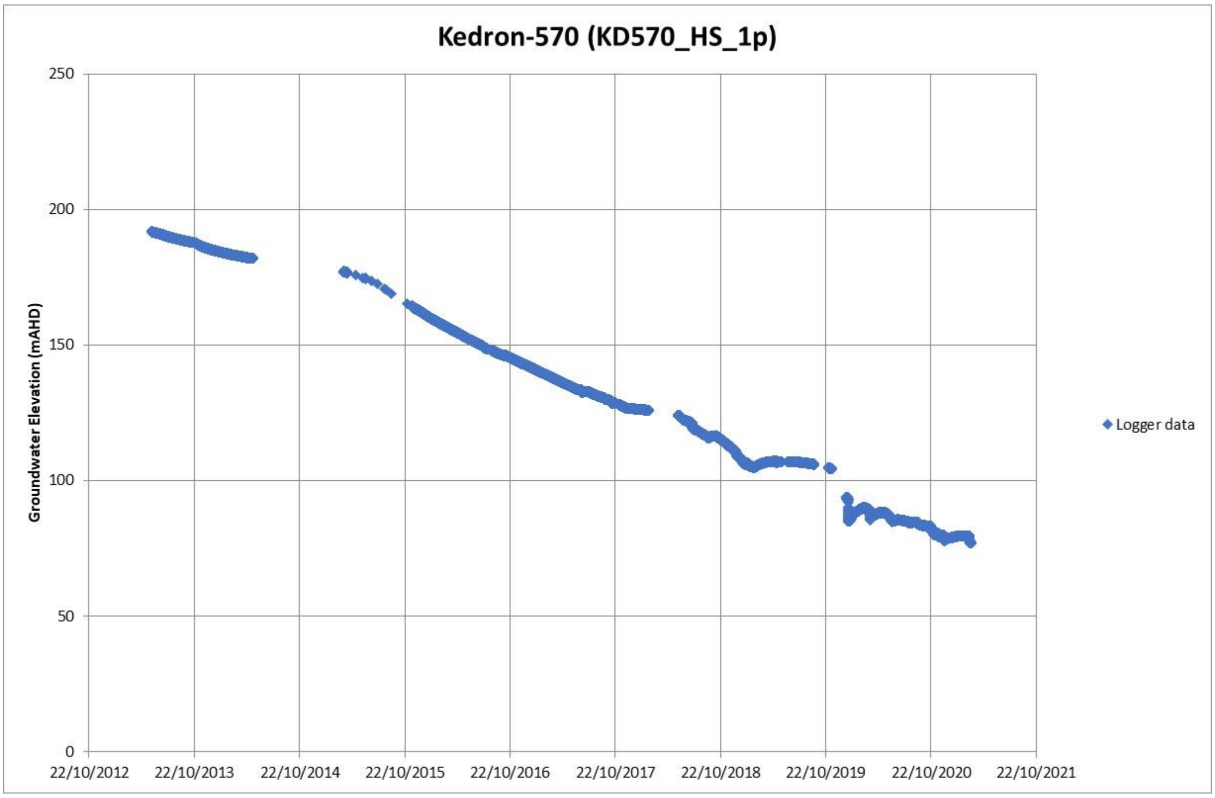

Glenburnie-18 - Taroom CM (GB18_WCMc_1p)
Groundwater Elevation (mAHD)
360
340
320
300
280
260
240
220
200
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data

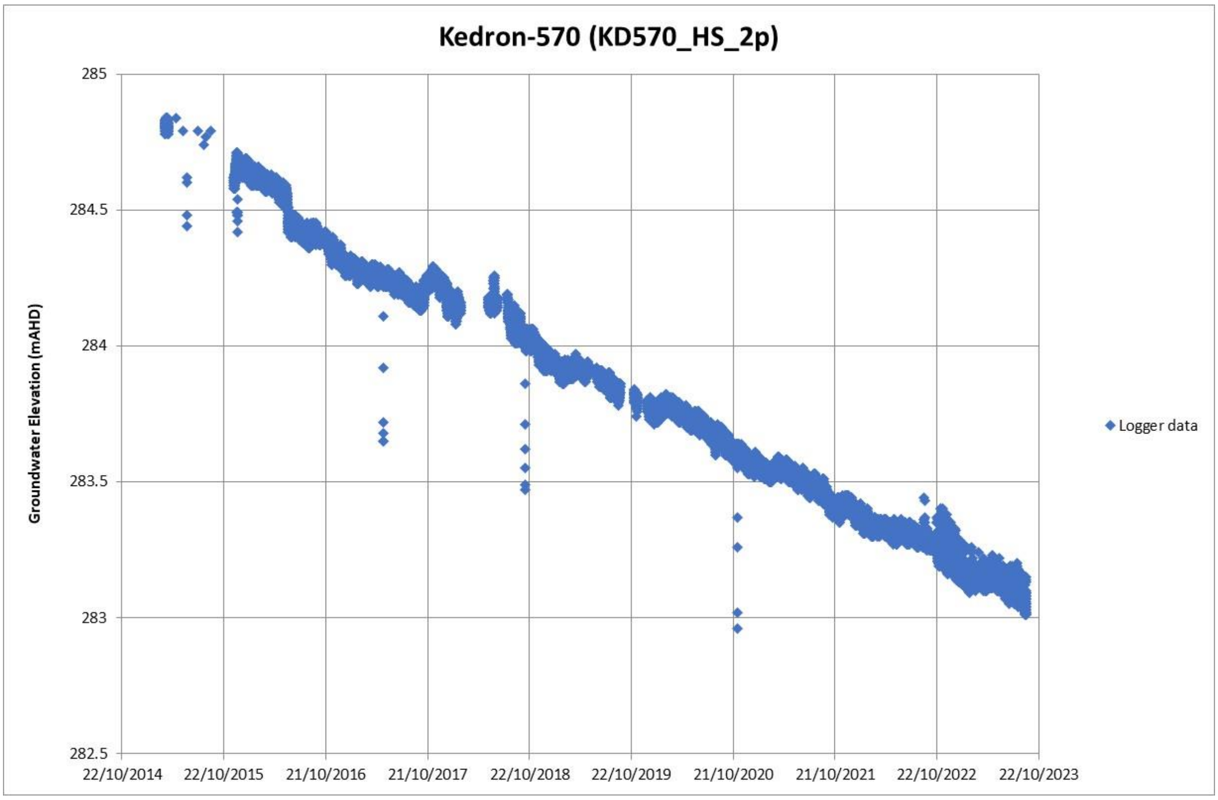

Hopeland-17 - Upper Springbok Sandstone (HL17_SS_2p)
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
01/01/2018
28/10/2018
24/08/2019
19/06/2020
15/04/2021
09/02/2022
06/12/2022
02/10/2023
Logger data

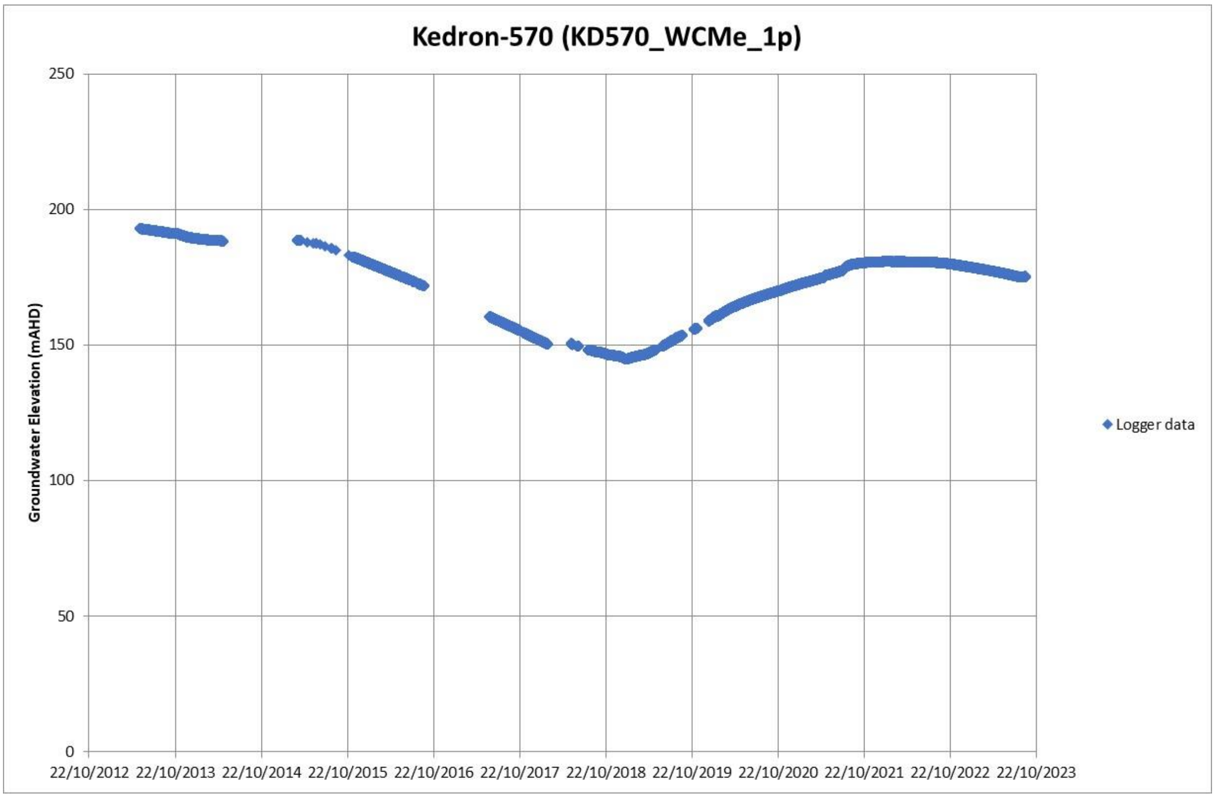

Hopeland-17 - Lower Juandah CM (HL17_WCMa_1p)
Groundwater Elevation (mAHD)
300
280
260
240
220
200
180
160
140
120
100
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

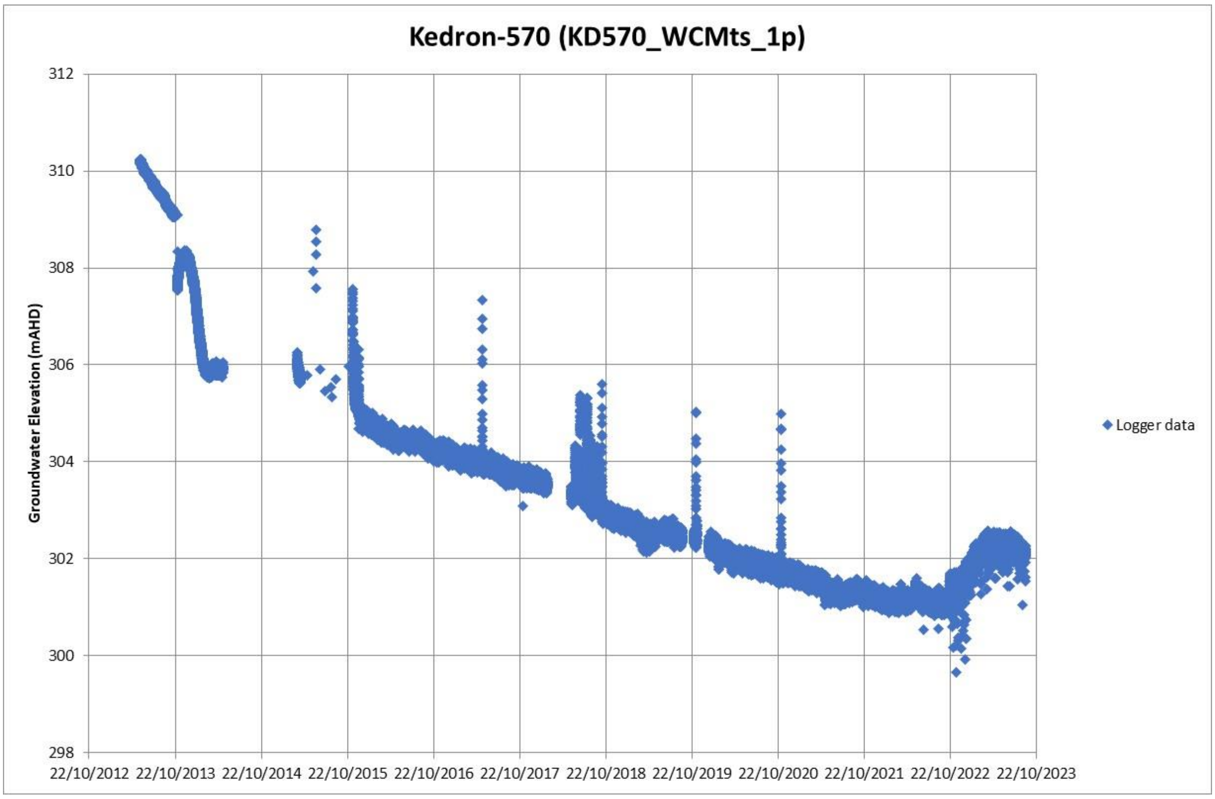

Hopeland-17 - Upper Juandah CM (HL17_WCMm_1p)
Groundwater Elevation (mAHD)
350
300
250
200
150
100
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

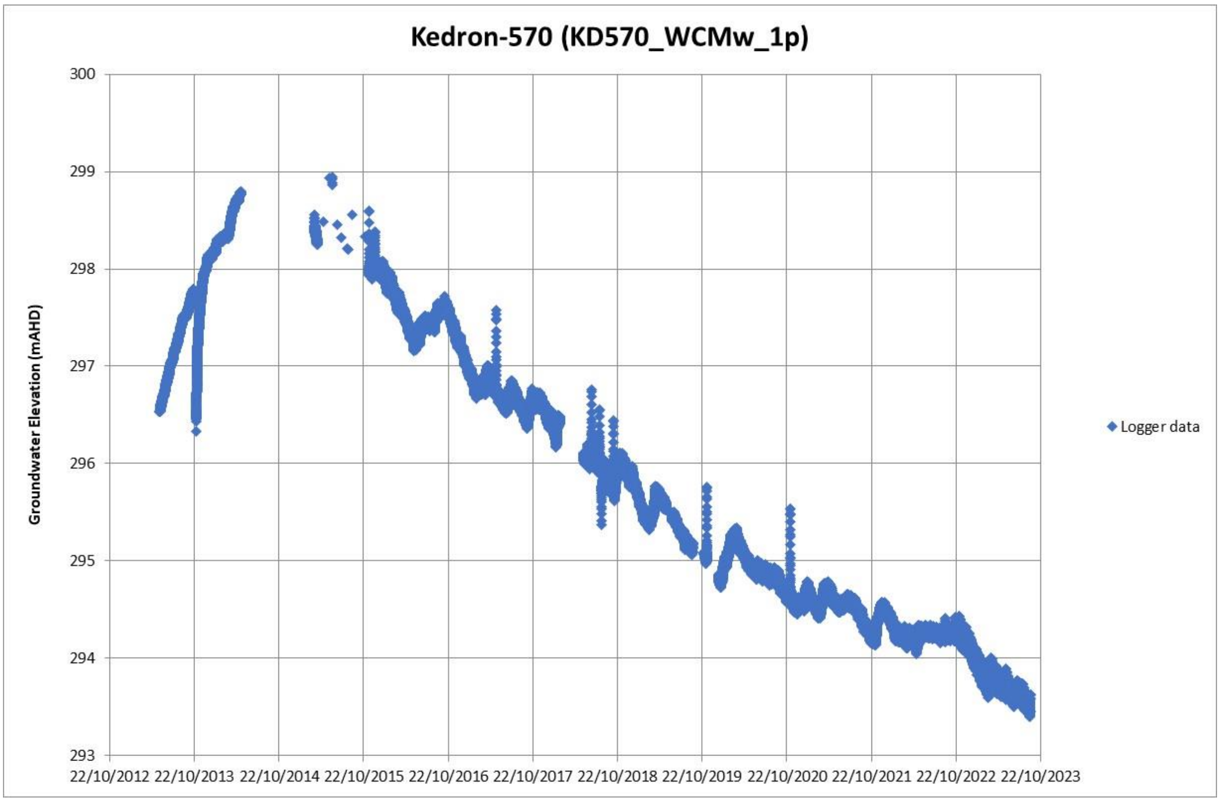

Hopeland-17 - Taroom CM (HL17_WCMut_1p)
Groundwater Elevation (mAHD)
300
250
200
150
100
50
0
-50
-100
-150
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

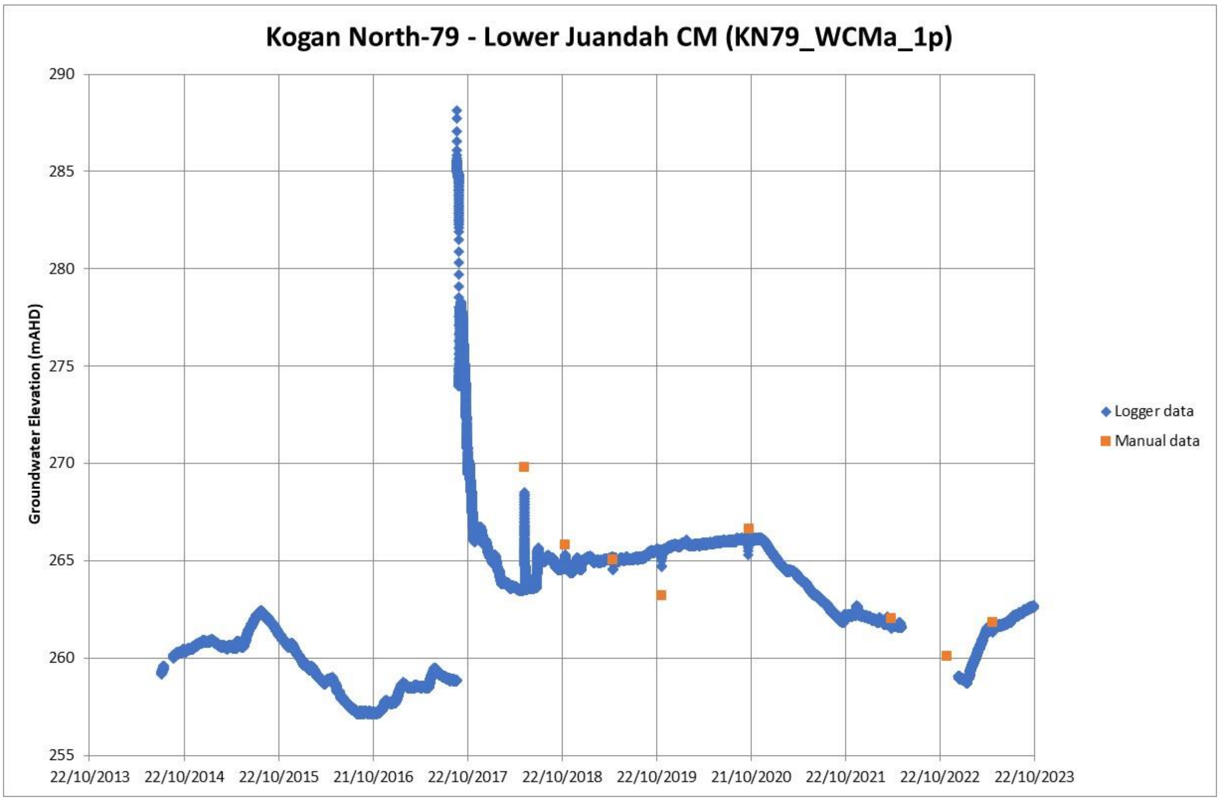

Kedron-570 (KD570_HS_1p)
Groundwater Elevation (mAHD)
250
200
150
100
50
0
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
Logger data

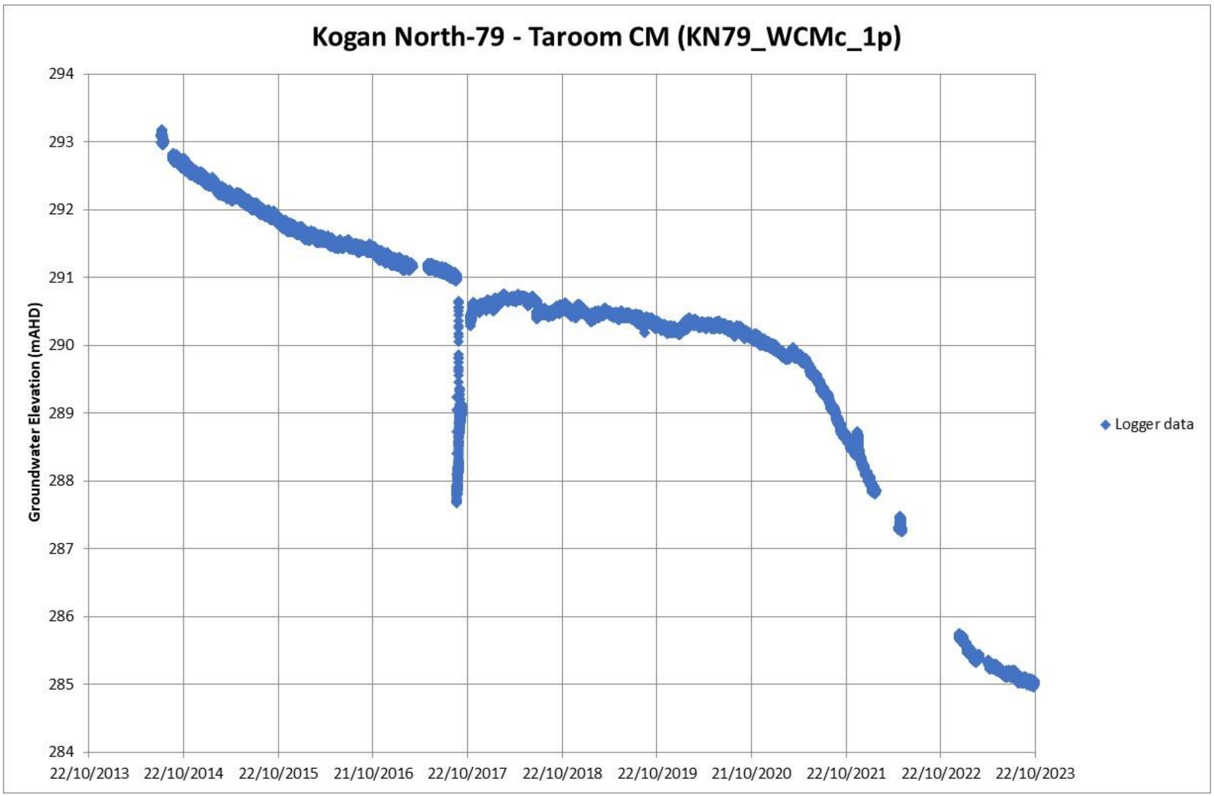

Kedron-570 (KD570_HS_2p)
Groundwater Elevation (mAHD)
285
284.5
284
283.5
283
282.5
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

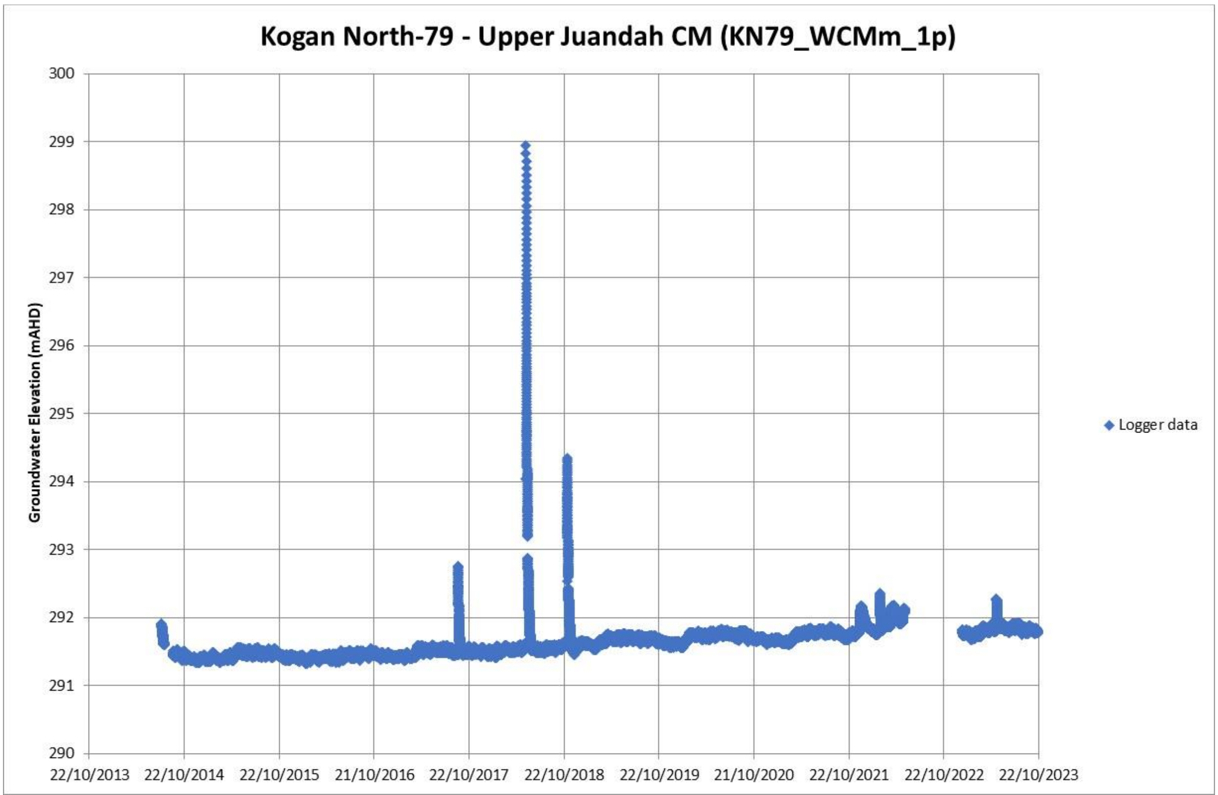

Kedron-570 (KD570_WCMe_1p)
Groundwater Elevation (mAHD)
250
200
150
100
50
0
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data

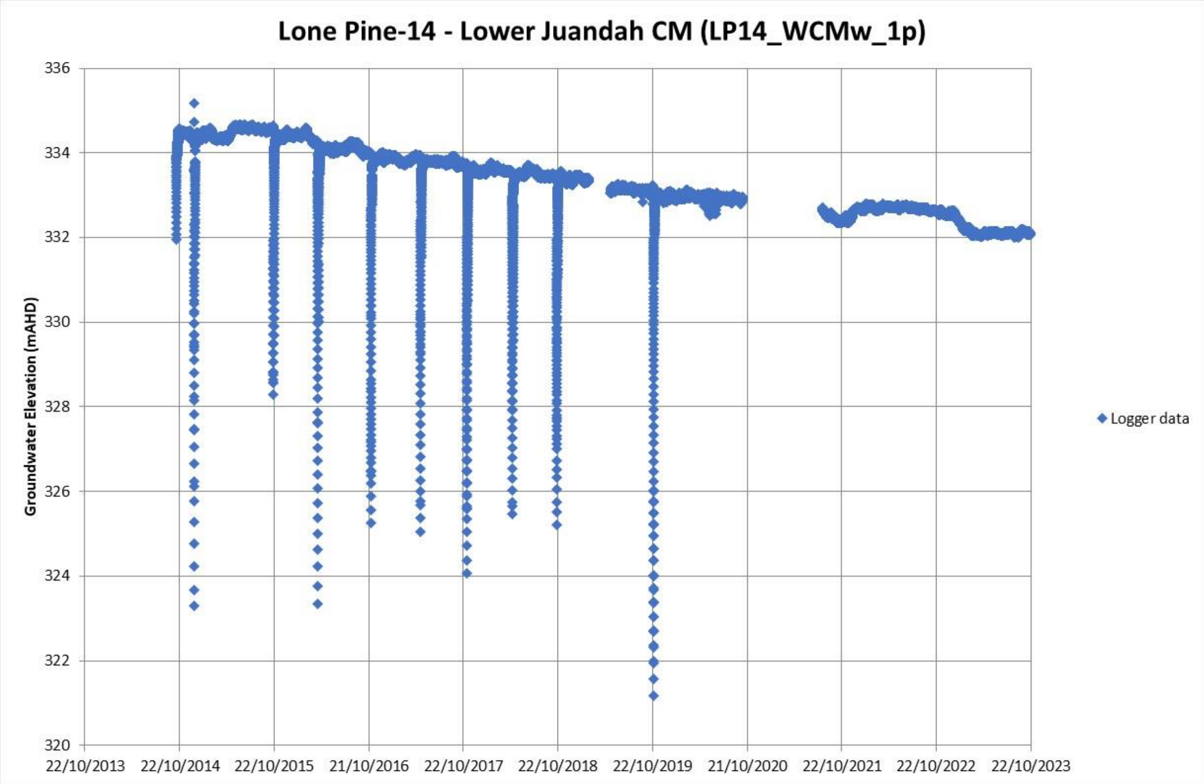

Kedron-570 (KD570_WCMts_1p)
Groundwater Elevation (mAHD)
312
310
308
306
304
302
300
298
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data

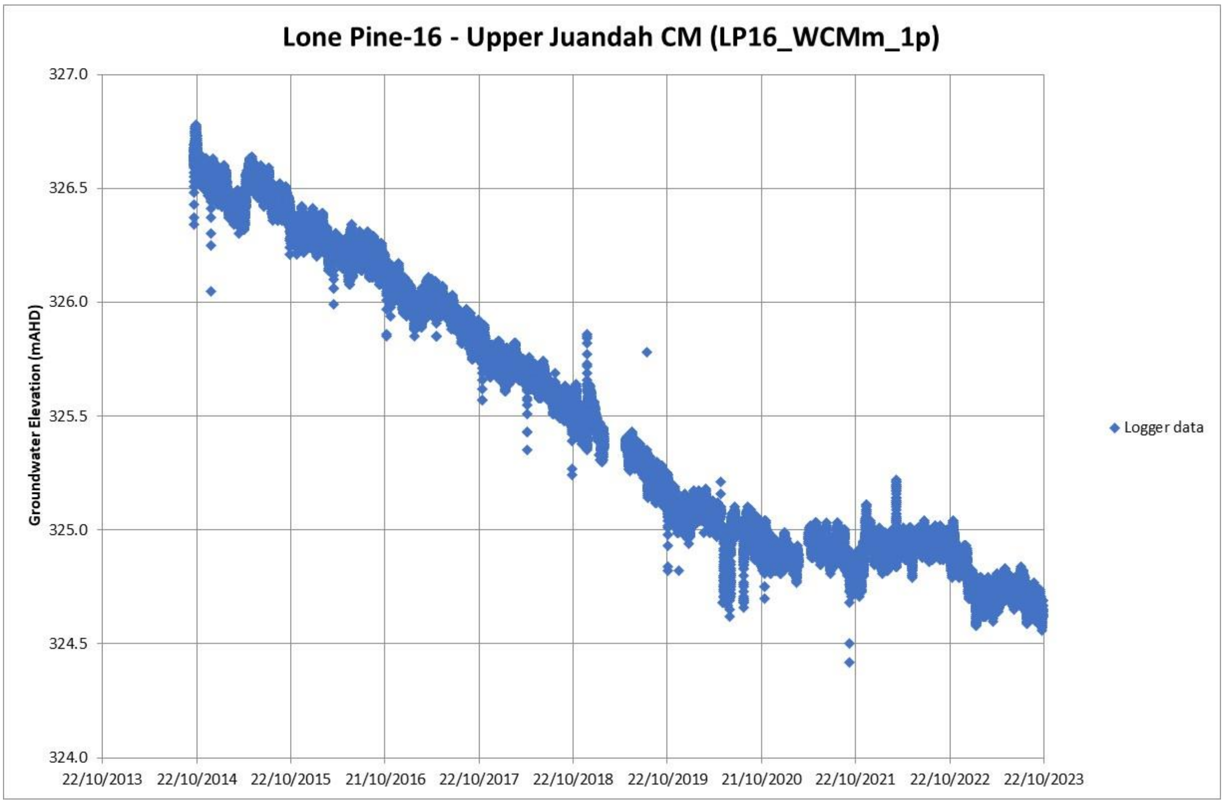

Kedron-570 (KD570_WCMw_1p)
Groundwater Elevation (mAHD)
300
299
298
297
296
295
294
293
22/10/2012 22/10/2013 22/10/2014 22/10/2015 22/10/2016 22/10/2017 22/10/2018 22/10/2019 22/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data

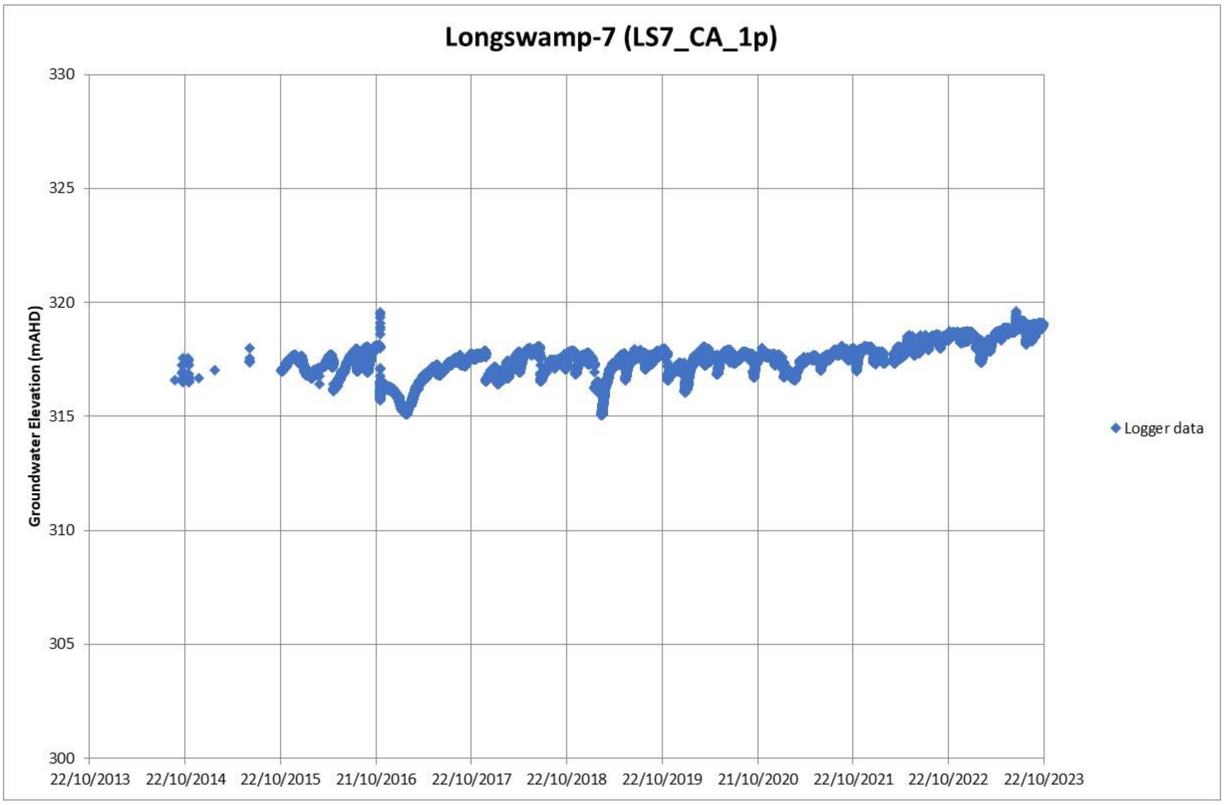

Kogan North-79 - Lower Juandah CM (KN79_WCMa_1p)
Groundwater Elevation (mAHD)
290
285
280
275
270
265
260
255
22/10/2013 22/10/2014 22/10/2015 21/10/2016 22/10/2017 22/10/2018 22/10/2019 21/10/2020 22/10/2021 22/10/2022 22/10/2023
Logger data
Manual data

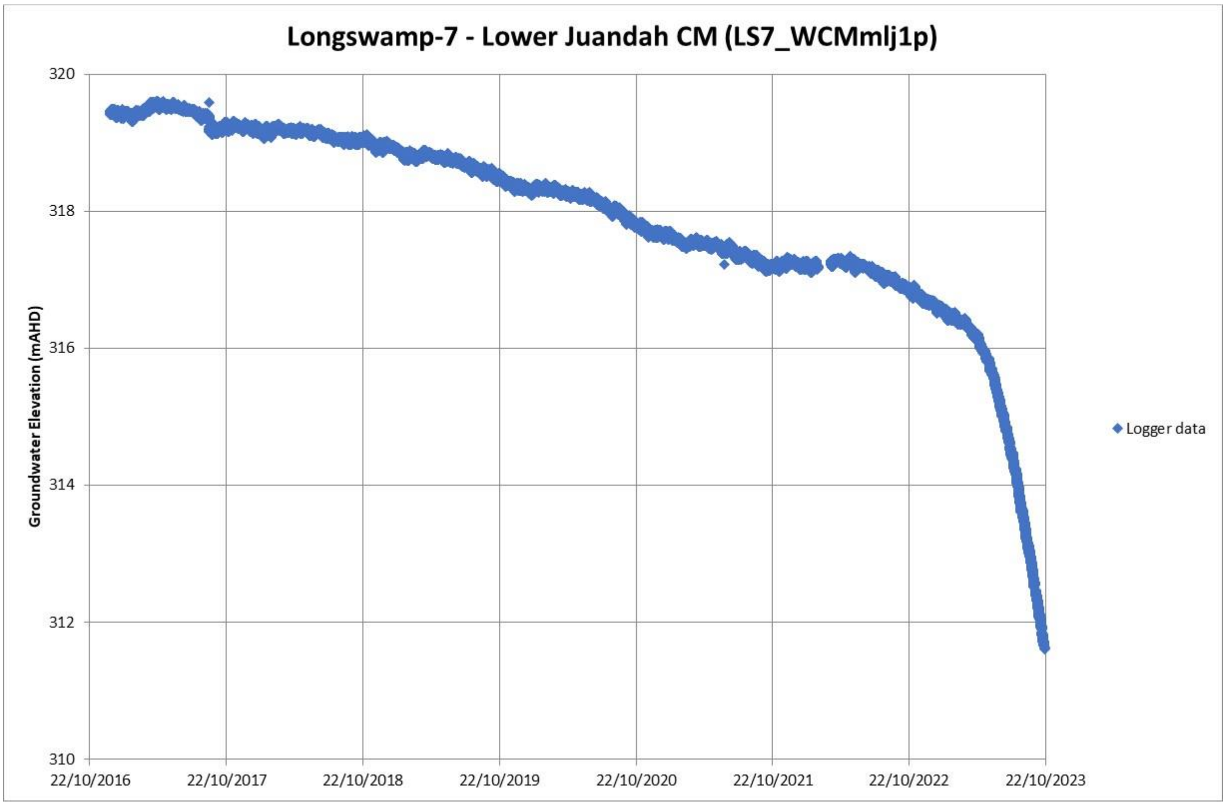

Kogan North-79 - Taroom CM (KN79_WCMc_1p)
Groundwater Elevation (mAHD)
294
293
292
291
290
289
288
287
286
285
284
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

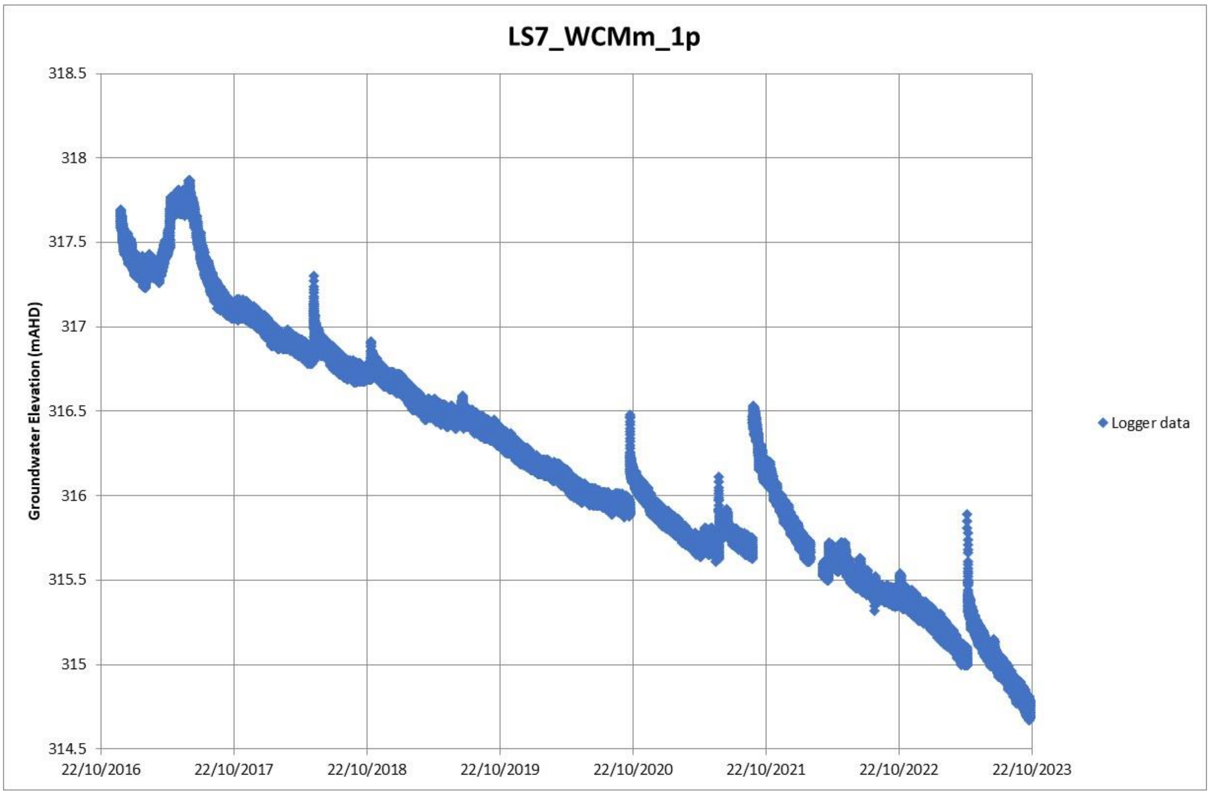

Kogan North-79 - Upper Juandah CM (KN79_WCMm_1p)
Groundwater Elevation (mAHD)
300
299
298
297
296
295
294
293
292
291
290
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

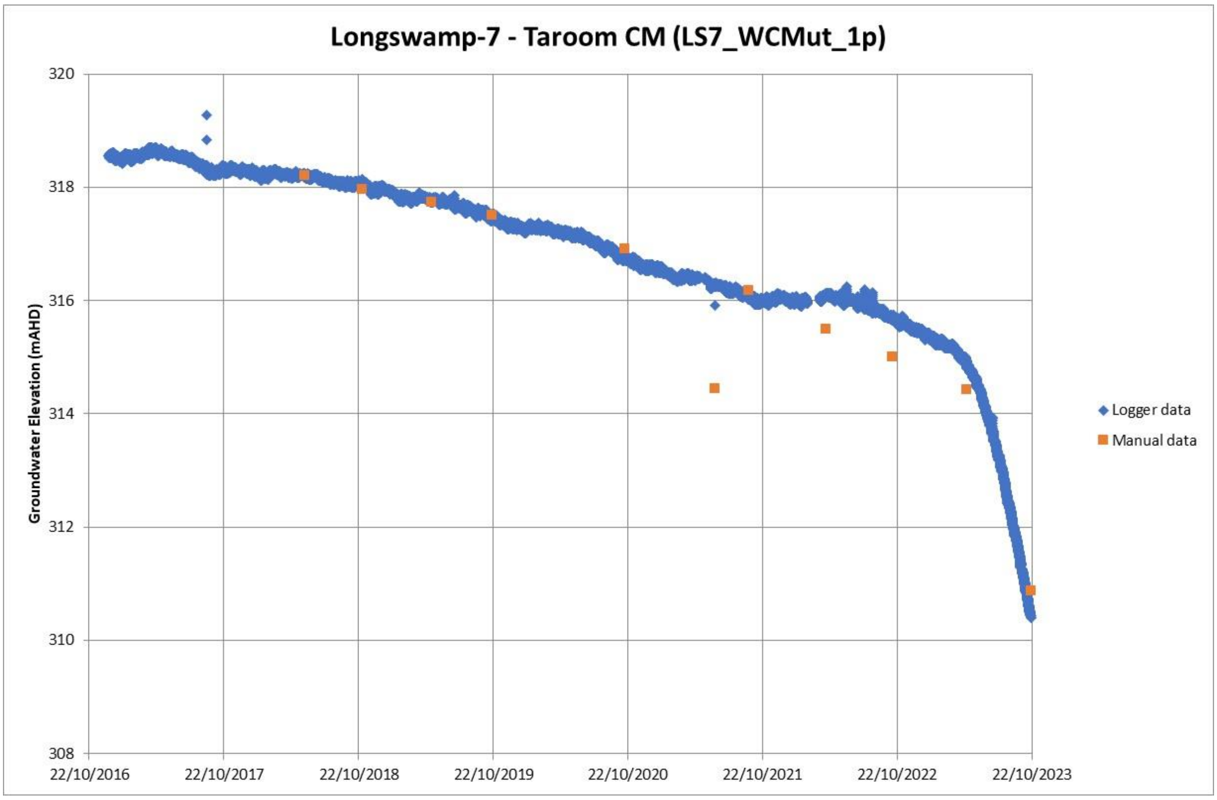

Lone Pine-14 - Lower Juandah CM (LP14_WCMw_1p)
Groundwater Elevation (mAHD)
336
334
332
330
328
326
324
322
320
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

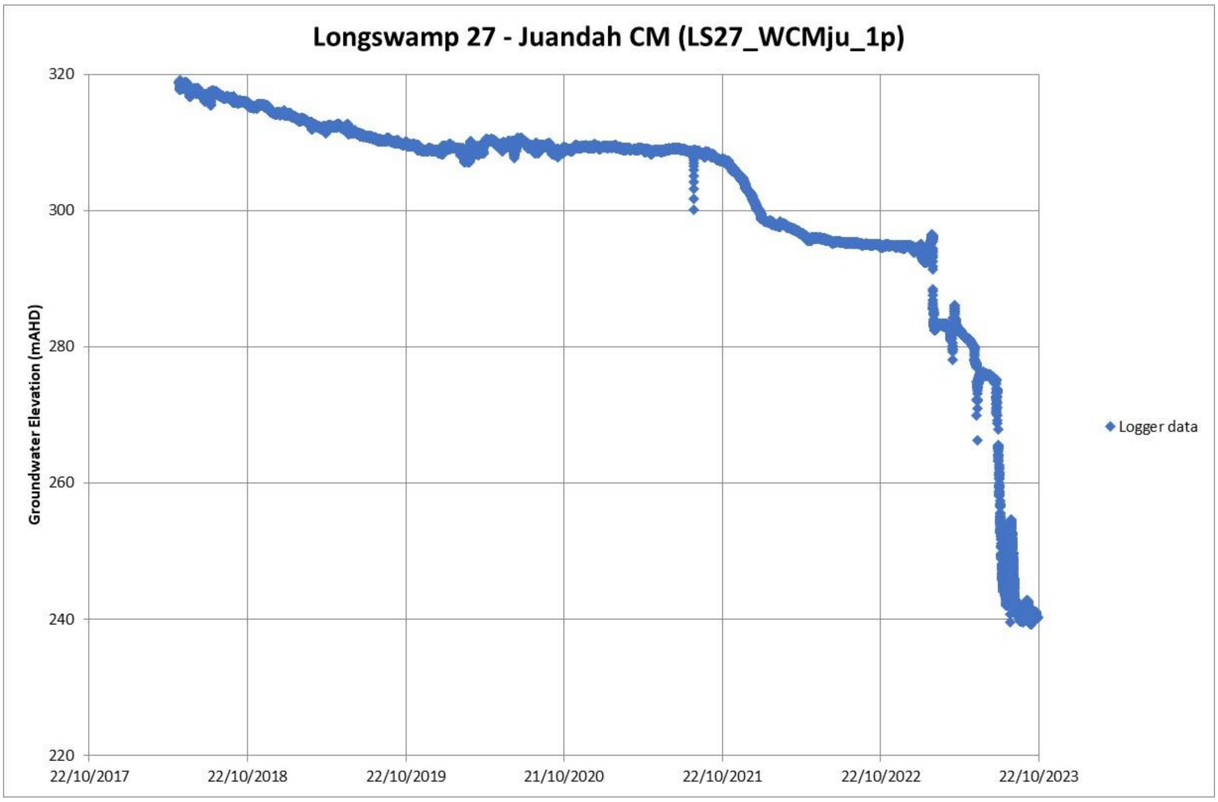

Lone Pine-16 - Upper Juandah CM (LP16_WCMm_1p)
Groundwater Elevation (mAHD)
327.0
326.5
326.0
325.5
325.0
324.5
324.0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

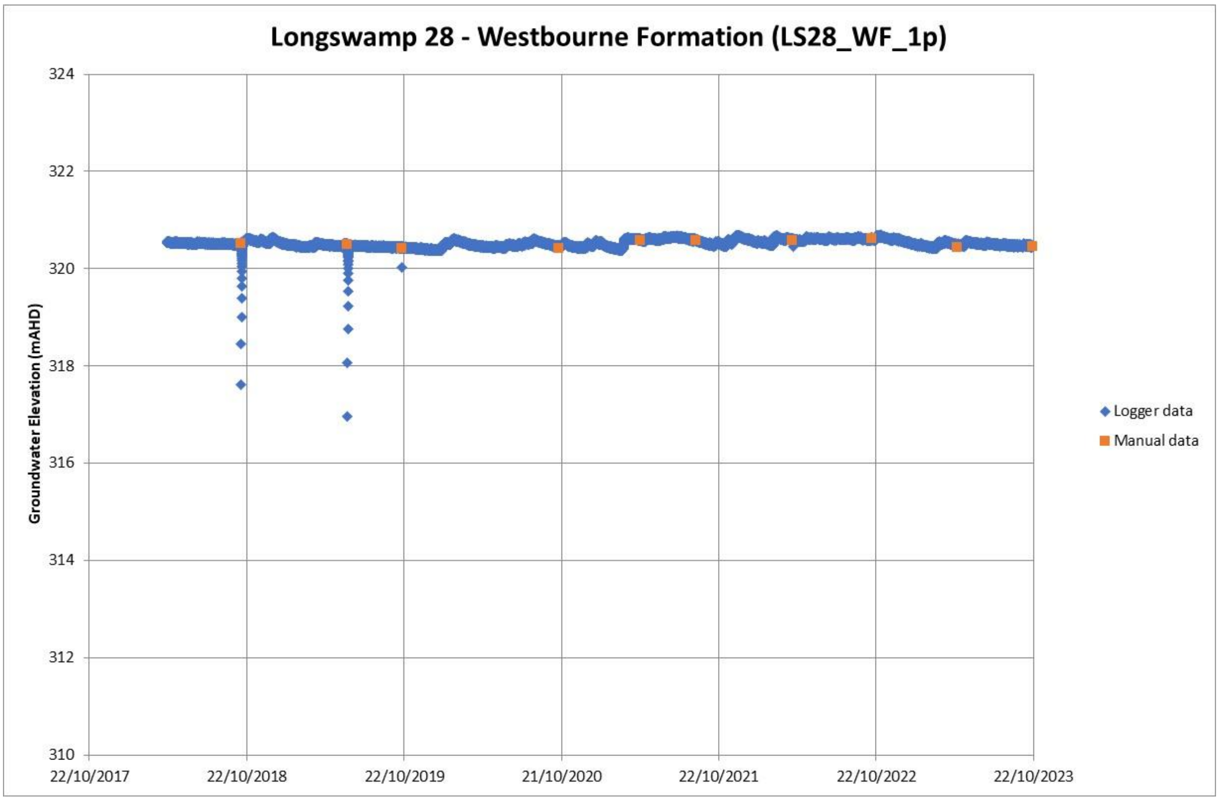

Longswamp-7 (LS7_CA_1p)
Groundwater Elevation (mAHD)
330
325
320
315
310
305
300
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

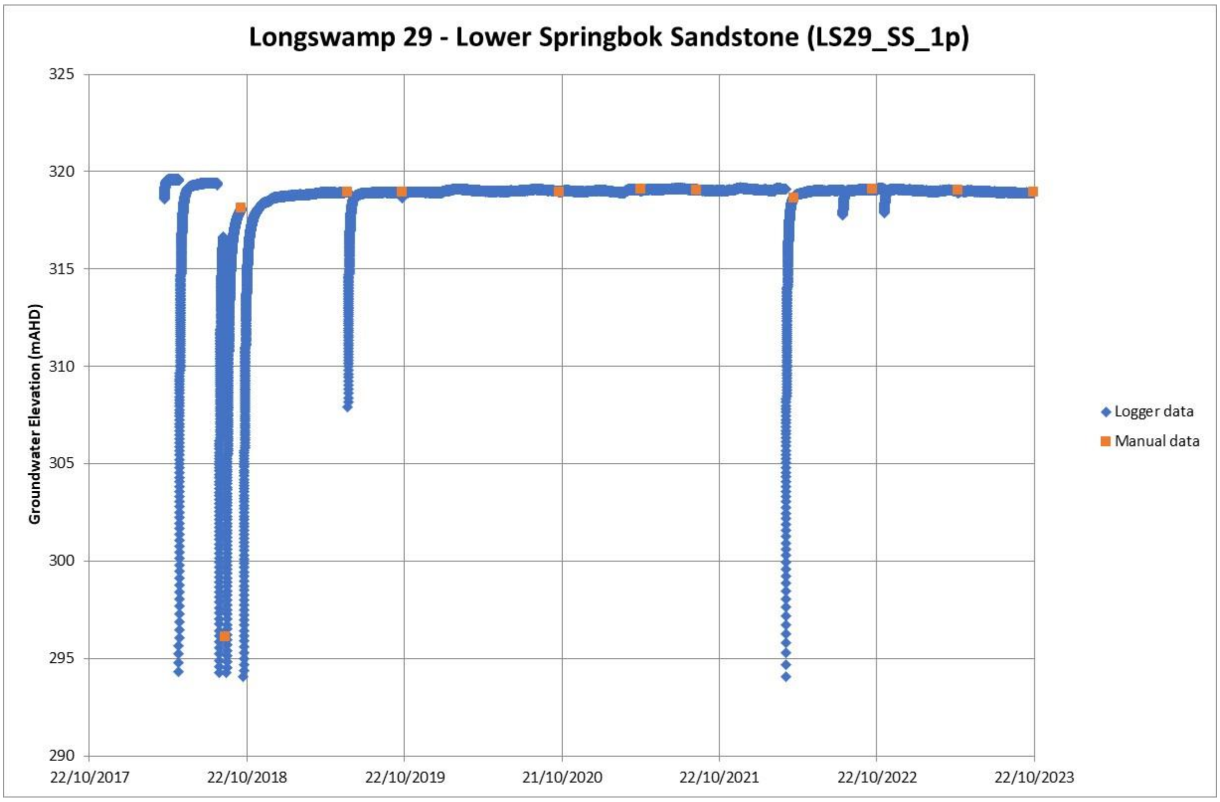

Longswamp-7 - Lower Juandah CM (LS7_WCMmlj1p)
Groundwater Elevation (mAHD)
320
318
316
314
312
310
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

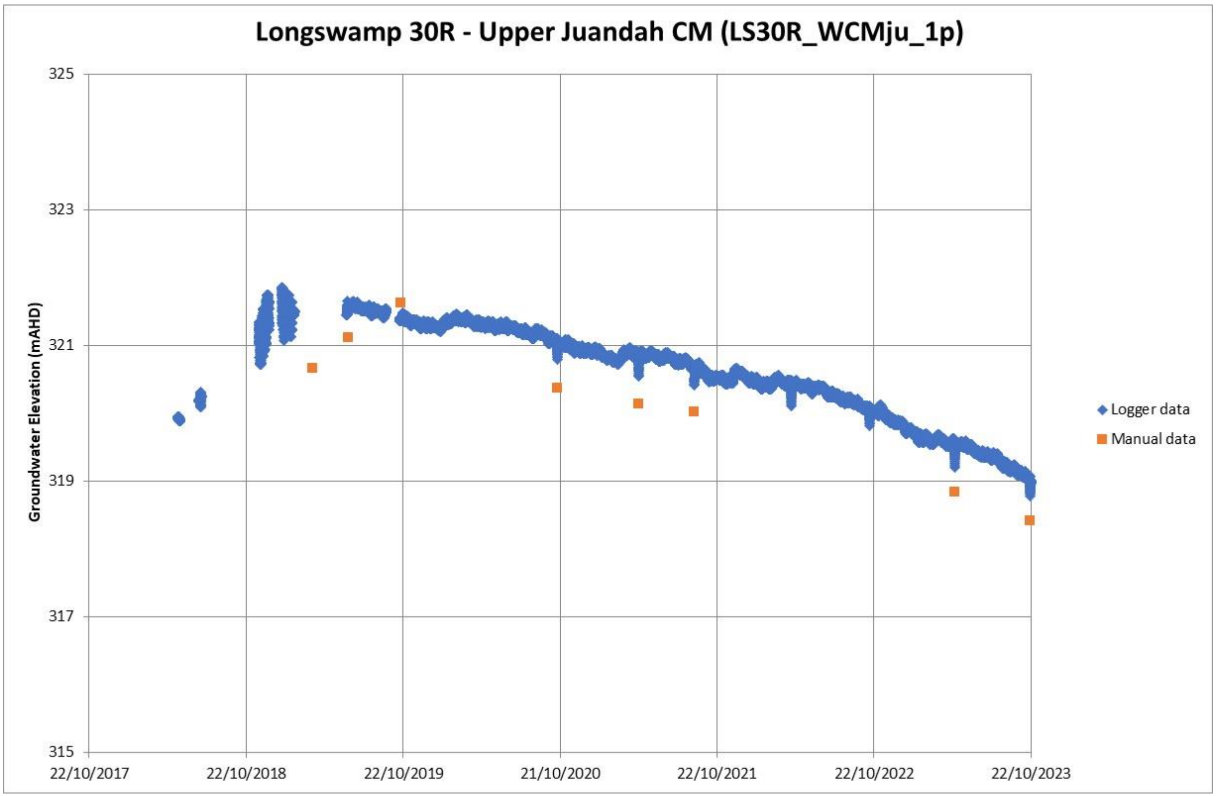

LS7_WCMm_1p
Groundwater Elevation (mAHD)
318.5
318
317.5
317
316.5
316
315.5
315
314.5
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

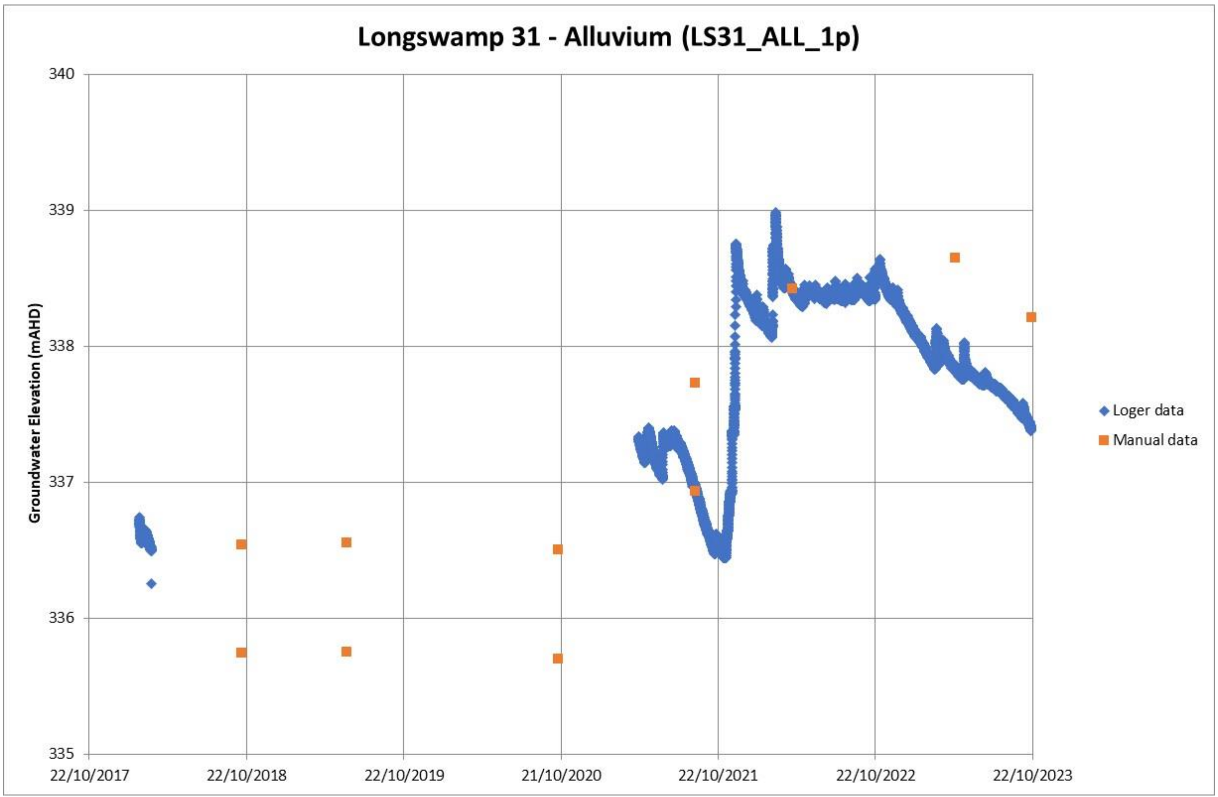

Longswamp-7 - Taroom CM (LS7_WCMut_1p)
Groundwater Elevation (mAHD)
320
318
316
314
312
310
308
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

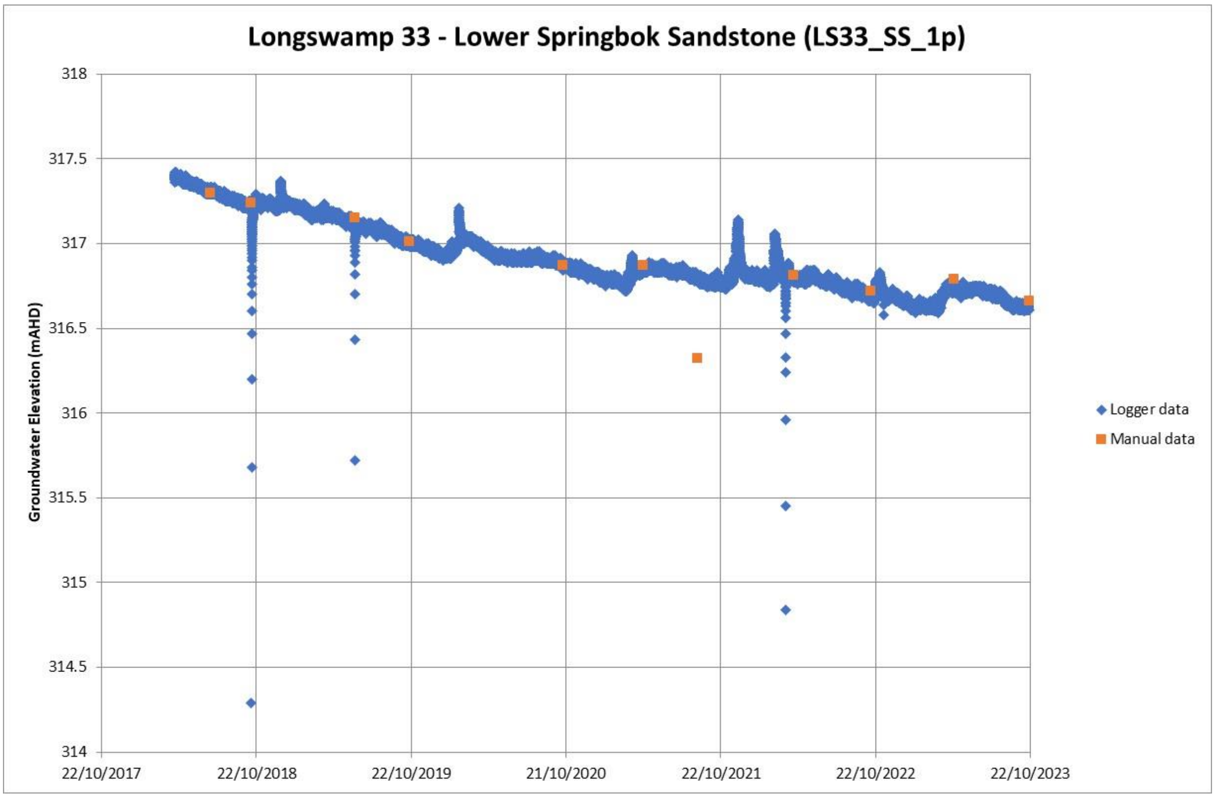

Longswamp 27 - Juandah CM (LS27_WCMju_1p)
Groundwater Elevation (mAHD)
320
300
280
260
240
220
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

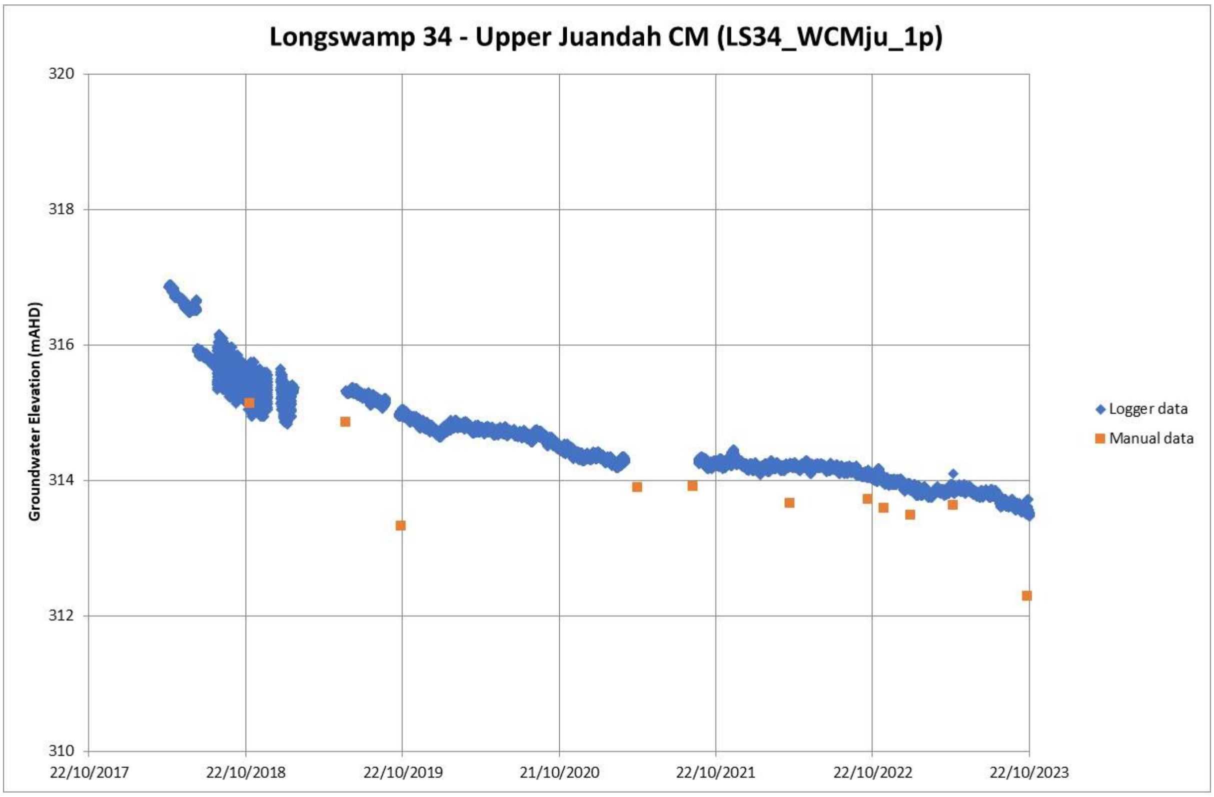

Longswamp 28 - Westbourne Formation (LS28_WF_1p)
Groundwater Elevation (mAHD)
324
322
320
318
316
314
312
310
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

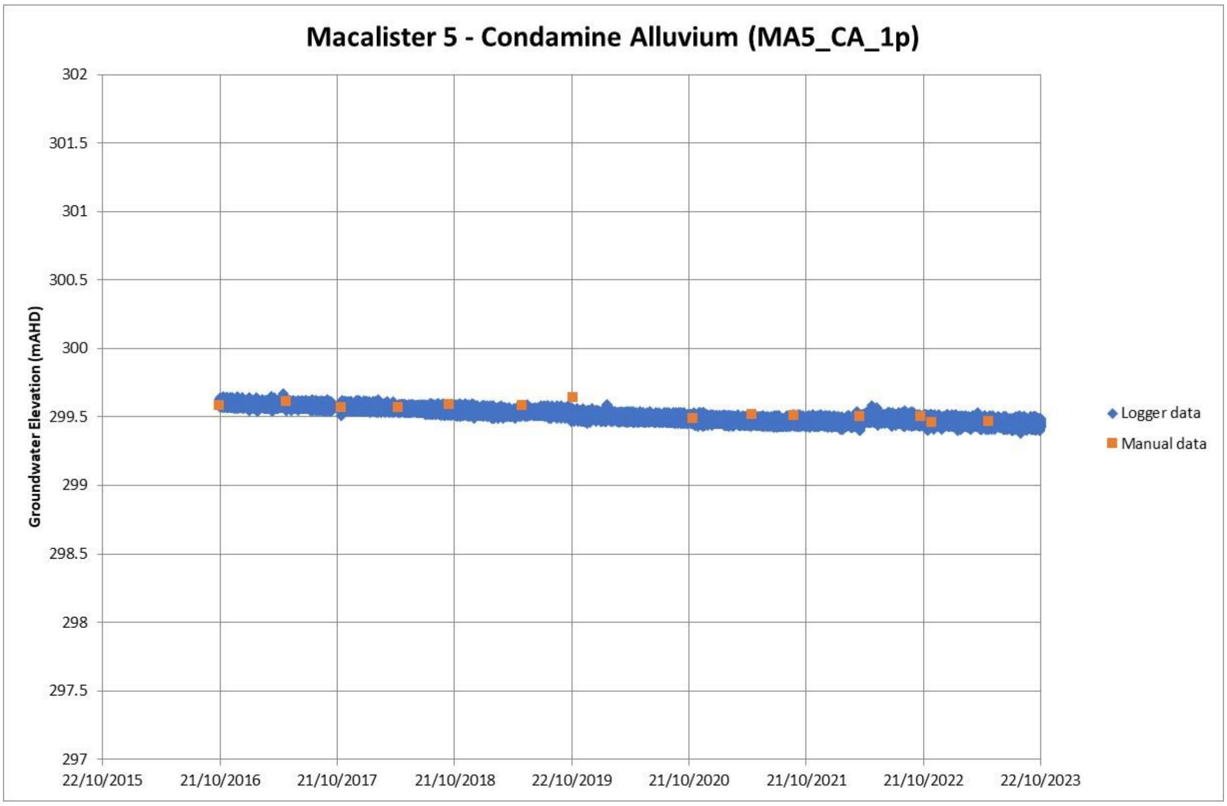

Longswamp 29 - Lower Springbok Sandstone (LS29_SS_1p)
Groundwater Elevation (mAHD)
325
320
315
310
305
300
295
290
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

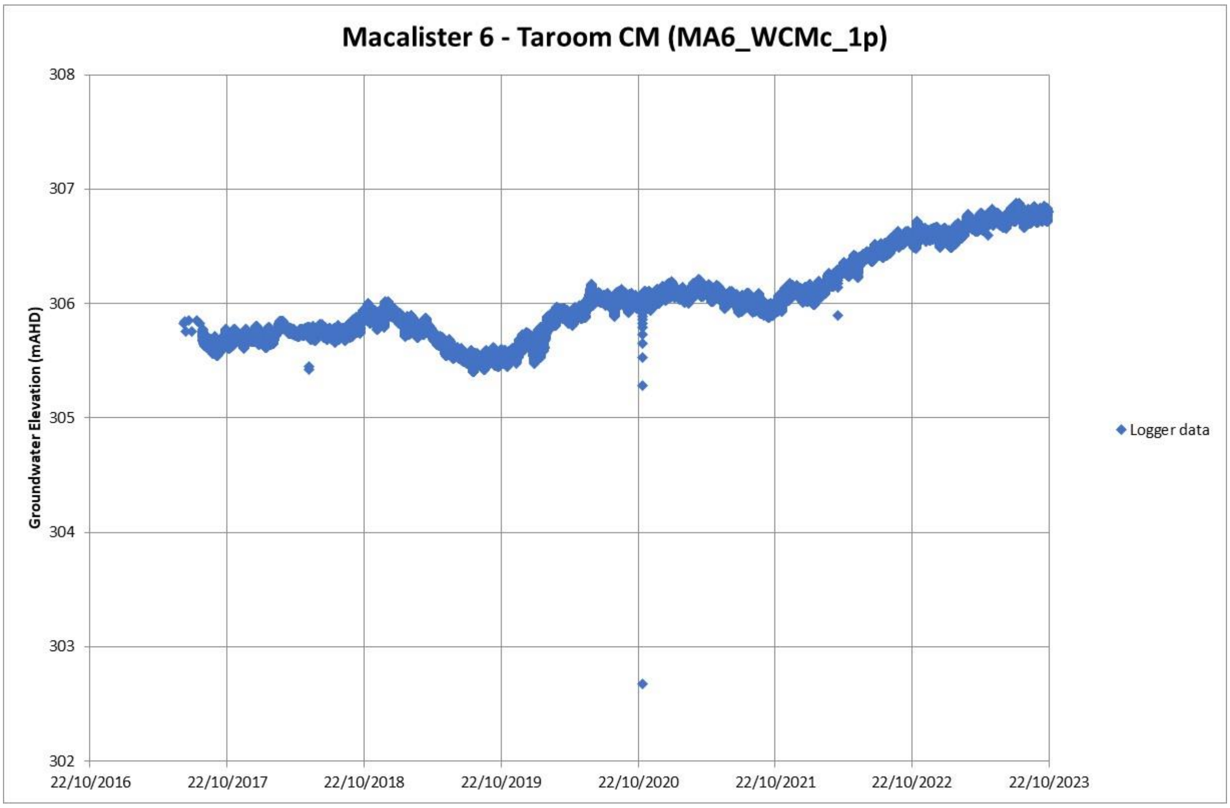

Longswamp 30R - Upper Juandah CM (LS30R_WCMju_1p)
Groundwater Elevation (mAHD)
325
323
321
319
317
315
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

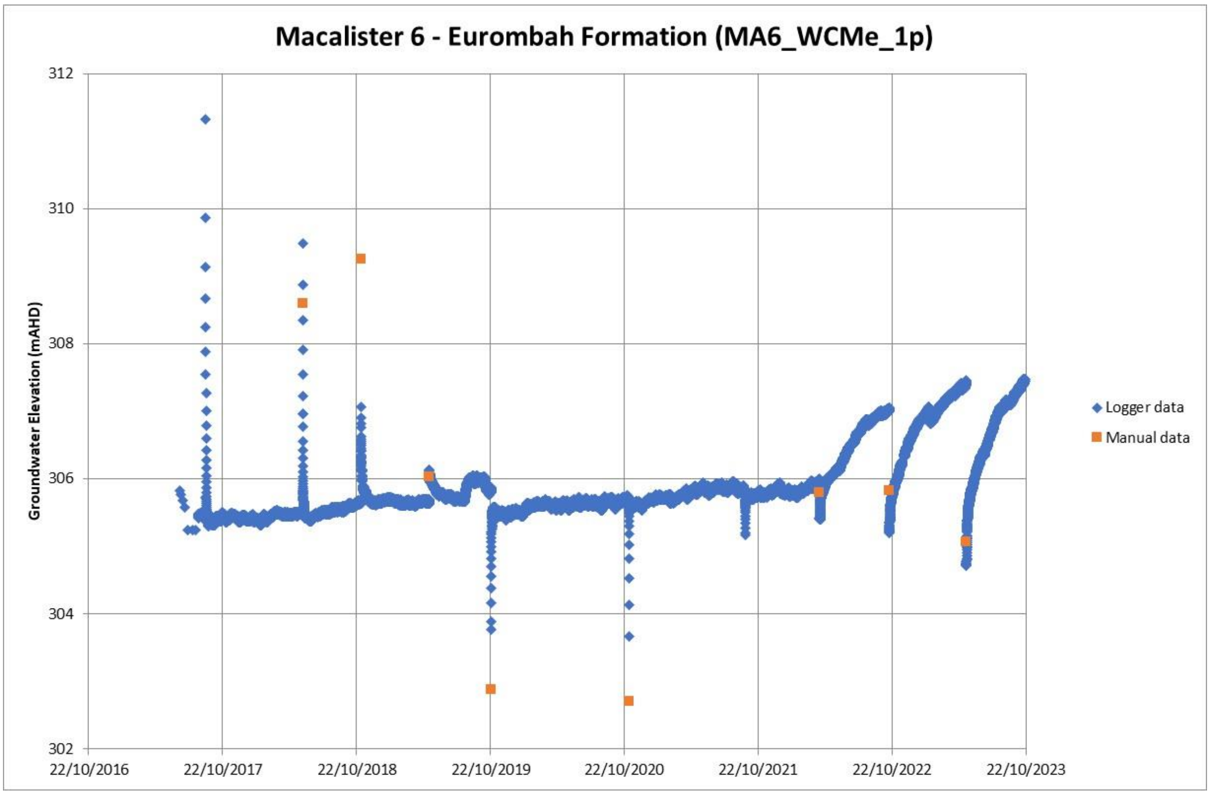

Longswamp 31 - Alluvium (LS31_ALL_1p)
Groundwater Elevation (mAHD)
340
339
338
337
336
335
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Loger data
Manual data

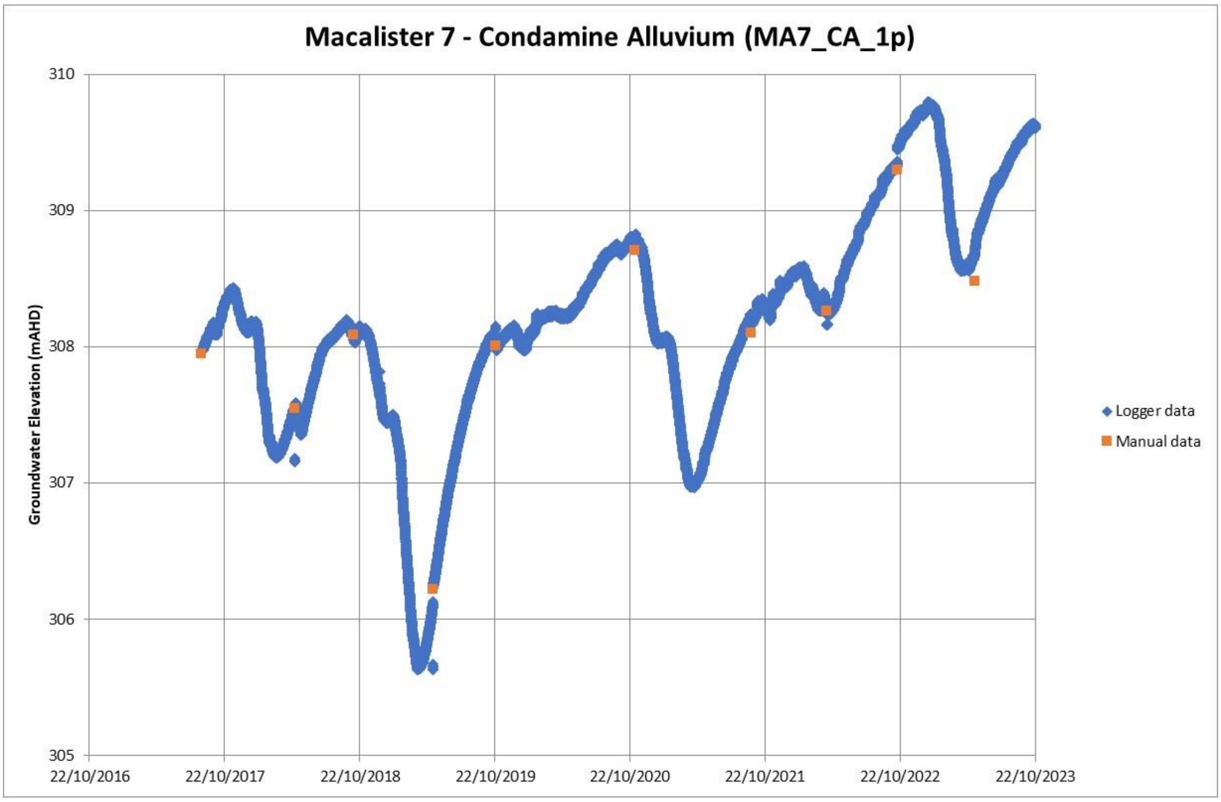

Longswamp 33 - Lower Springbok Sandstone (LS33_SS_1p)
Groundwater Elevation (mAHD)
318
317.5
317
316.5
316
315.5
315
314.5
314
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

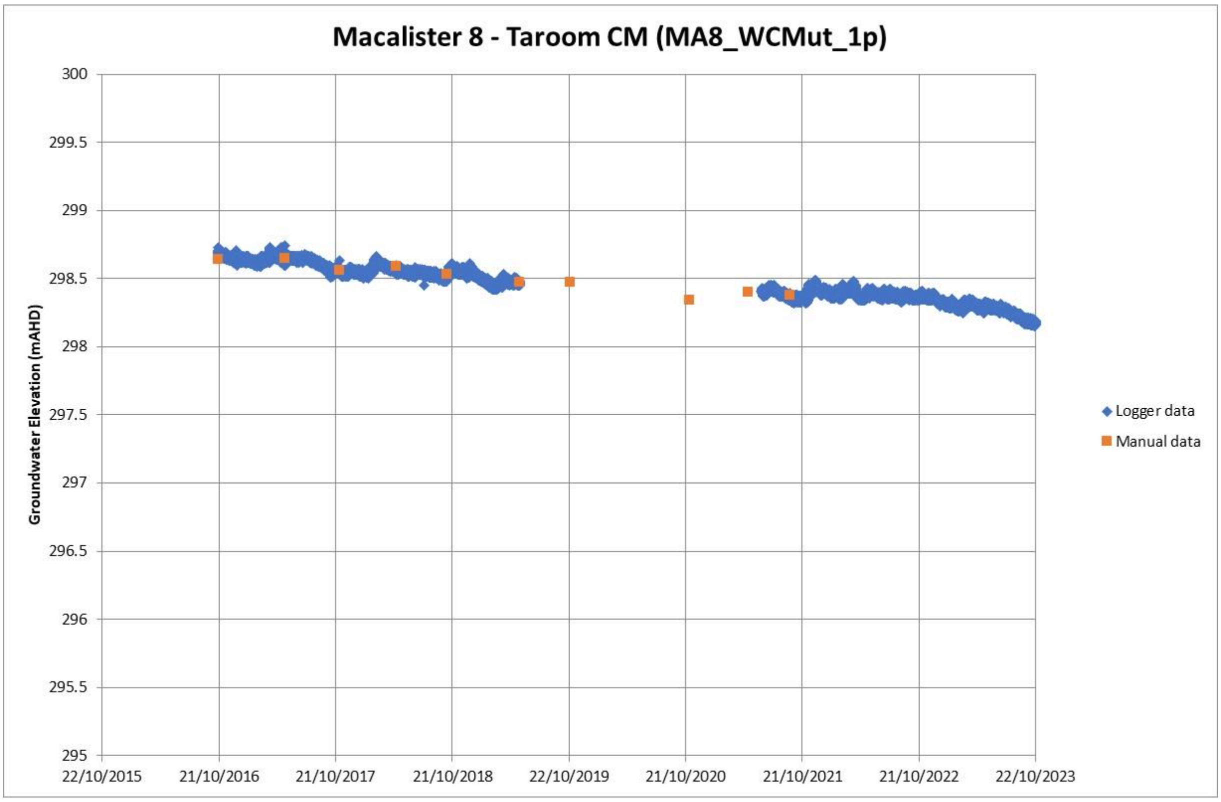

Longswamp 34 - Upper Juandah CM (LS34_WCMju_1p)
Groundwater Elevation (mAHD)
320
318
316
314
312
310
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

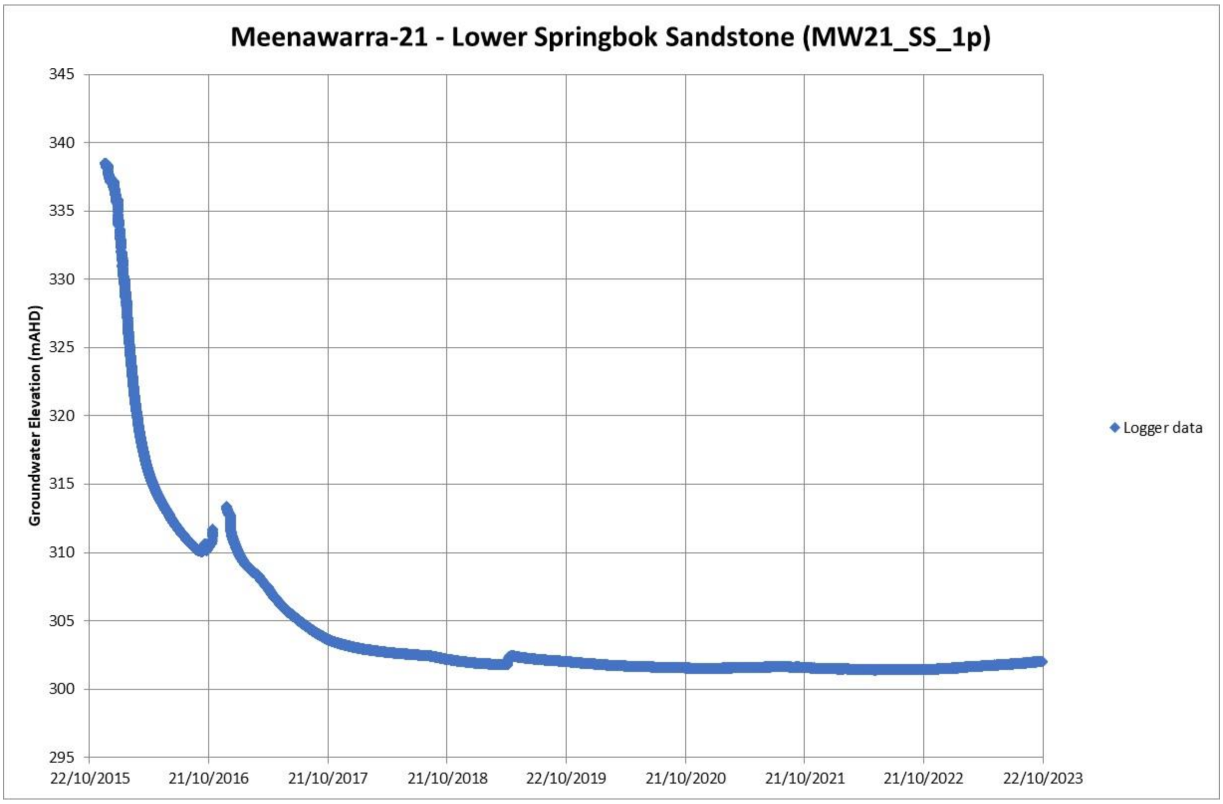

Macalister 5 - Condamine Alluvium (MA5_CA_1p)
Groundwater Elevation (mAHD)
302
301.5
301
300.5
300
299.5
299
298.5
298
297.5
297
22/10/2015
21/10/2016
21/10/2017
21/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data
Manual data

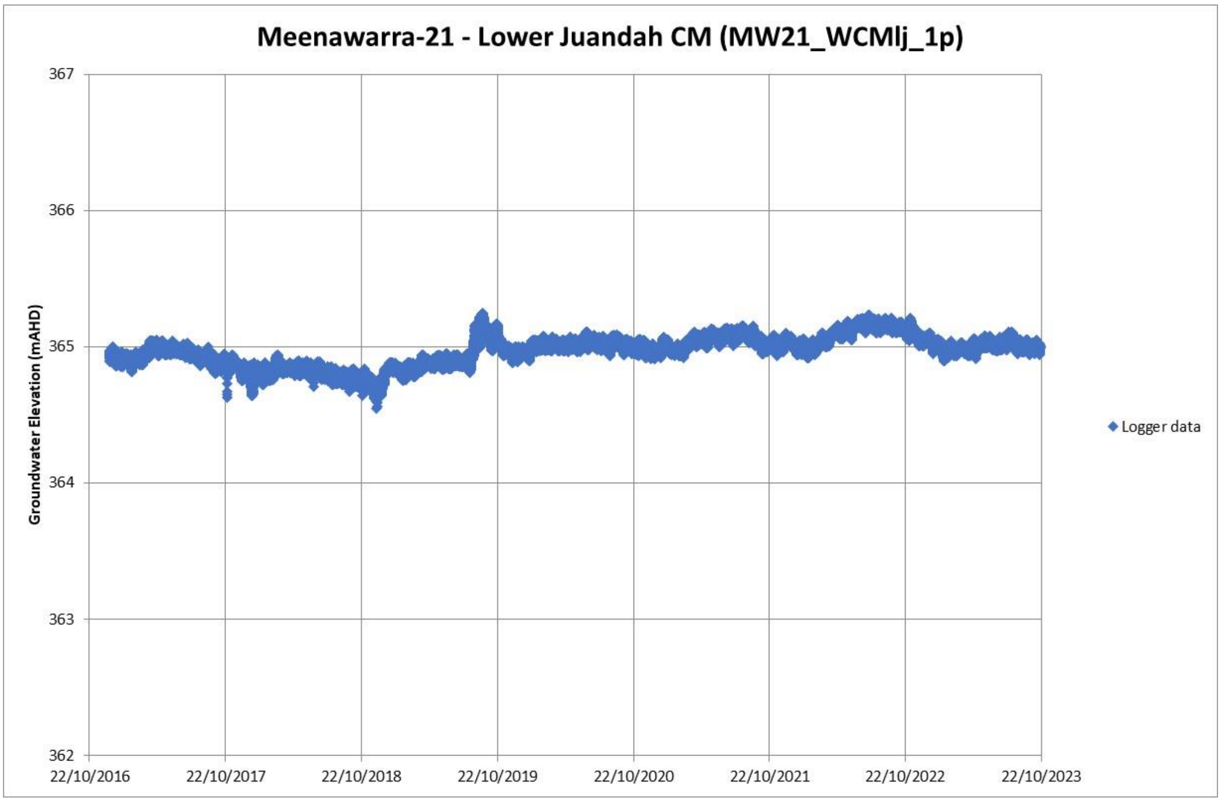

Macalister 6 - Taroom CM (MA6_WCMc_1p)
Groundwater Elevation (mAHD)
308
307
306
305
304
303
302
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

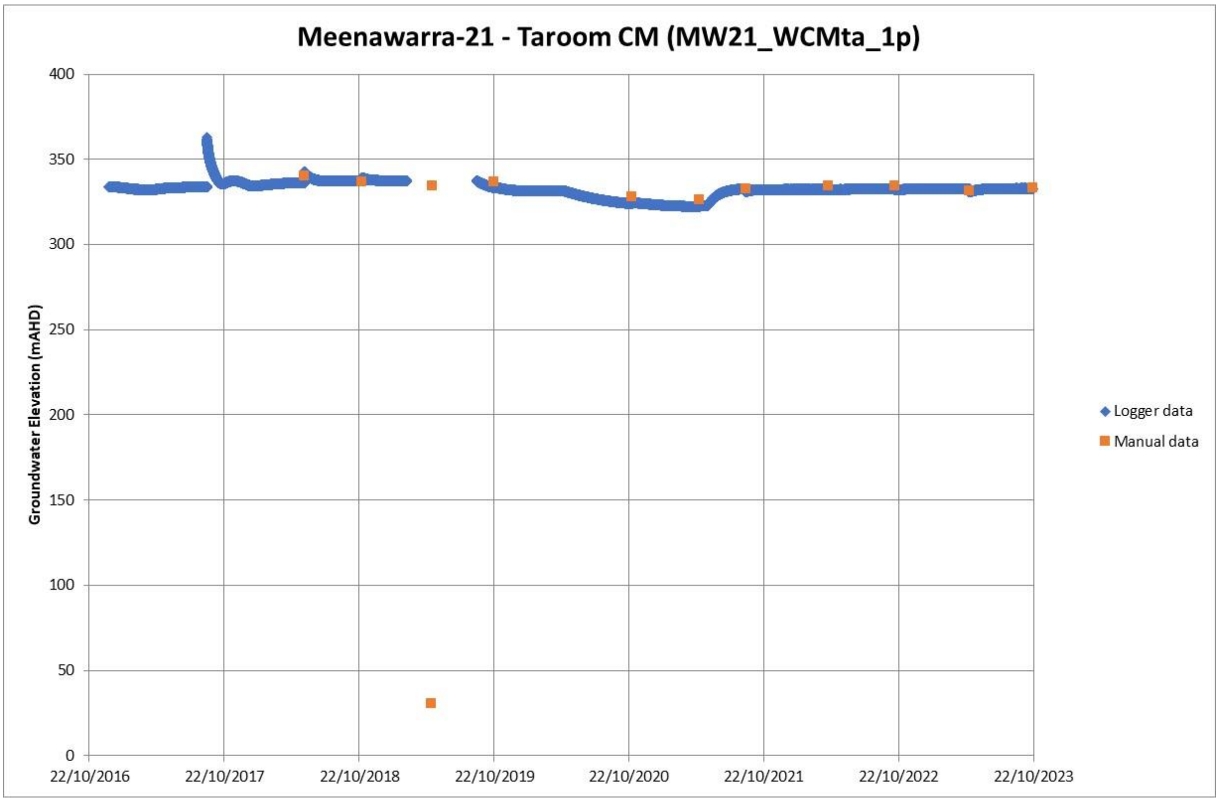

Macalister 6 - Eurombah Formation (MA6_WCMe_1p)
Groundwater Elevation (mAHD)
312
310
308
306
304
302
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

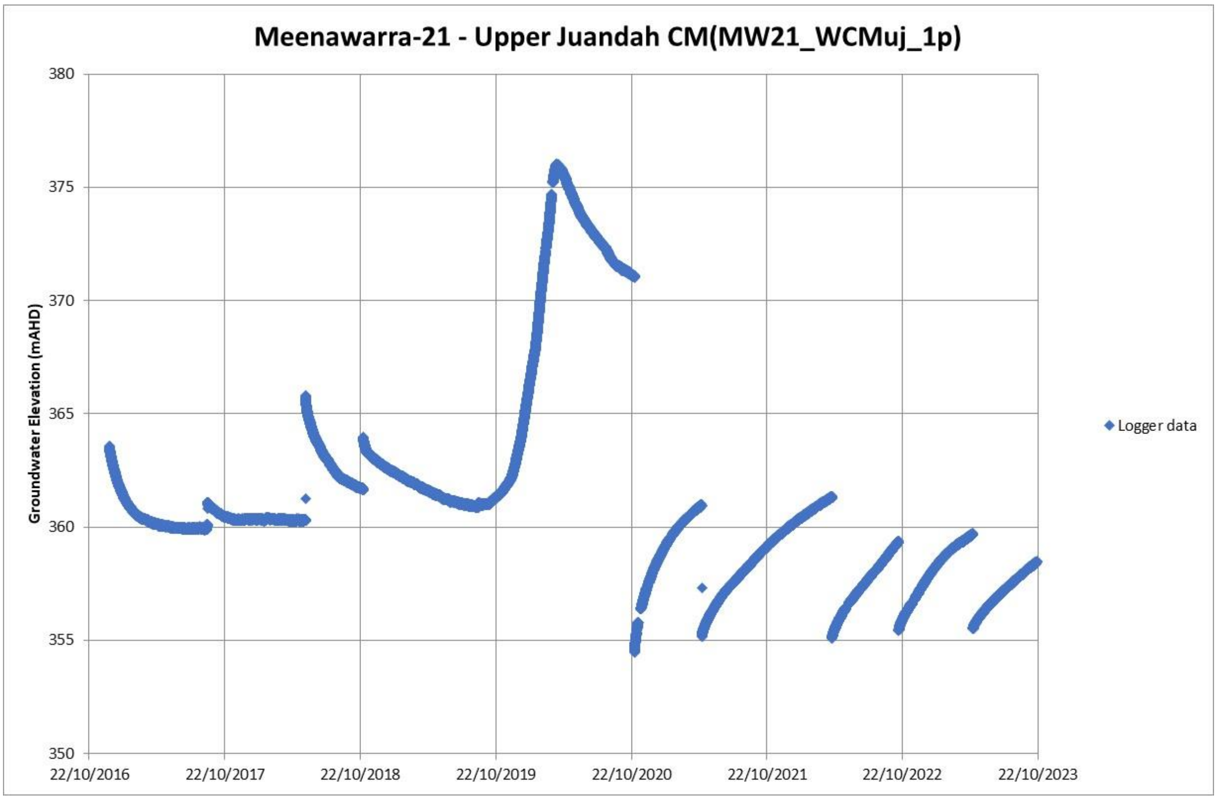

Macalister 7 - Condamine Alluvium (MA7_CA_1p)
Groundwater Elevation (mAHD)
310
309
308
307
306
305
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

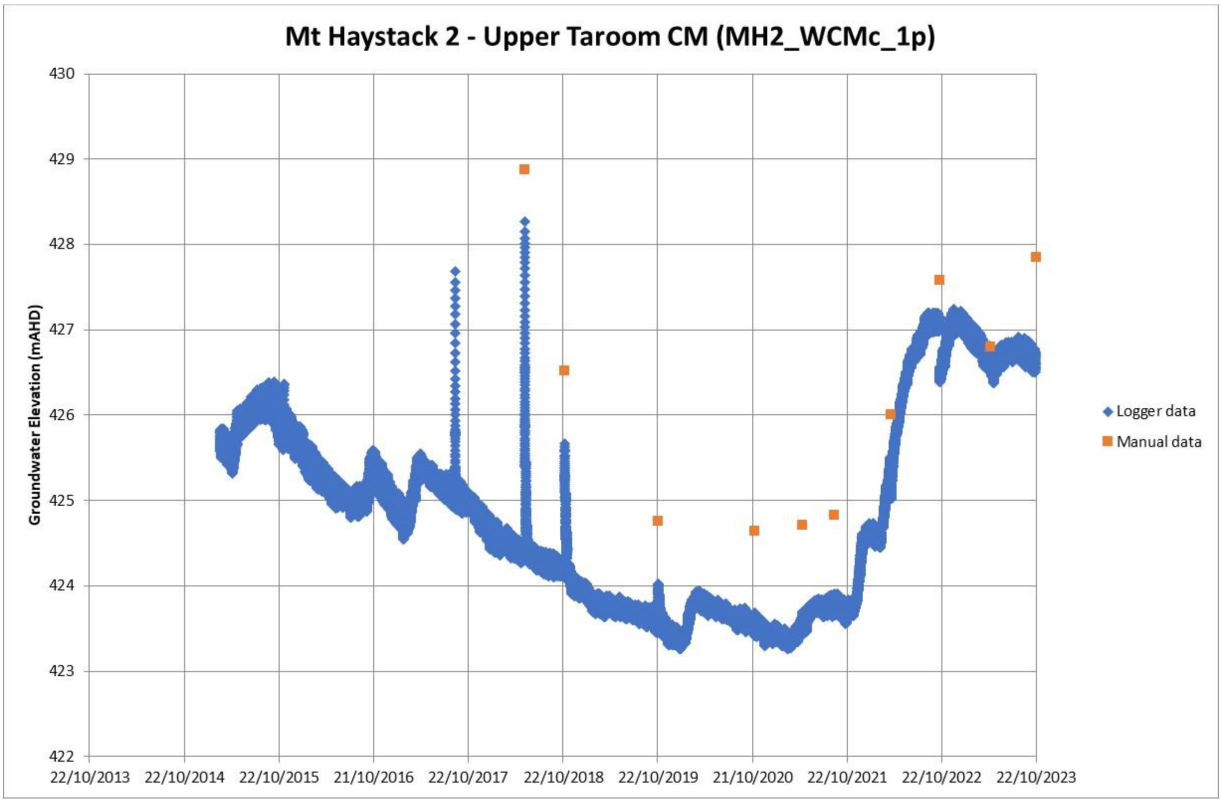

Macalister 8 - Taroom CM (MA8_WCMut_1p)
Groundwater Elevation (mAHD)
300
299.5
299
298.5
298
297.5
297
296.5
296
295.5
295
22/10/2015
21/10/2016
21/10/2017
21/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data
Manual data

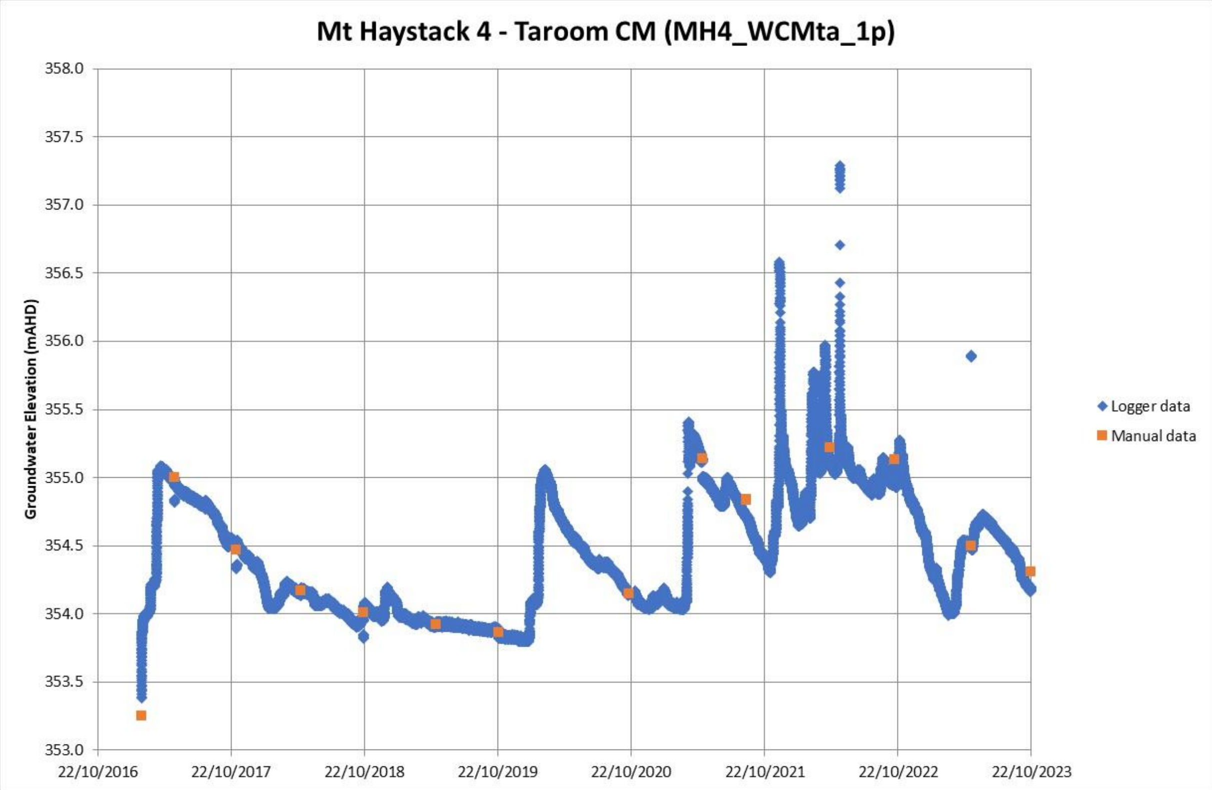

Meenawarra-21 - Lower Springbok Sandstone (MW21_SS_1p)
Groundwater Elevation (mAHD)
345
340
335
330
325
320
315
310
305
300
295
22/10/2015
21/10/2016
21/10/2017
21/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data

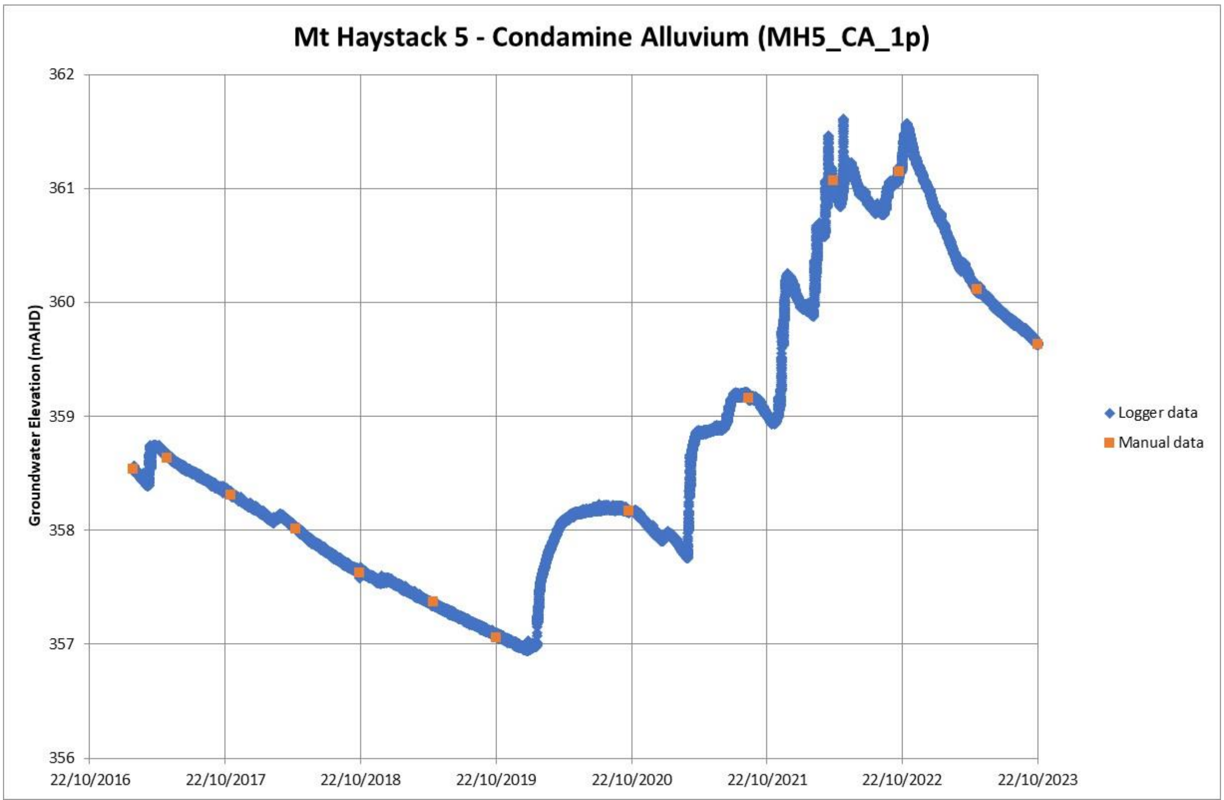

Meenawarra-21 - Lower Juandah CM (MW21_WCMlj_1p)
Groundwater Elevation (mAHD)
367
366
365
364
363
362
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

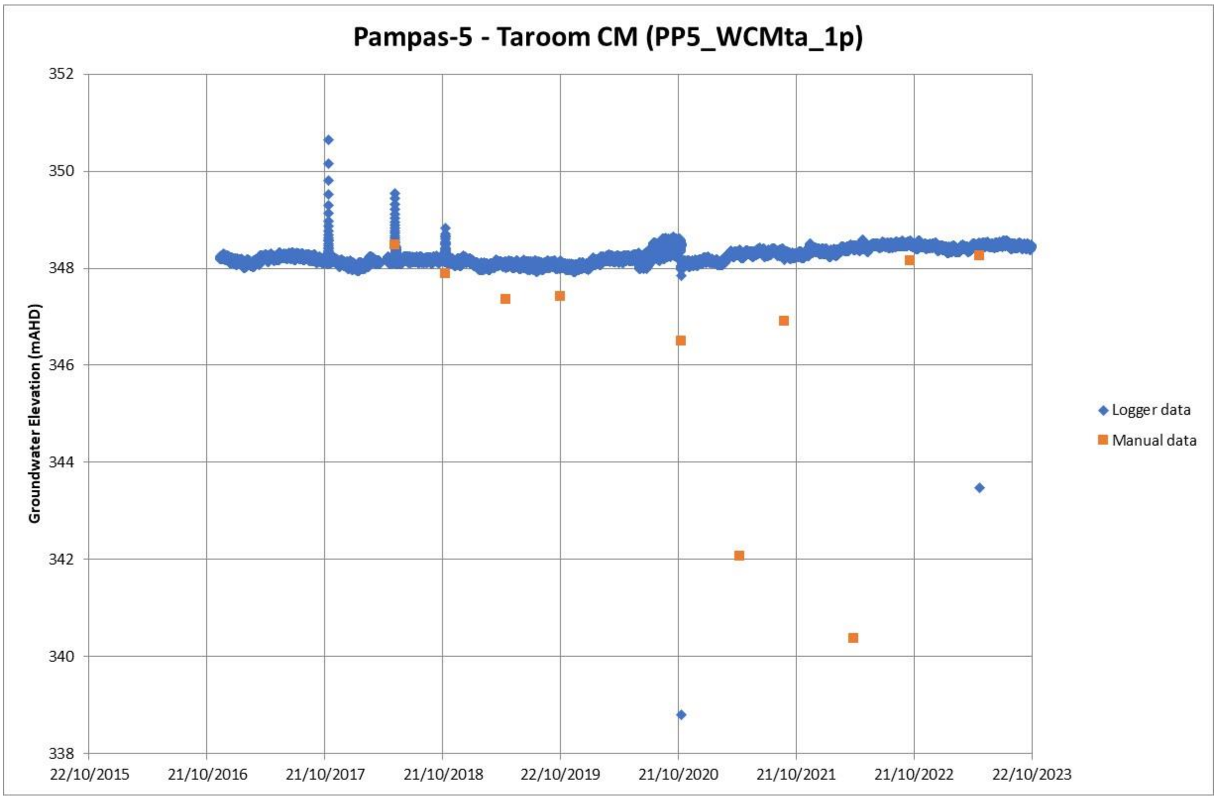

Meenawarra-21 - Taroom CM (MW21_WCMta_1p)
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

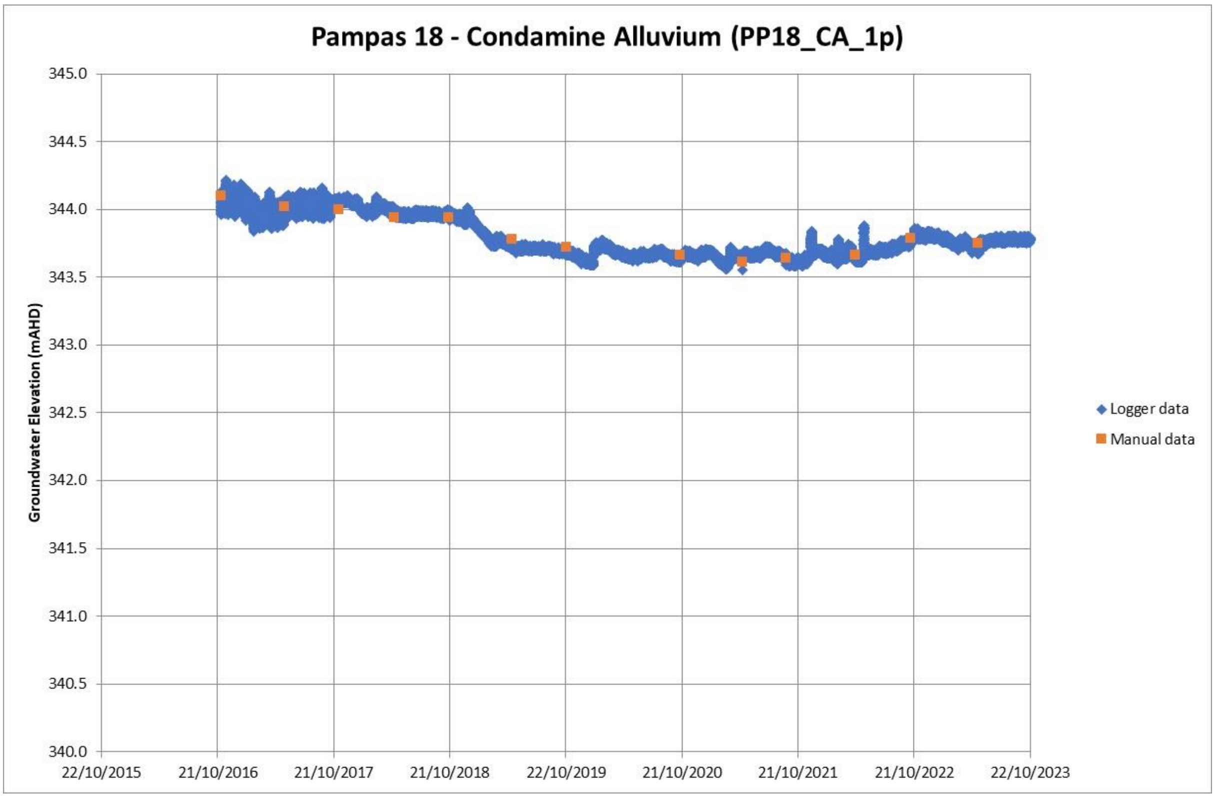

Meenawarra-21 - Upper Juandah CM(MW21_WCMuj_1p)
Groundwater Elevation (mAHD)
380
375
370
365
360
355
350
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

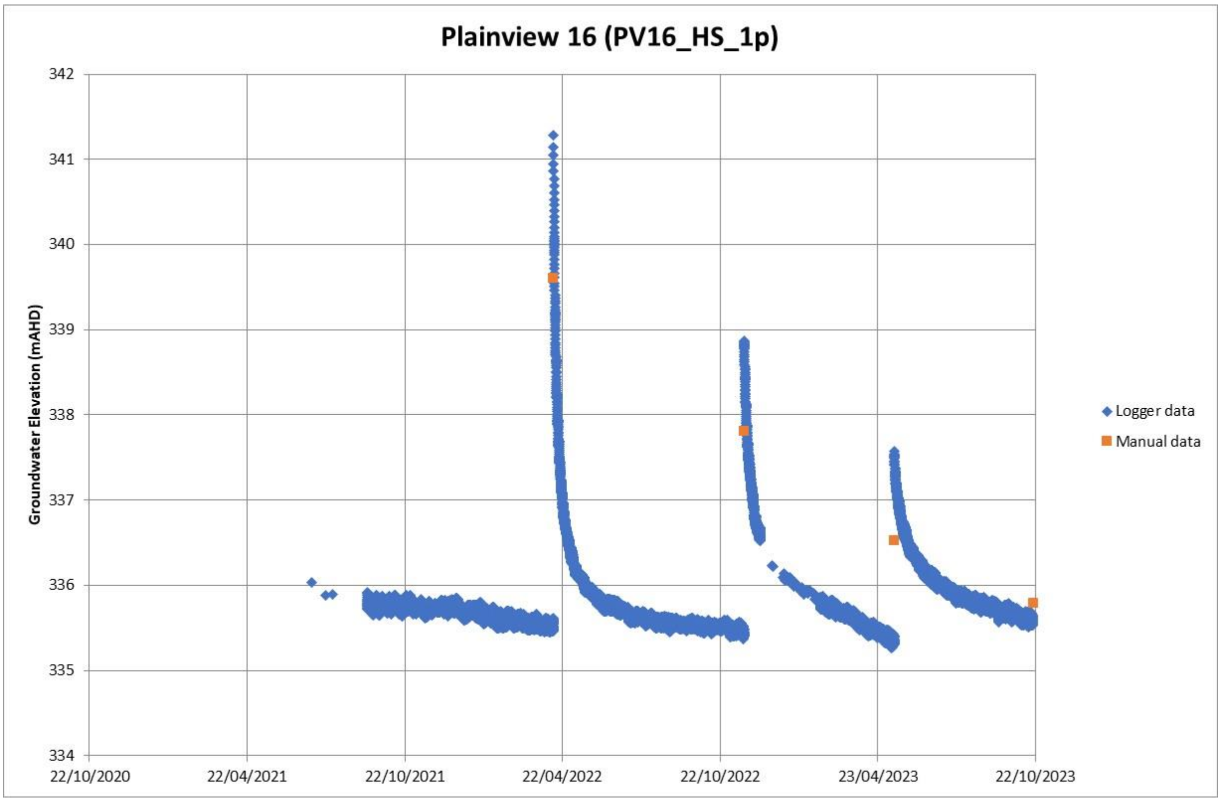

Mt Haystack 2 - Upper Taroom CM (MH2_WCMc_1p)
Groundwater Elevation (mAHD)
430
429
428
427
426
425
424
423
422
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

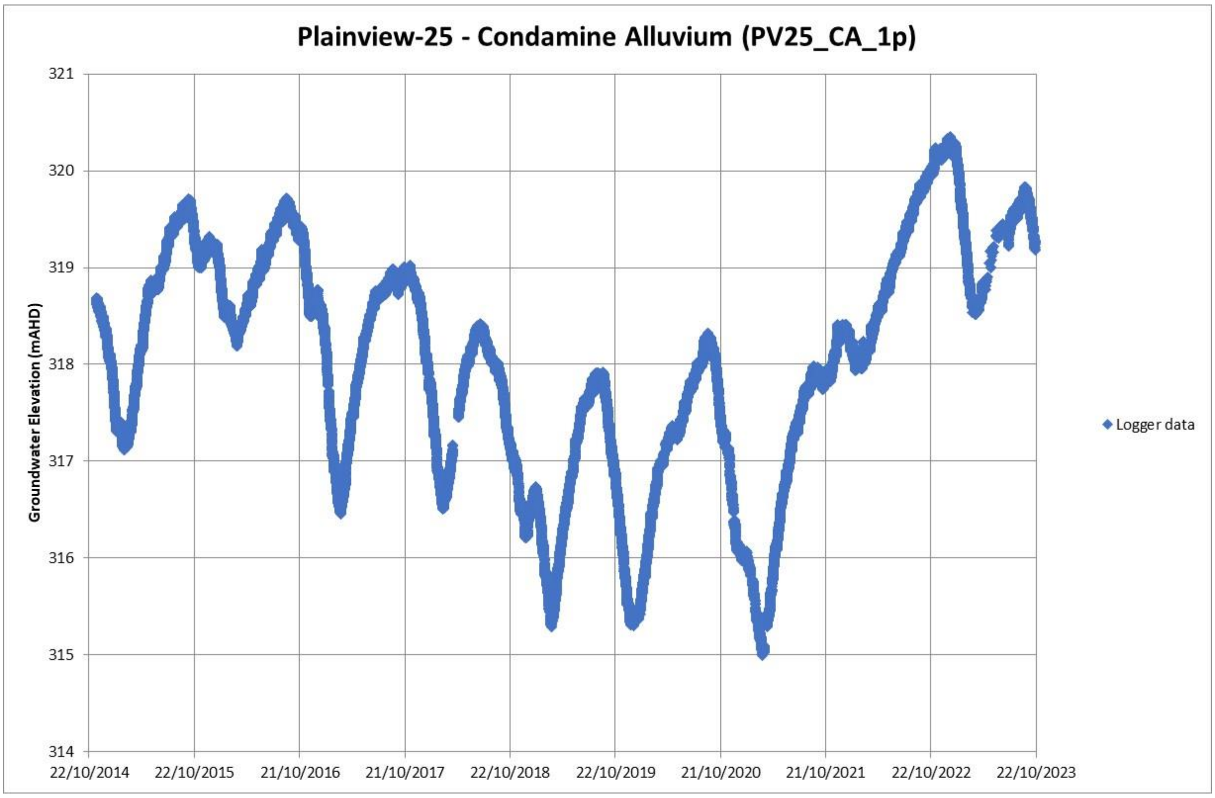

Mt Haystack 4 - Taroom CM (MH4_WCMta_1p)
Groundwater Elevation (mAHD)
358.0
357.5
357.0
356.5
356.0
355.5
355.0
354.5
354.0
353.5
353.0
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

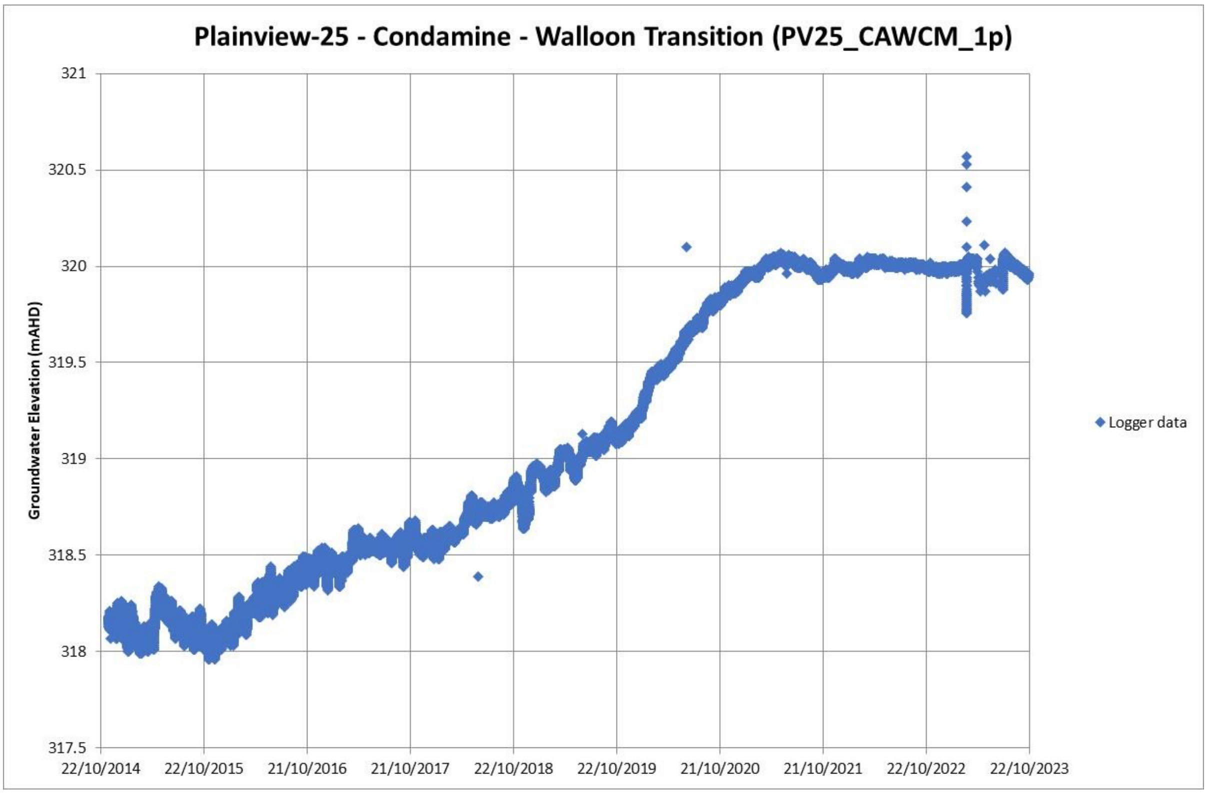

Mt Haystack 5 - Condamine Alluvium (MH5_CA_1p)
Groundwater Elevation (mAHD)
362
361
360
359
358
357
356
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

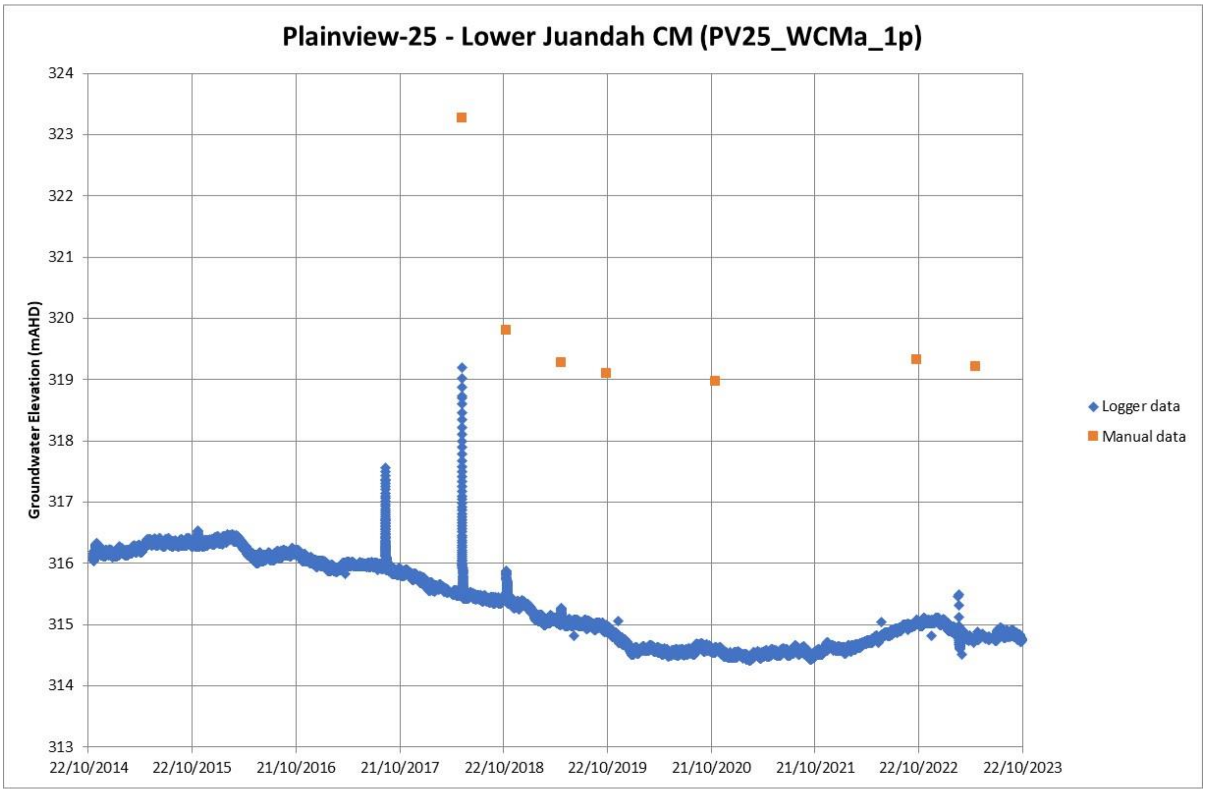

Pampas-5 - Taroom CM (PP5_WCMta_1p)
Groundwater Elevation (mAHD)
352
350
348
346
344
342
340
338
22/10/2015
21/10/2016
21/10/2017
21/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data
Manual data

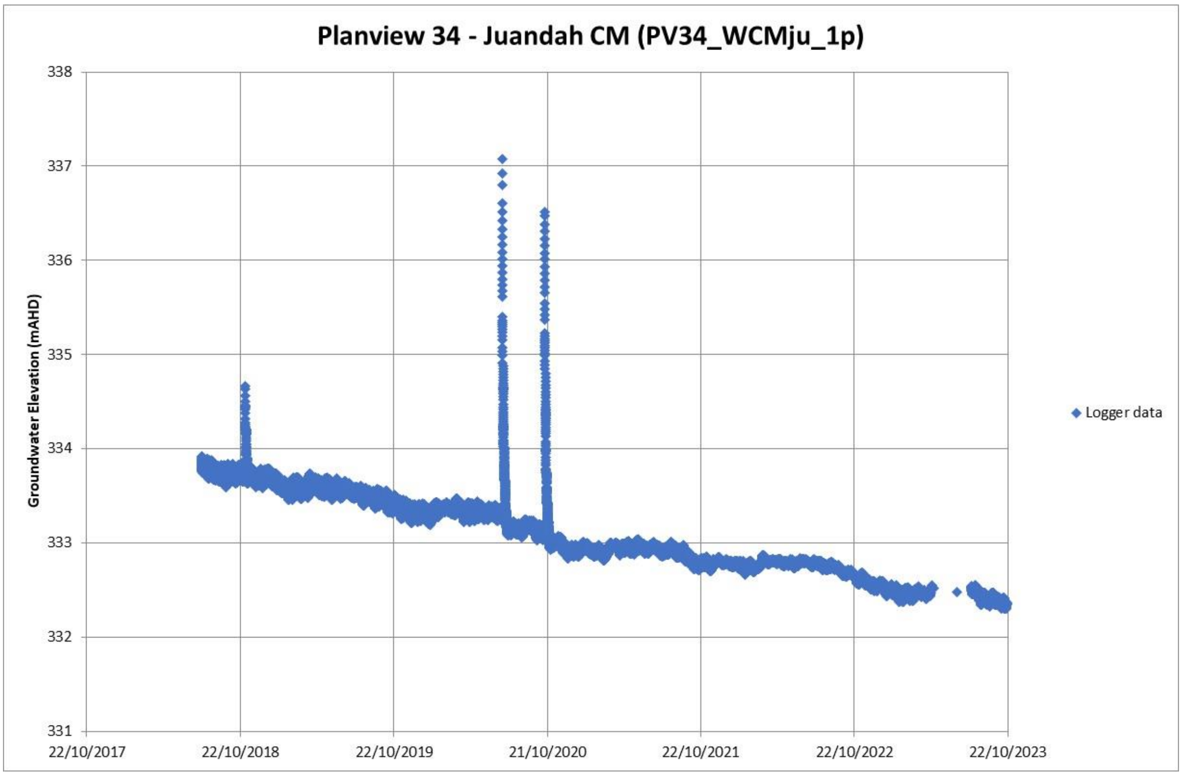

Pampas 18 - Condamine Alluvium (PP18_CA_1p)
Groundwater Elevation (mAHD)
345.0
344.5
344.0
343.5
343.0
342.5
342.0
341.5
341.0
340.5
340.0
22/10/2015
21/10/2016
21/10/2017
21/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data
Manual data


Plainview 16 (PV16_HS_1p)
Groundwater Elevation (mAHD)
342
341
340
339
338
337
336
335
334
22/10/2020
22/04/2021
22/10/2021
22/04/2022
22/10/2022
23/04/2023
22/10/2023
Logger data
Manual data

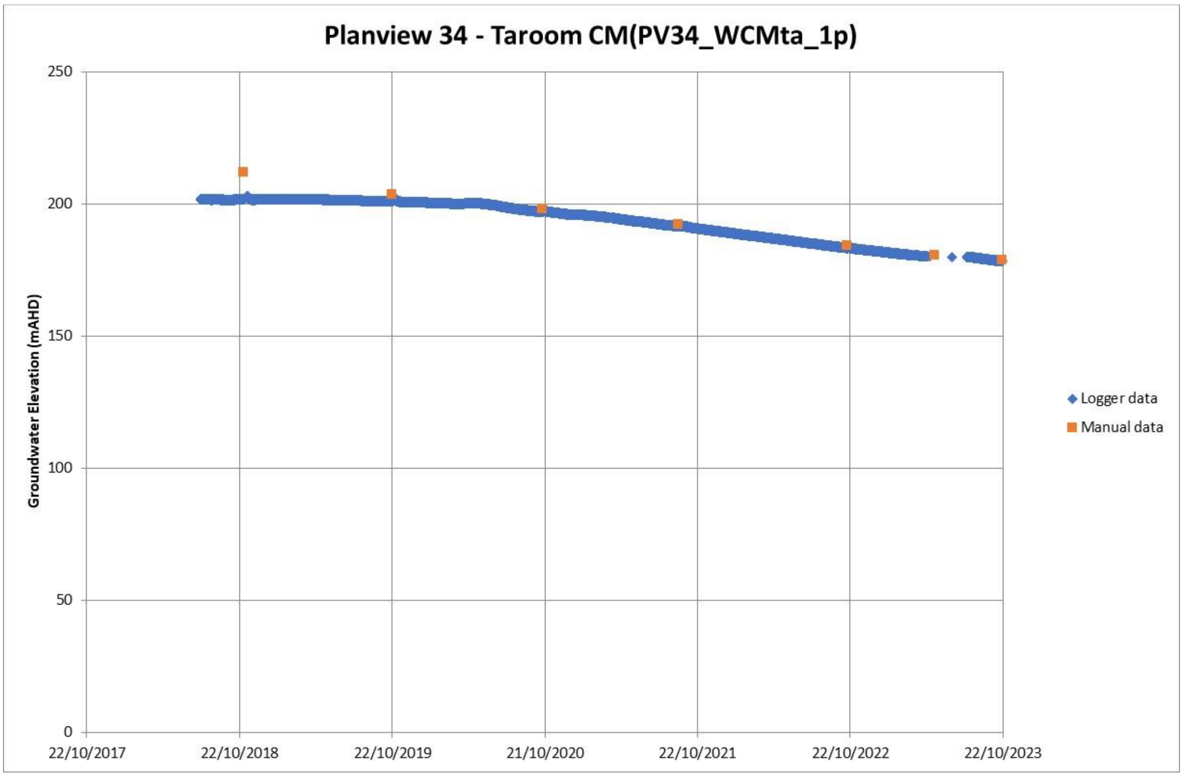

Plainview-25 - Condamine Alluvium (PV25_CA_1p)
Groundwater Elevation (mAHD)
321
320
319
318
317
316
315
314
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data


Plainview-25 - Condamine - Walloon Transition (PV25_CAWCM_1p)
Groundwater Elevation (mAHD)
321
320.5
320
319.5
319
318.5
318
317.5
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

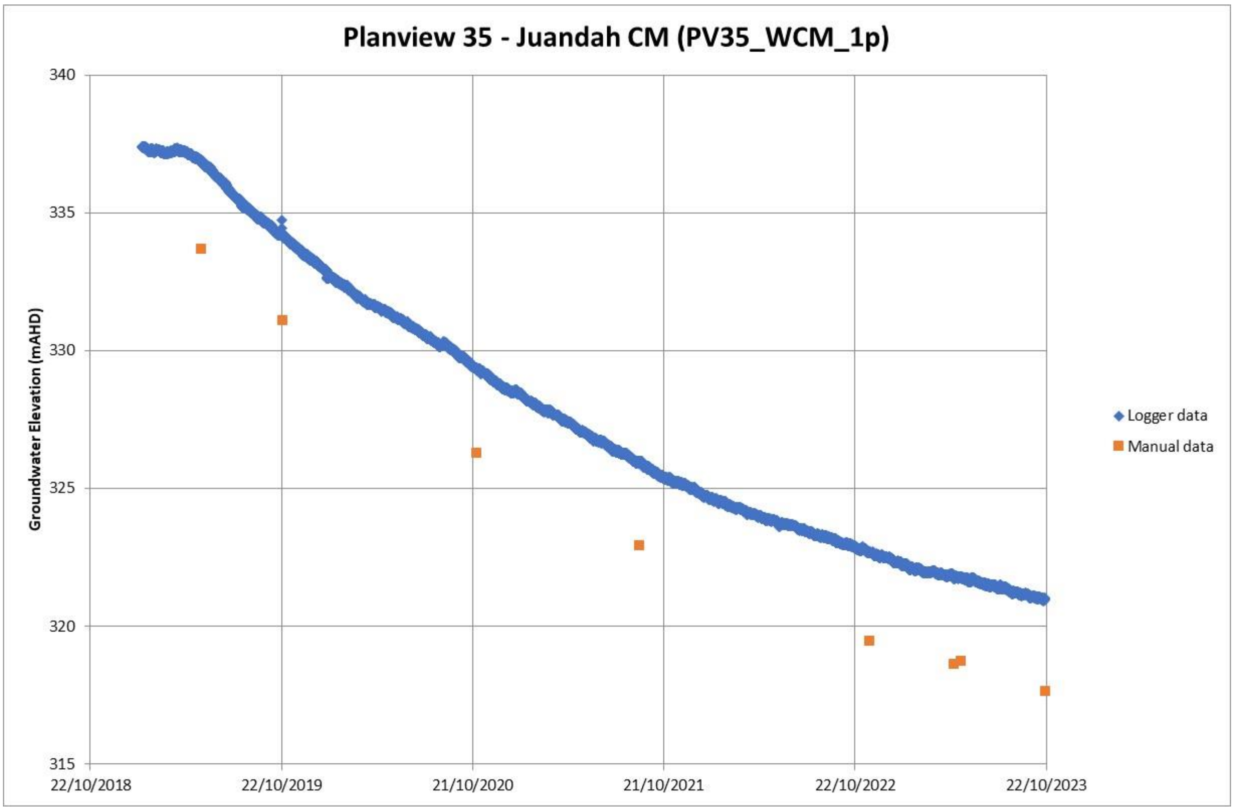

Plainview-25 - Lower Juandah CM (PV25_WCMa_1p)
Groundwater Elevation (mAHD)
324
323
322
321
320
319
318
317
316
315
314
313
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

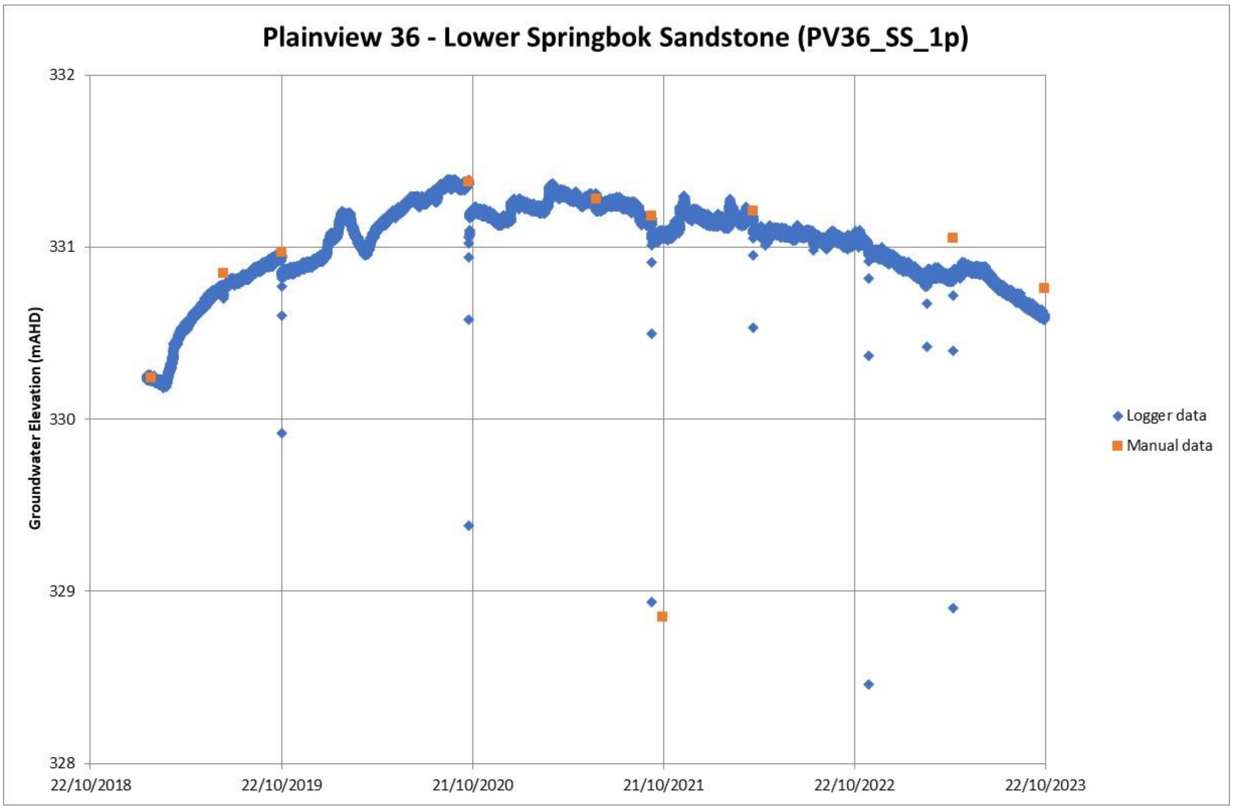


Planview 34 - Juandah CM (PV34_WCMju_1p)
Groundwater Elevation (mAHD)
338
337
336
335
334
333
332
331
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

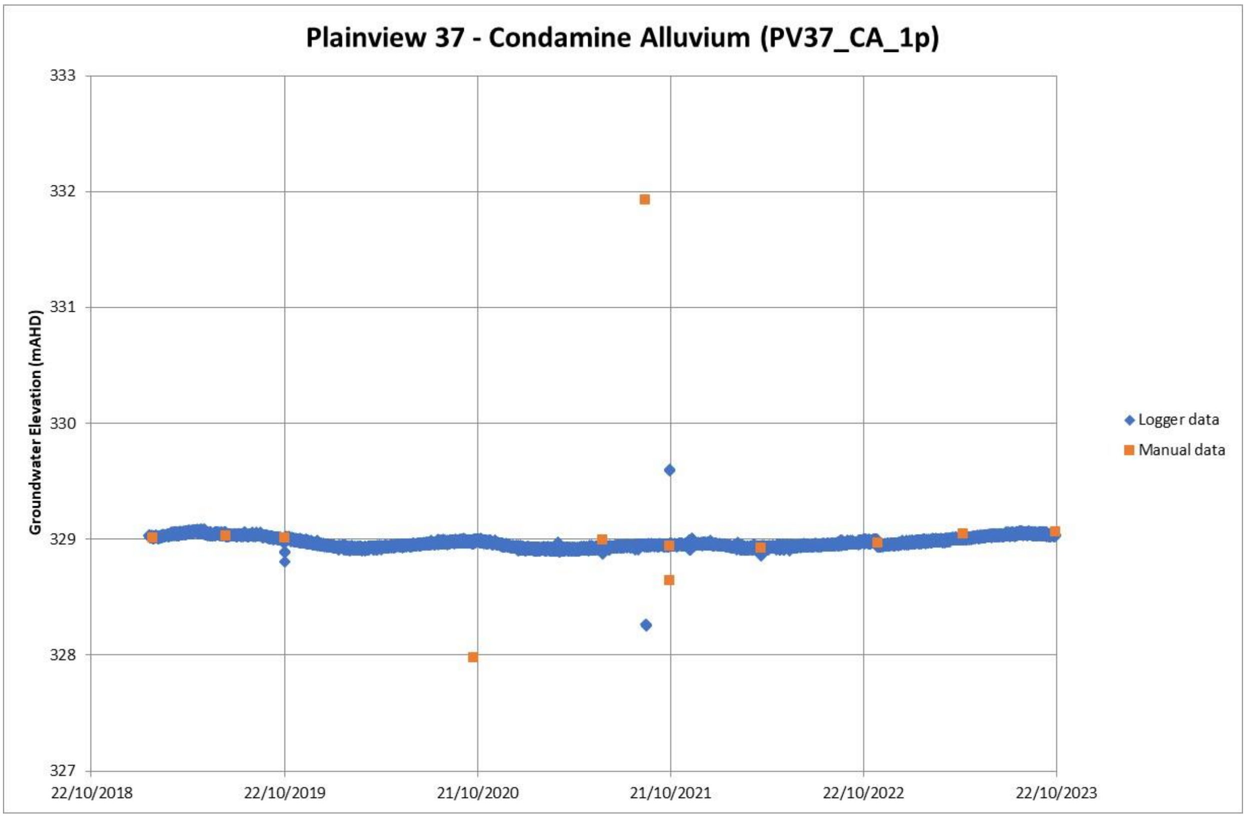


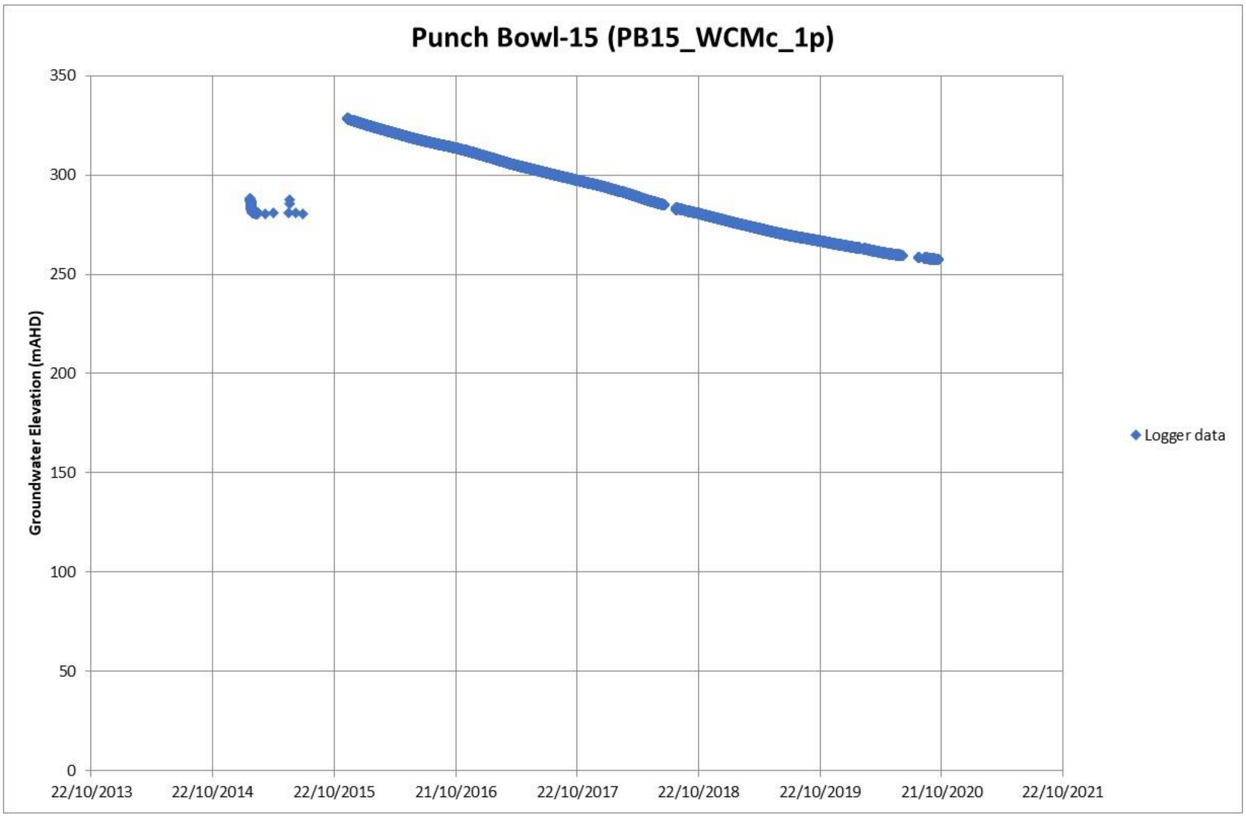
Planview 34 - Taroom CM(PV34_WCMta_1p)
Groundwater Elevation (mAHD)
250
200
150
100
50
0
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

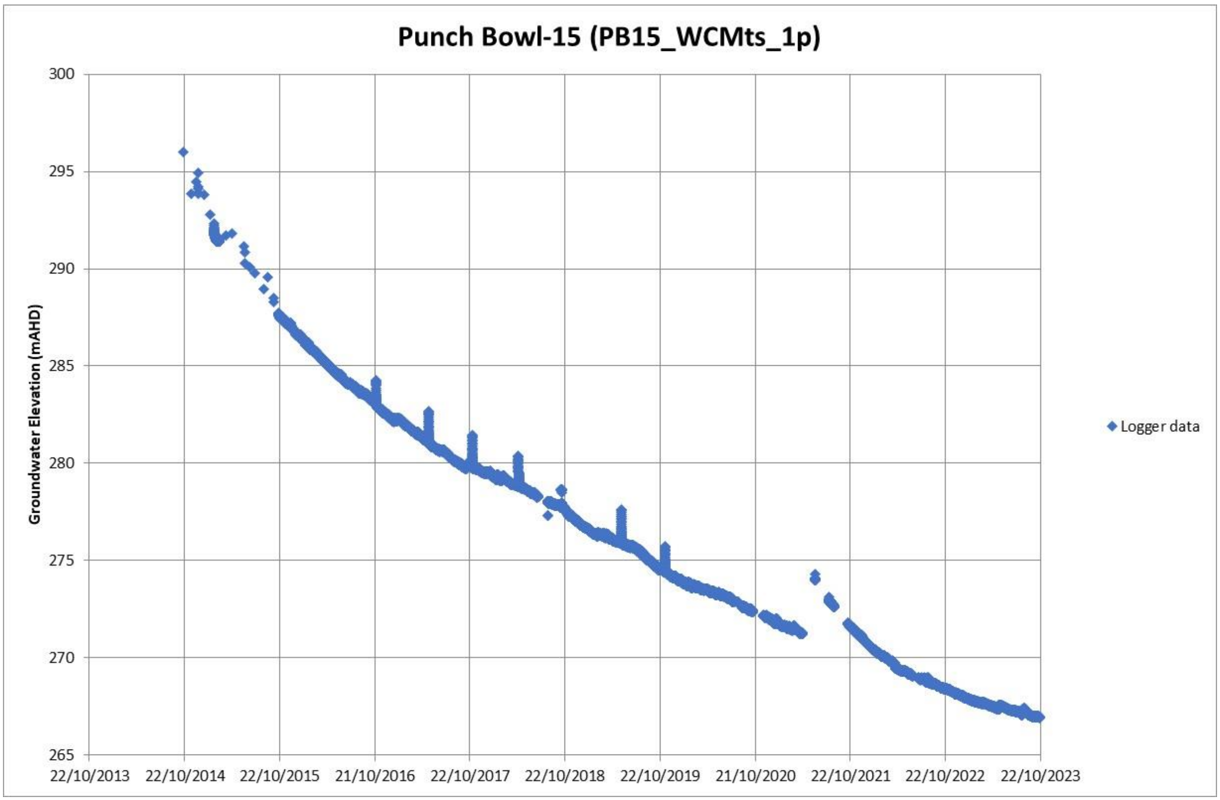


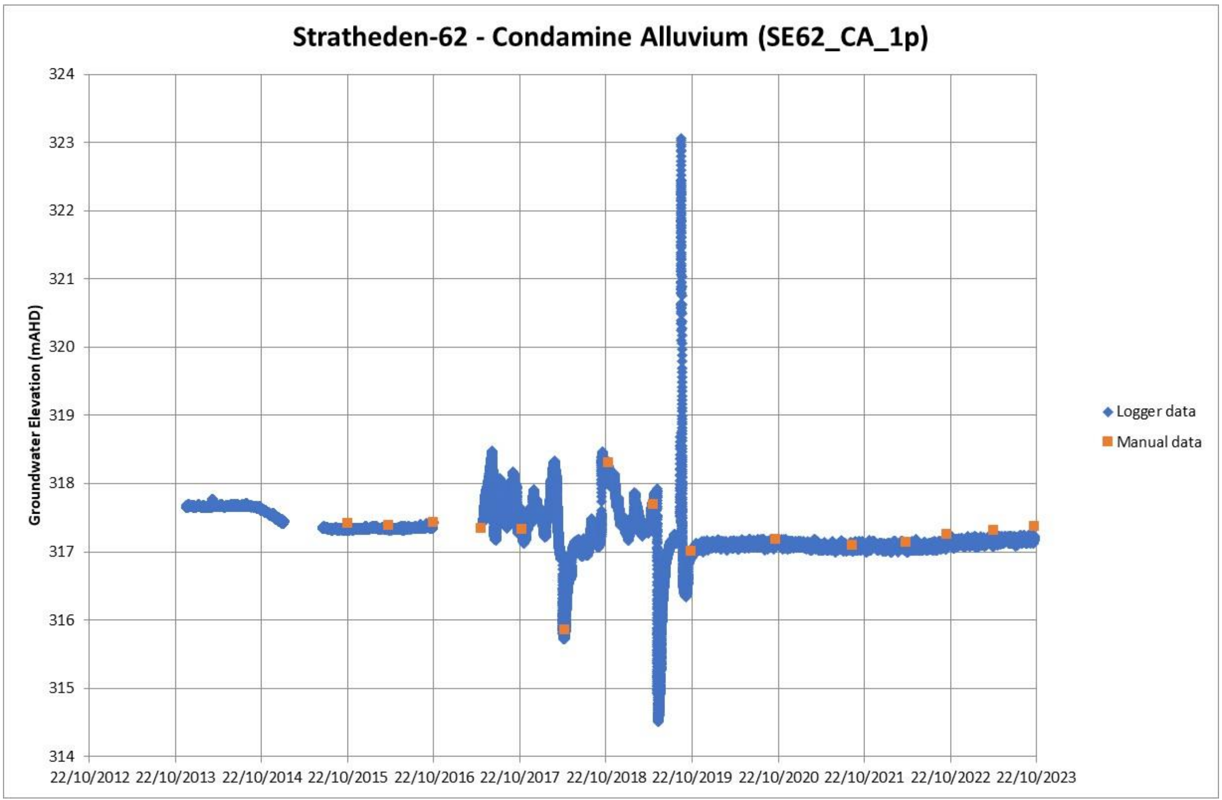


arrow energy go further

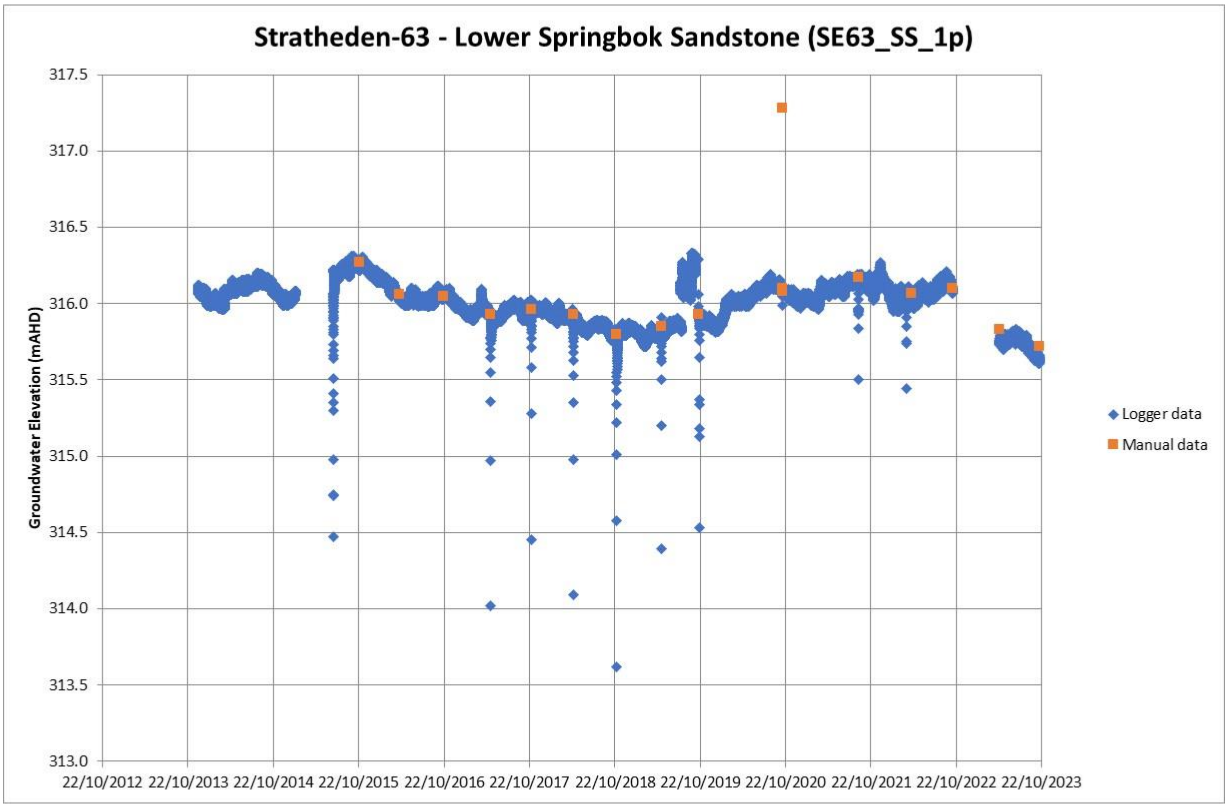

Plainview 37 - Condamine Alluvium (PV37_CA_1p)
Groundwater Elevation (mAHD)
333
332
331
330
329
328
327
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data


Punch Bowl-15 (PB15_WCMc_1p)
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
Logger data

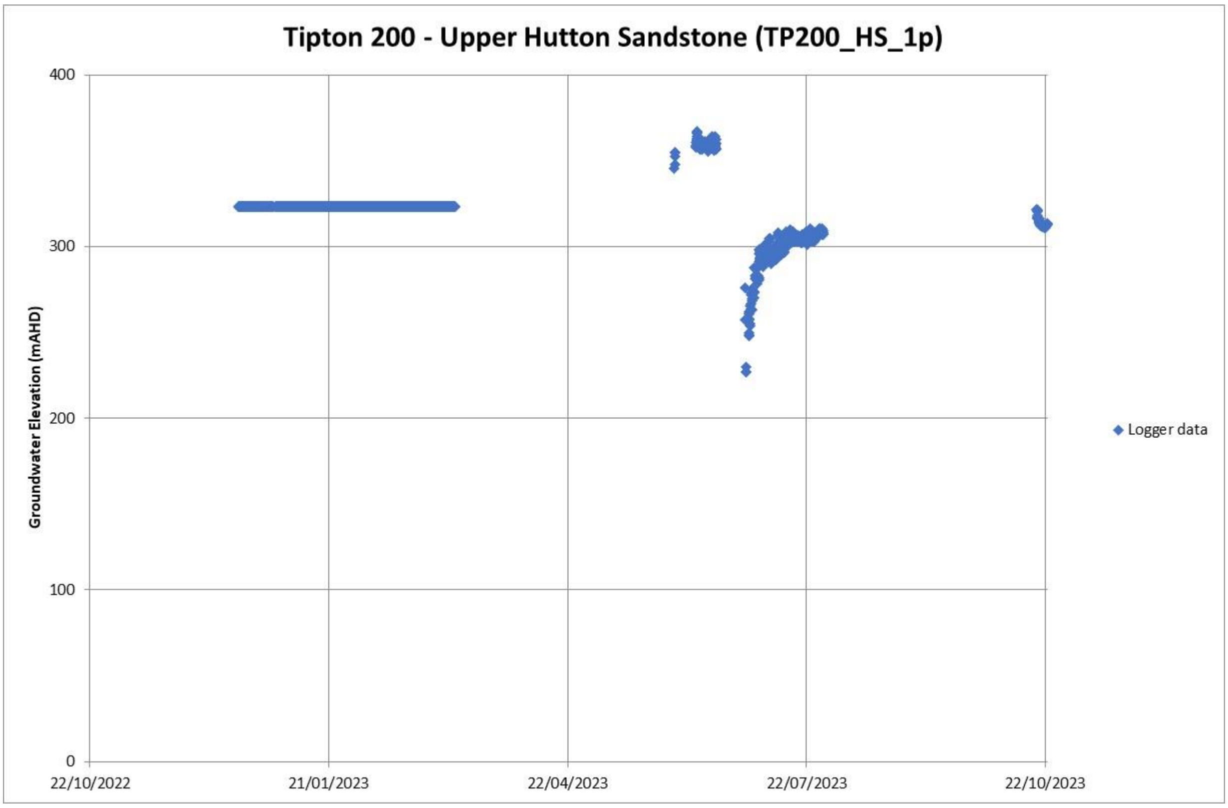




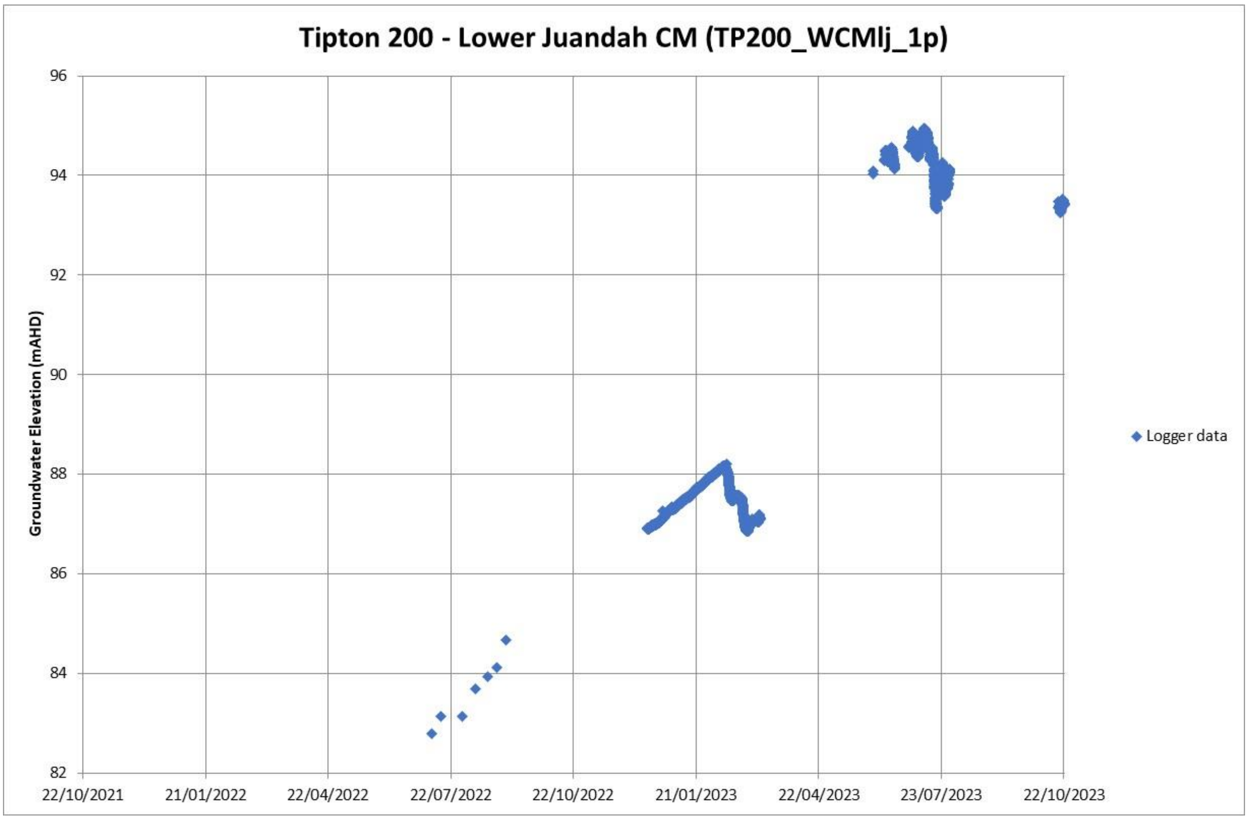
arrow energy
go further

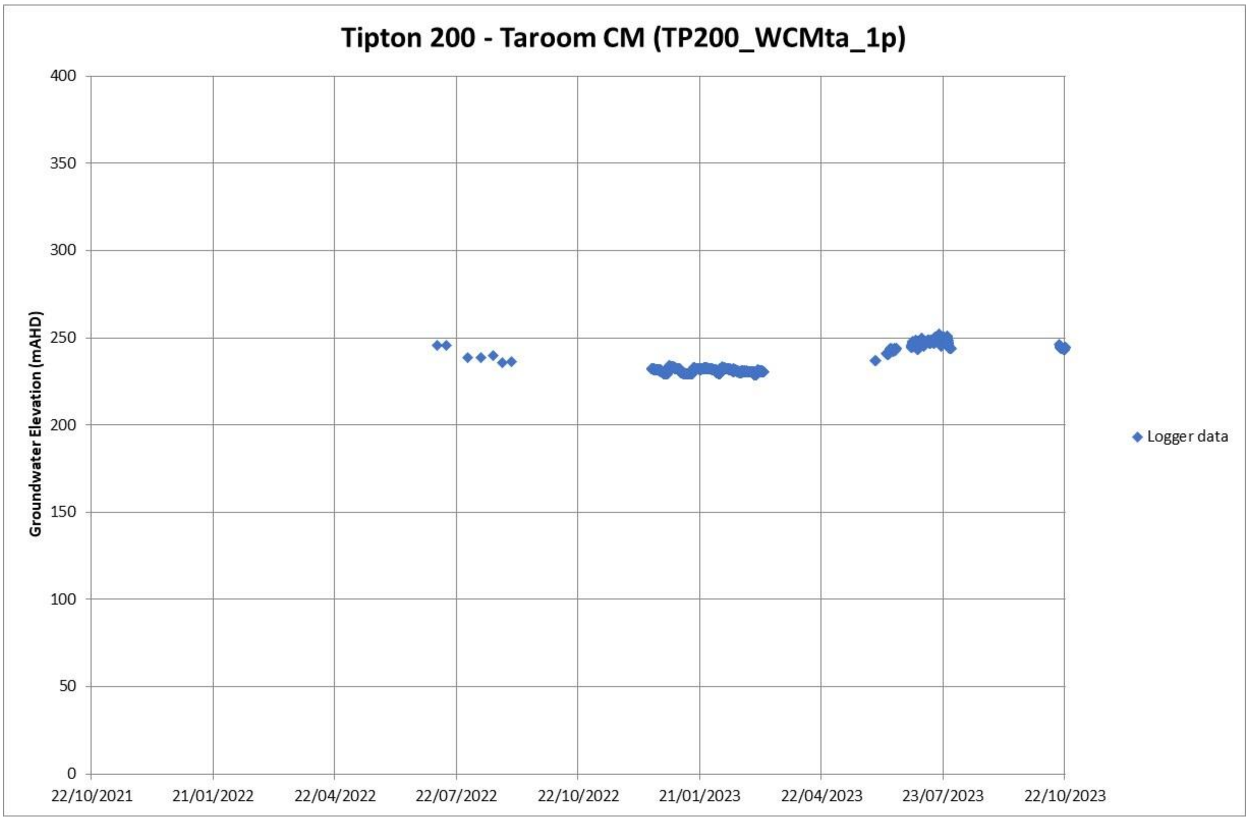


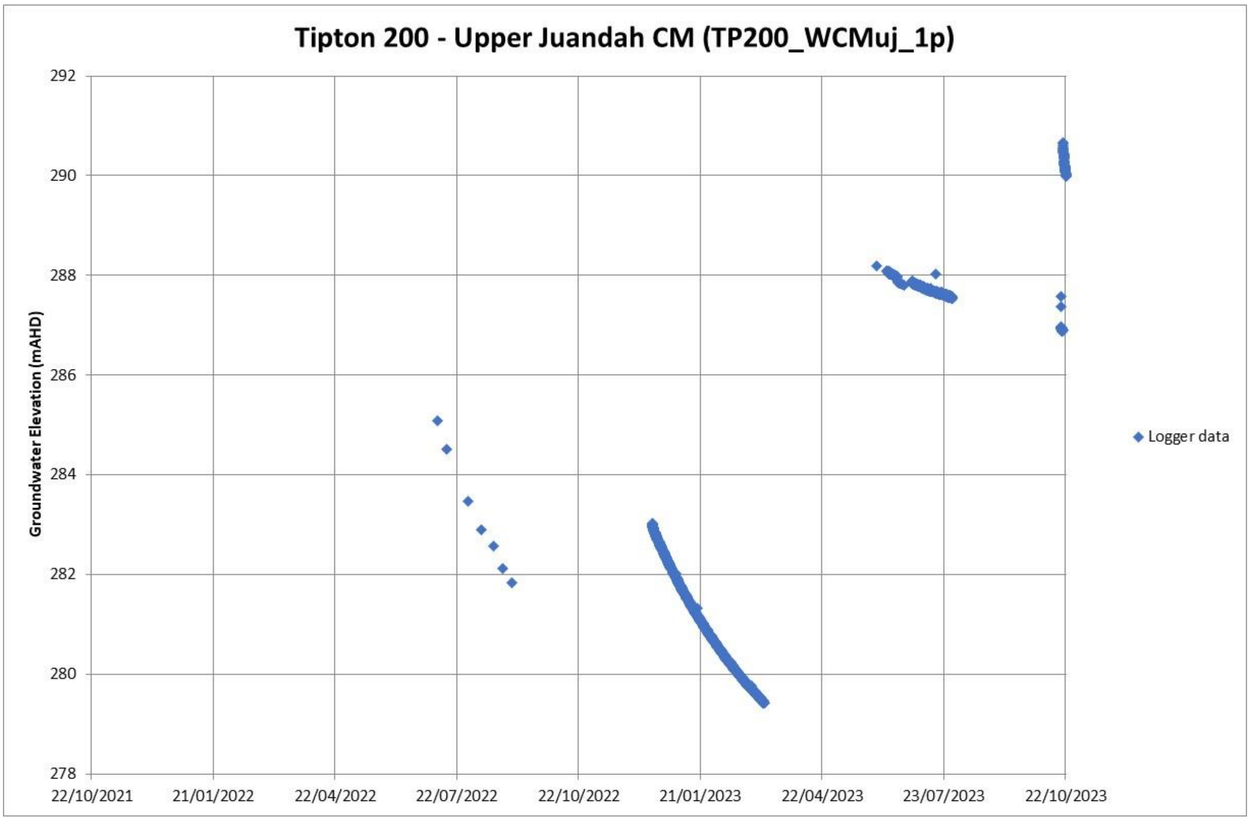
Stratheden-63 - Lower Springbok Sandstone (SE63_SS_1p)
Groundwater Elevation (mAHD)
317.5
317.0
316.5
316.0
315.5
315.0
314.5
314.0
313.5
313.0
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

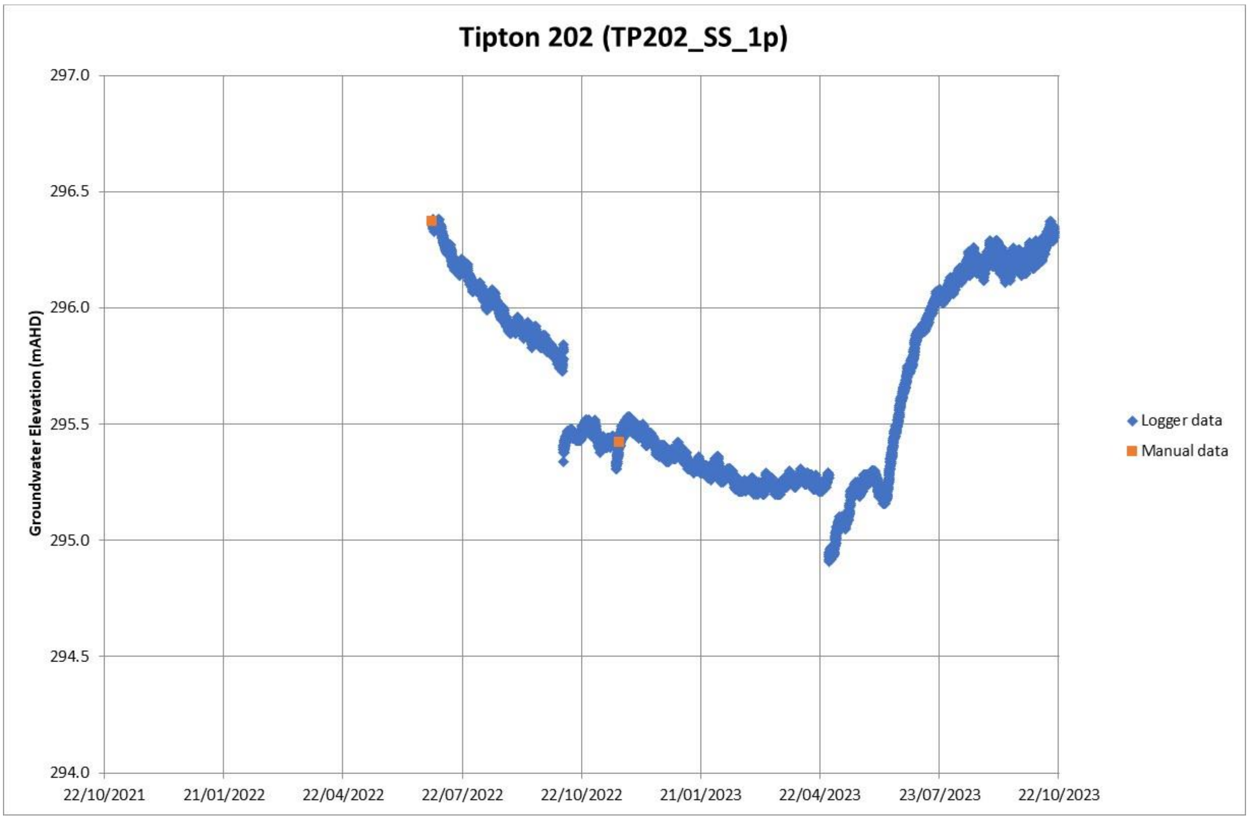


Tipton 200 - Upper Hutton Sandstone (TP200_HS_1p)
Groundwater Elevation (mAHD)
400
300
200
100
0
22/10/2022
21/01/2023
22/04/2023
22/07/2023
22/10/2023
Logger data

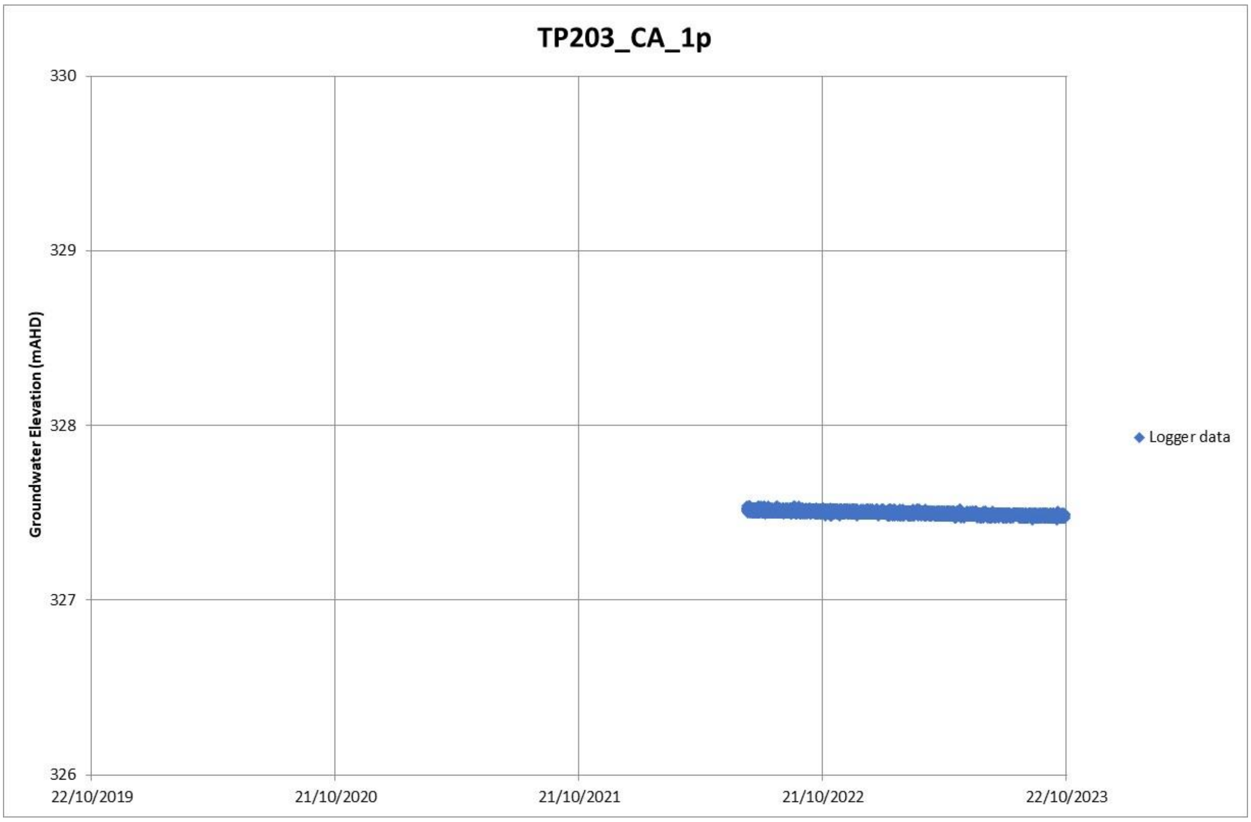

Tipton 200 - Lower Juandah CM (TP200_WCMlj_1p)
Groundwater Elevation (mAHD)
96
94
92
90
88
86
84
82
22/10/2021
21/01/2022
22/04/2022
22/07/2022
22/10/2022
21/01/2023
22/04/2023
23/07/2023
22/10/2023
Logger data

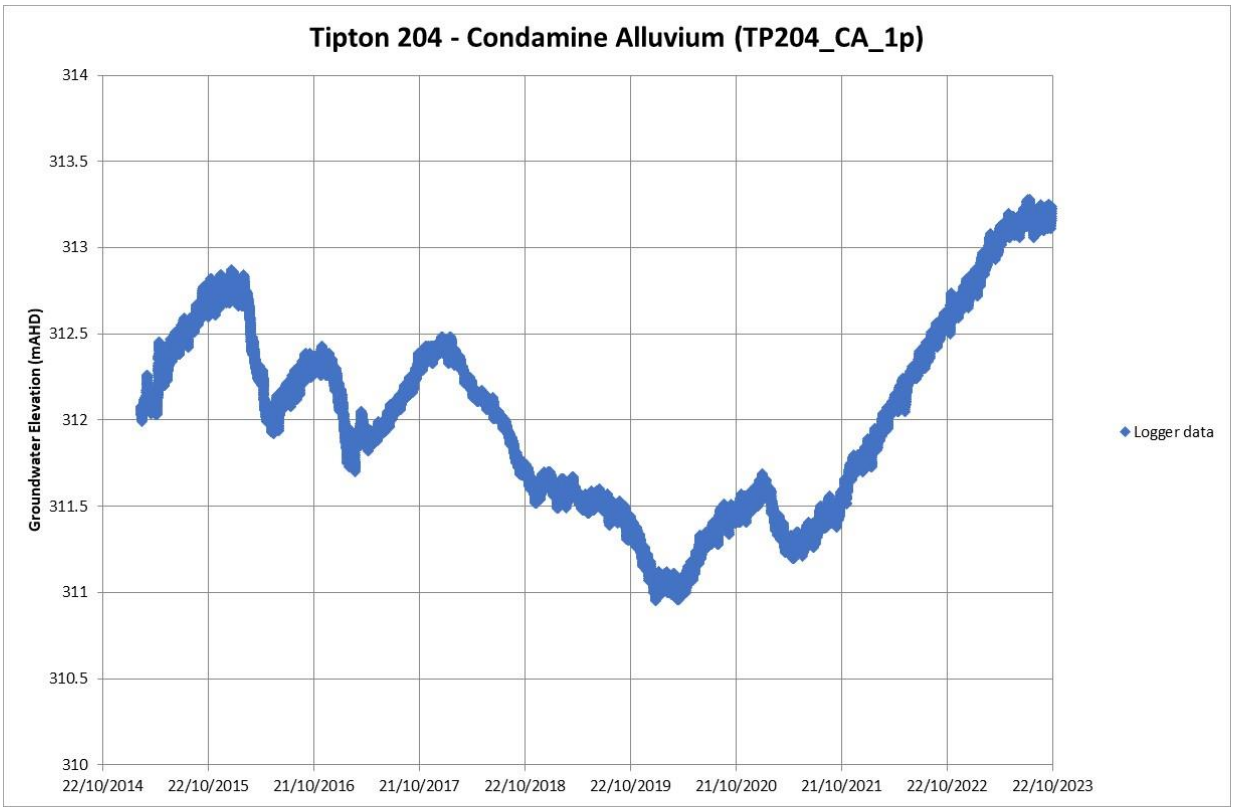

Tipton 200 - Taroom CM (TP200_WCMta_1p)
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2021
21/01/2022
22/04/2022
22/07/2022
22/10/2022
21/01/2023
22/04/2023
23/07/2023
22/10/2023
Logger data

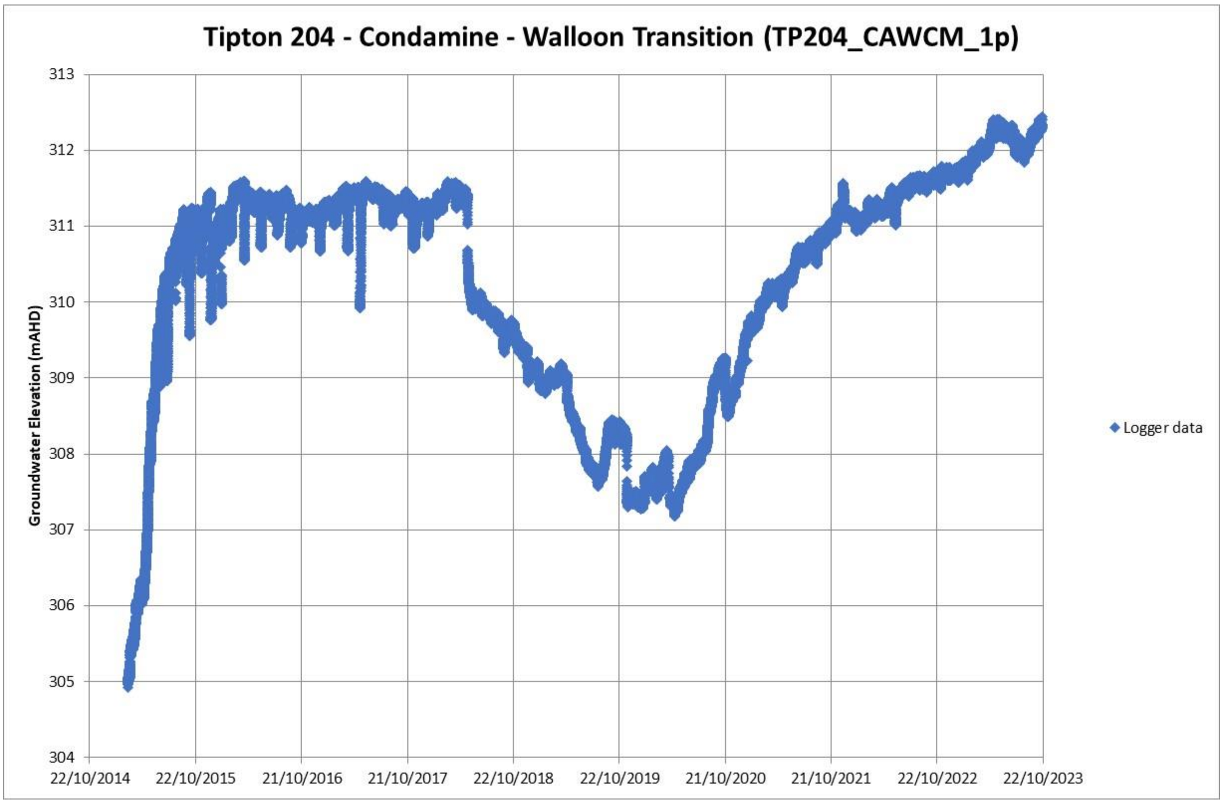


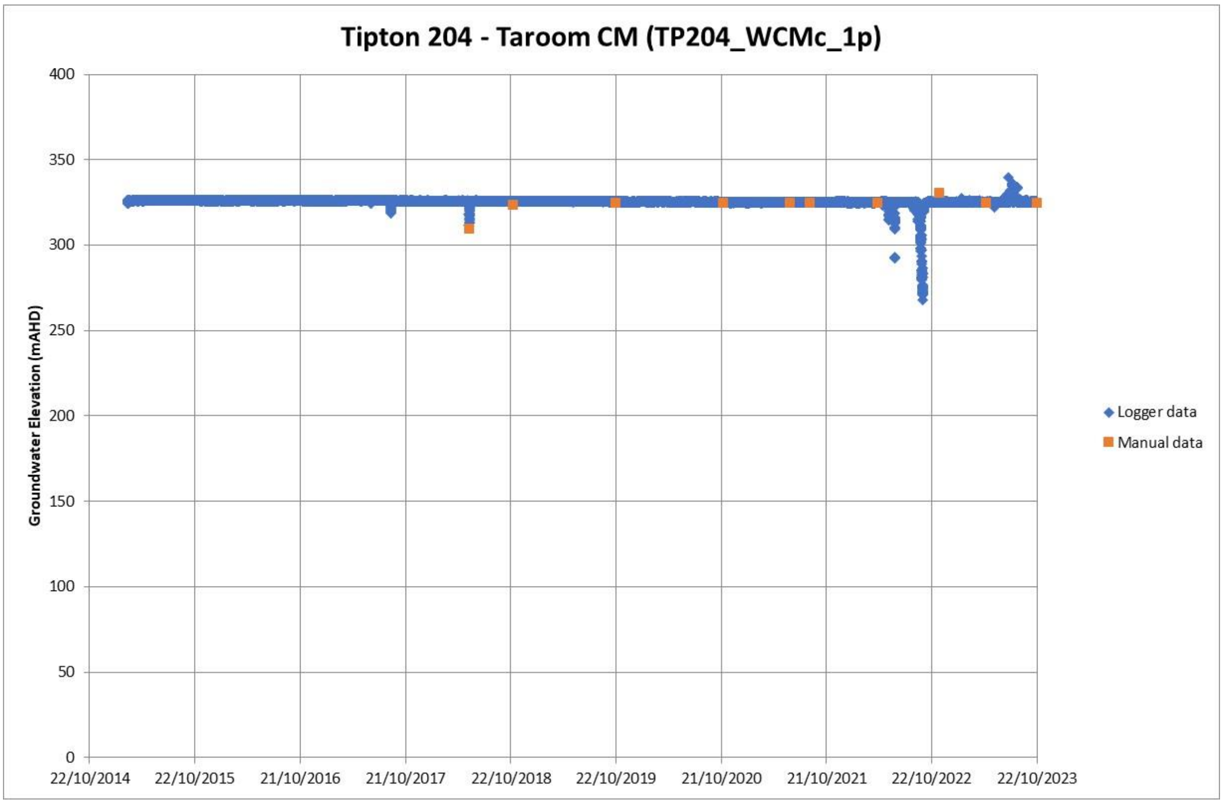


arrow energy go further

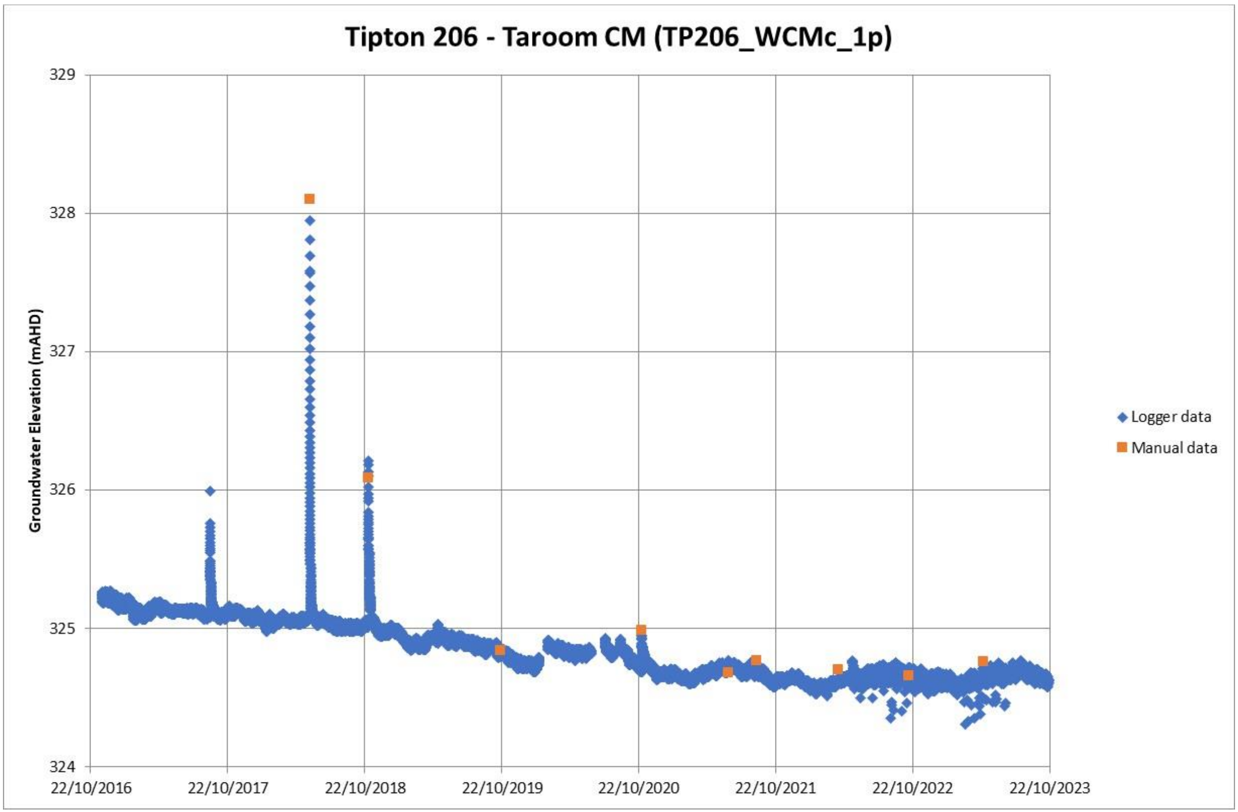

TP203_CA_1p
Groundwater Elevation (mAHD)
330
329
328
327
326
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data


Tipton 204 - Condamine Alluvium (TP204_CA_1p)
Groundwater Elevation (mAHD)
314
313.5
313
312.5
312
311.5
311
310.5
310
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

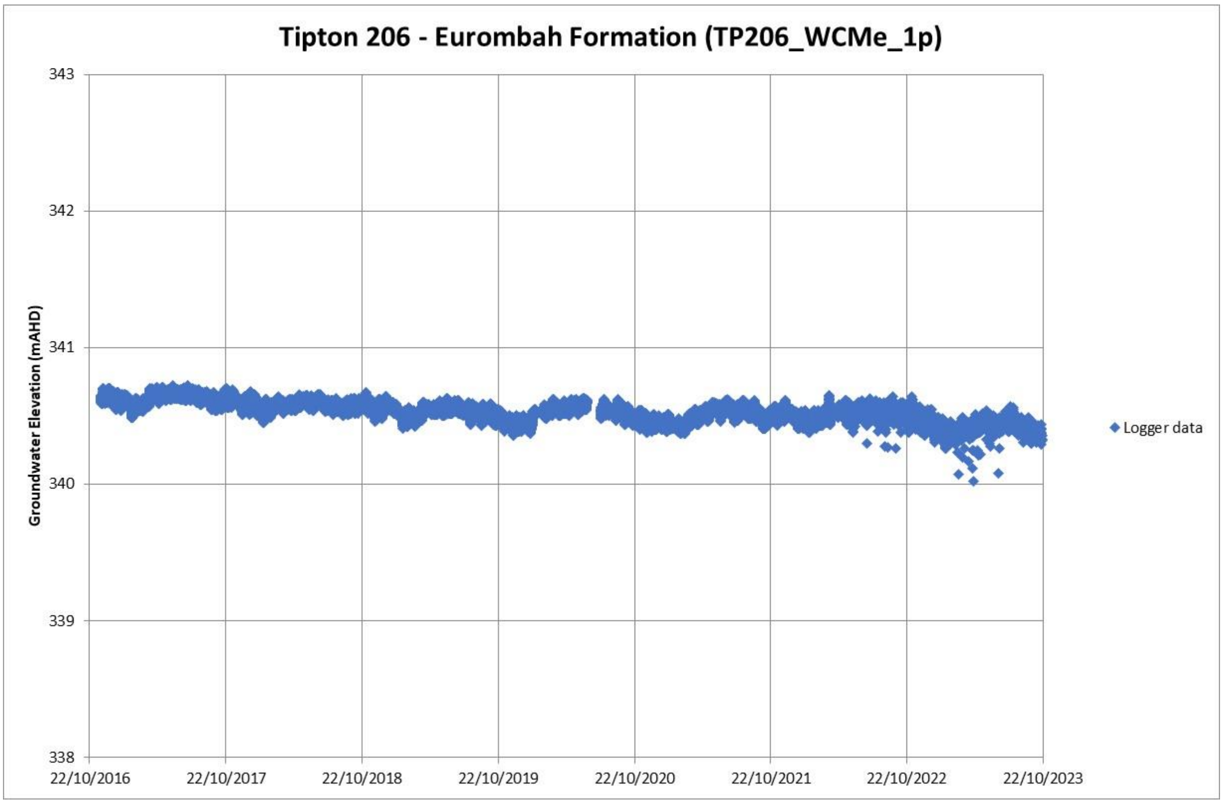

Tipton 204 - Condamine - Walloon Transition (TP204_CAWCM_1p)
Groundwater Elevation (mAHD)
313
312
311
310
309
308
307
306
305
304
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

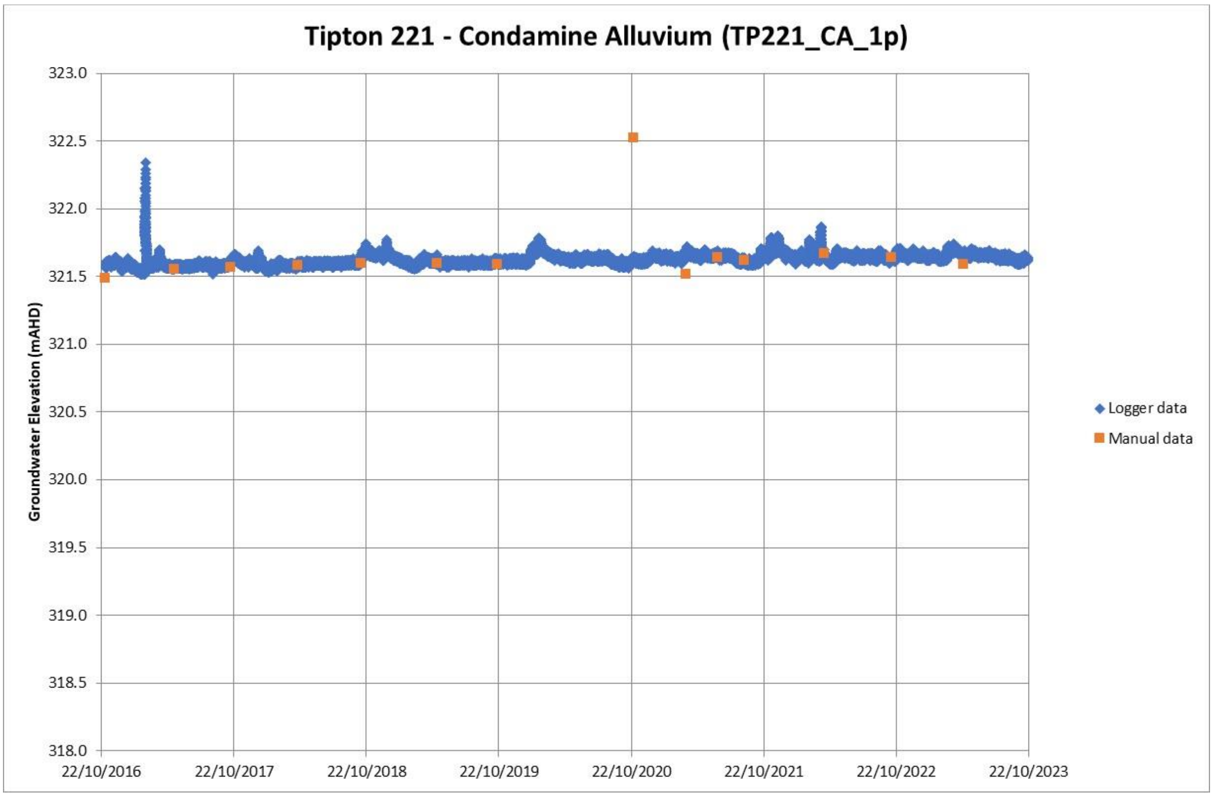


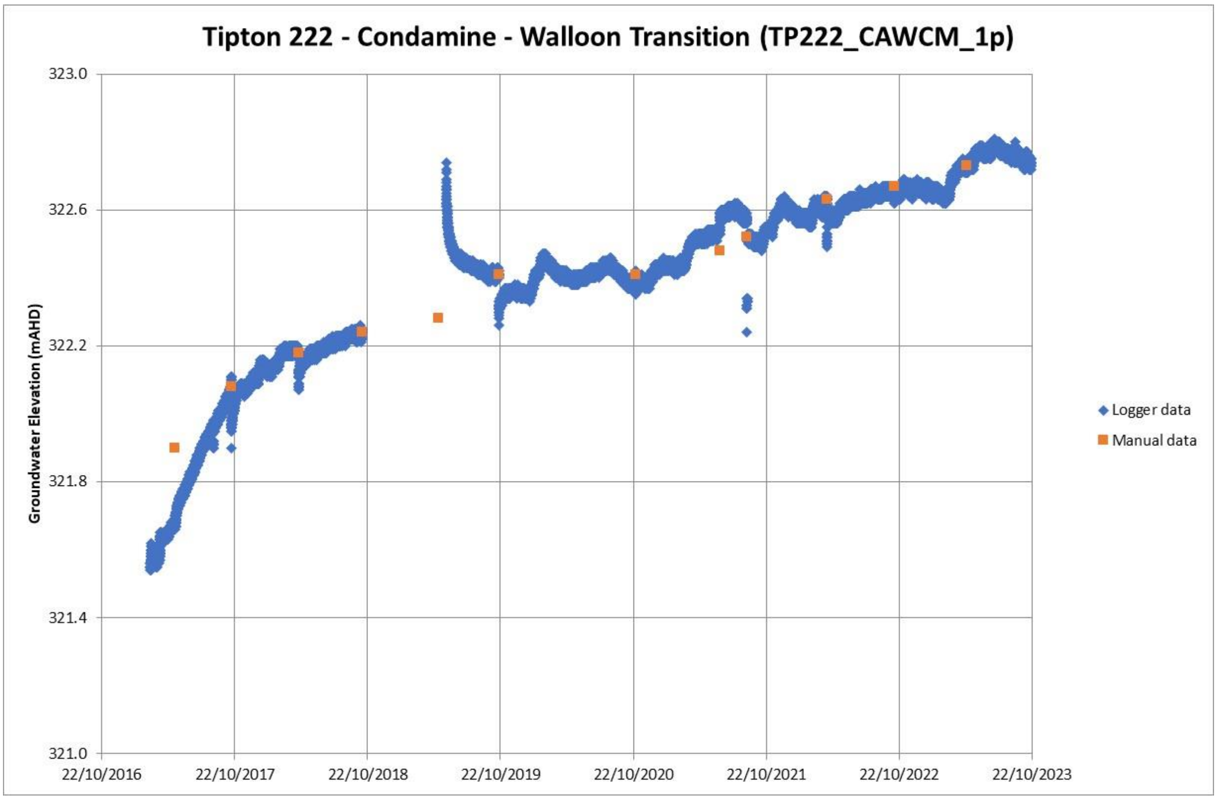
Tipton 204 - Taroom CM (TP204_WCMc_1p)
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

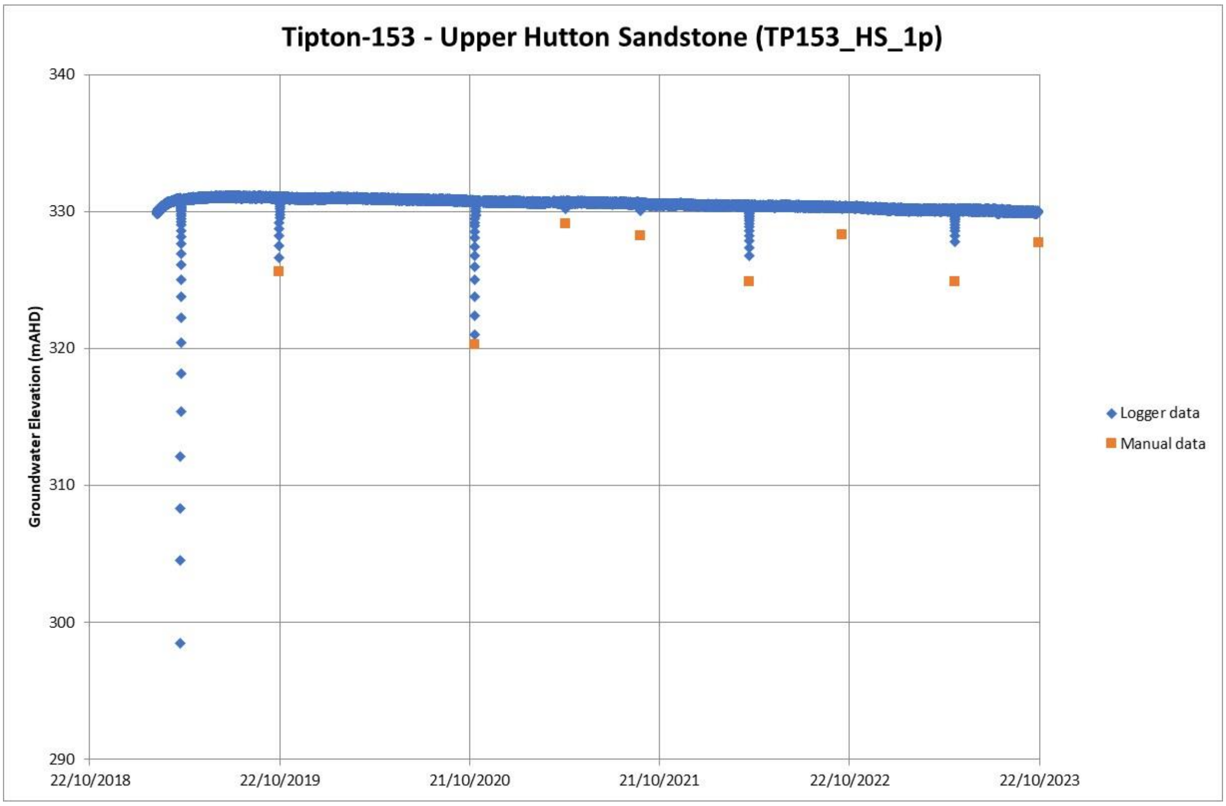


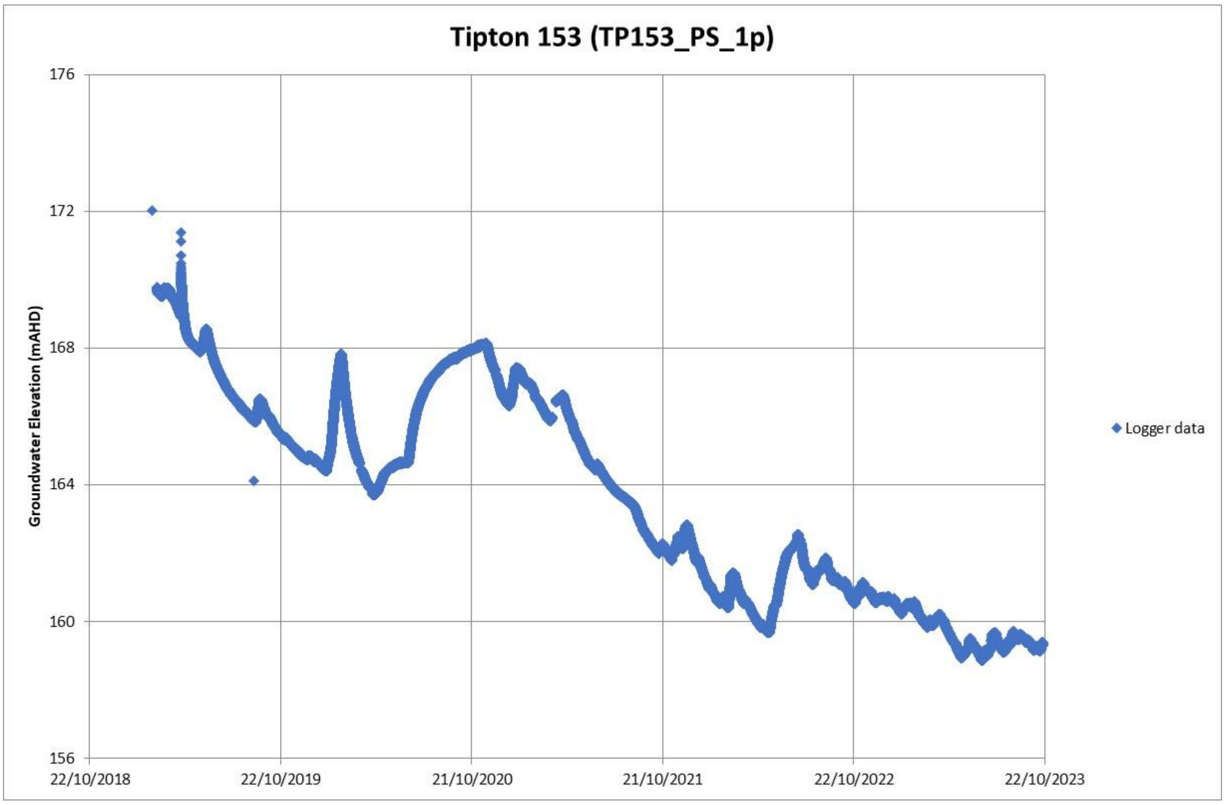
Tipton 206 - Taroom CM (TP206_WCMc_1p)
Groundwater Elevation (mAHD)
329
328
327
326
325
324
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

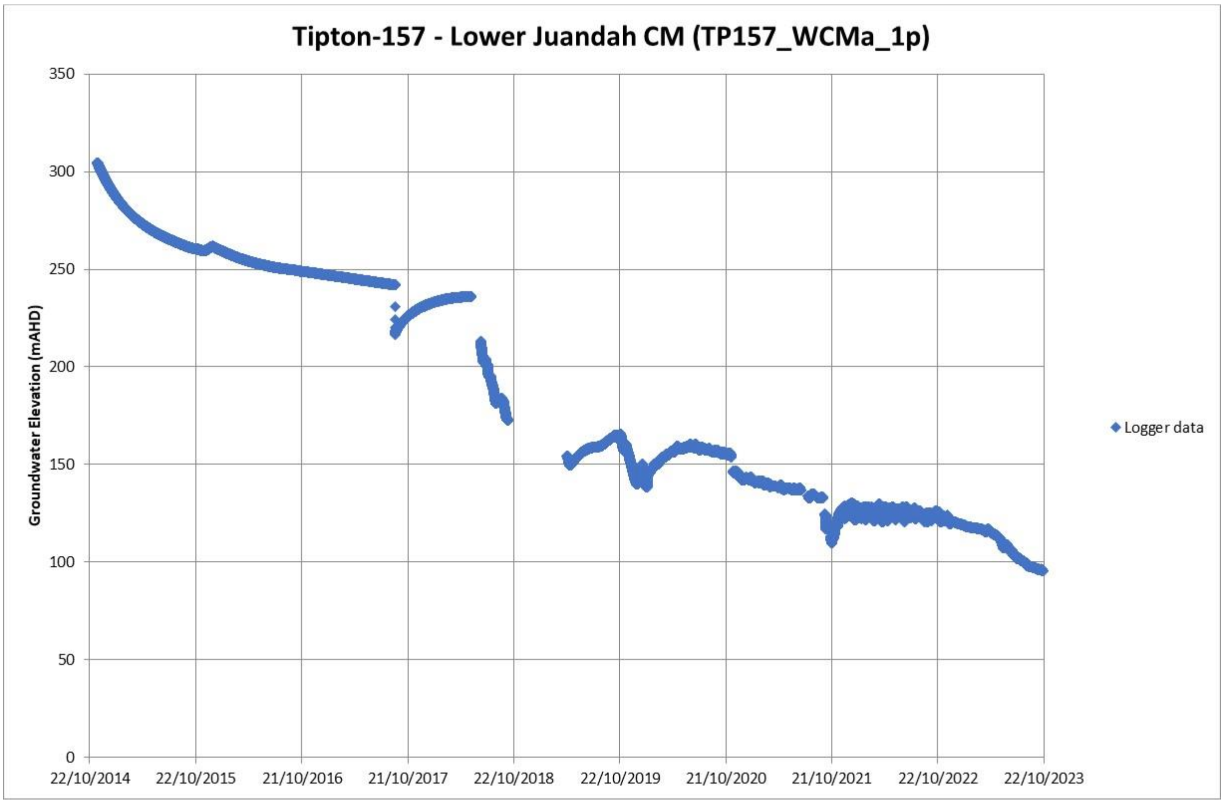

Tipton 206 - Eurombah Formation (TP206_WCMe_1p)
Groundwater Elevation (mAHD)
343
342
341
340
339
338
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

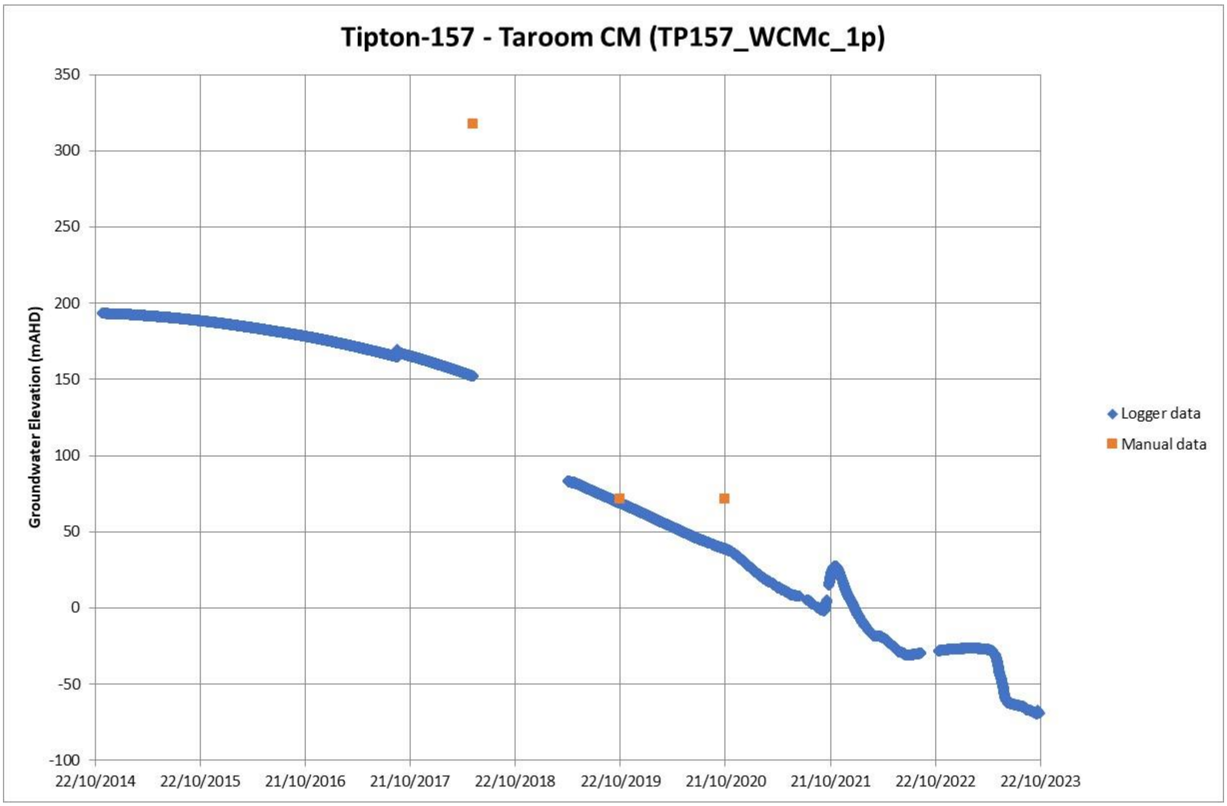

Tipton 221 - Condamine Alluvium (TP221_CA_1p)
Groundwater Elevation (mAHD)
323.0
322.5
322.0
321.5
321.0
320.5
320.0
319.5
319.0
318.5
318.0
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

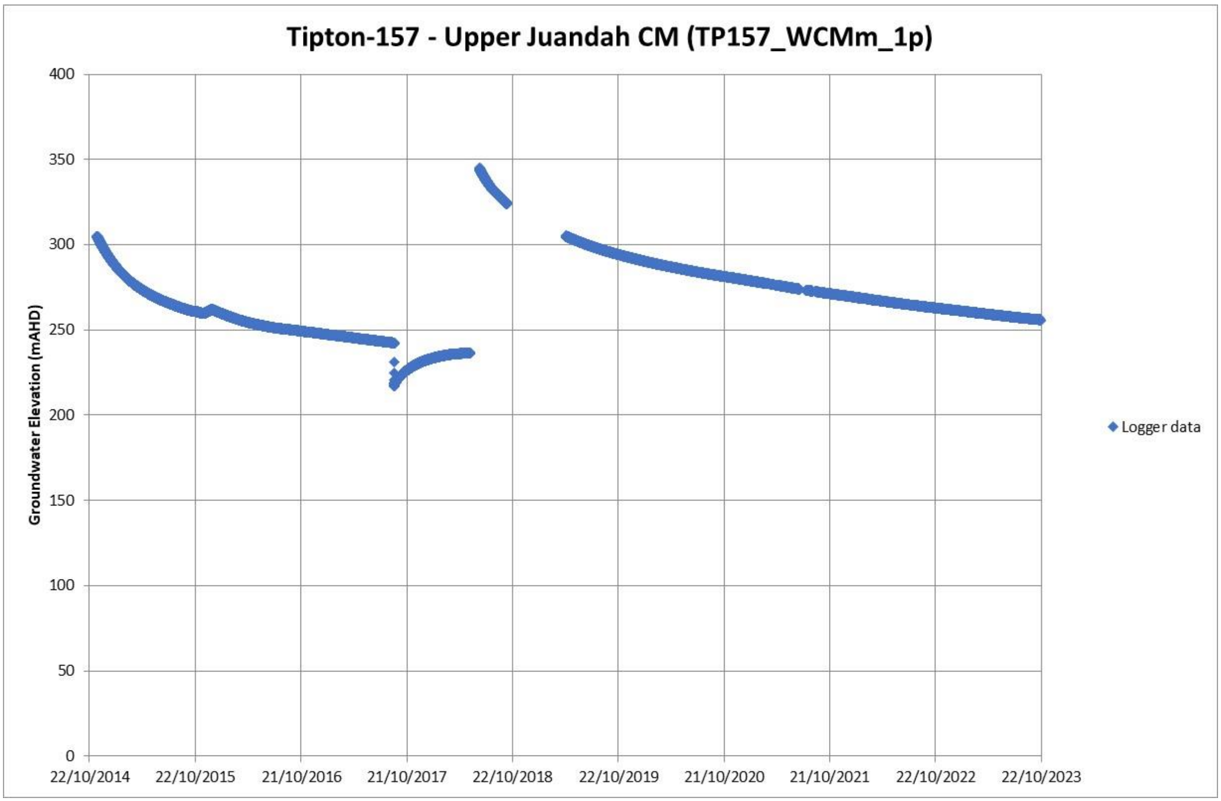

Tipton 222 - Condamine - Walloon Transition (TP222_CAWCM_1p)
Groundwater Elevation (mAHD)
323.0
322.6
322.2
321.8
321.4
321.0
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

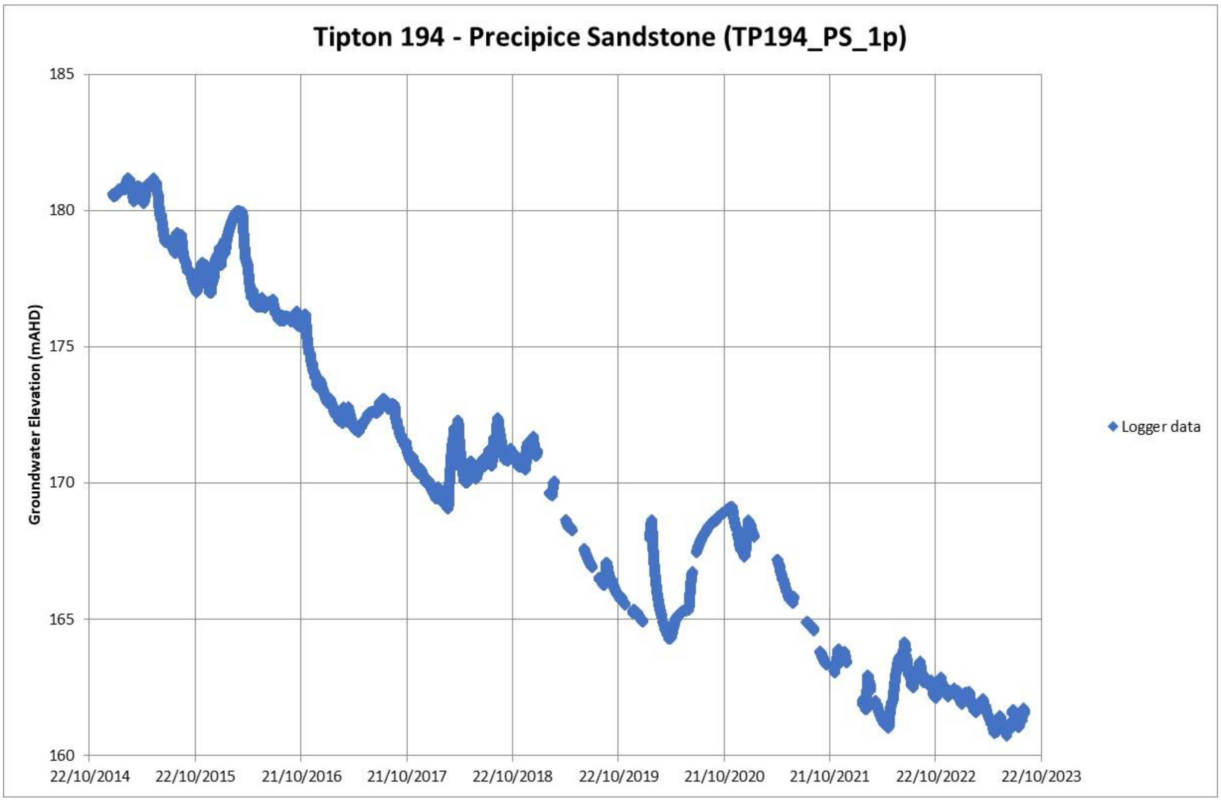

Tipton-153 - Upper Hutton Sandstone (TP153_HS_1p)
Groundwater Elevation (mAHD)
340
330
320
310
300
290
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

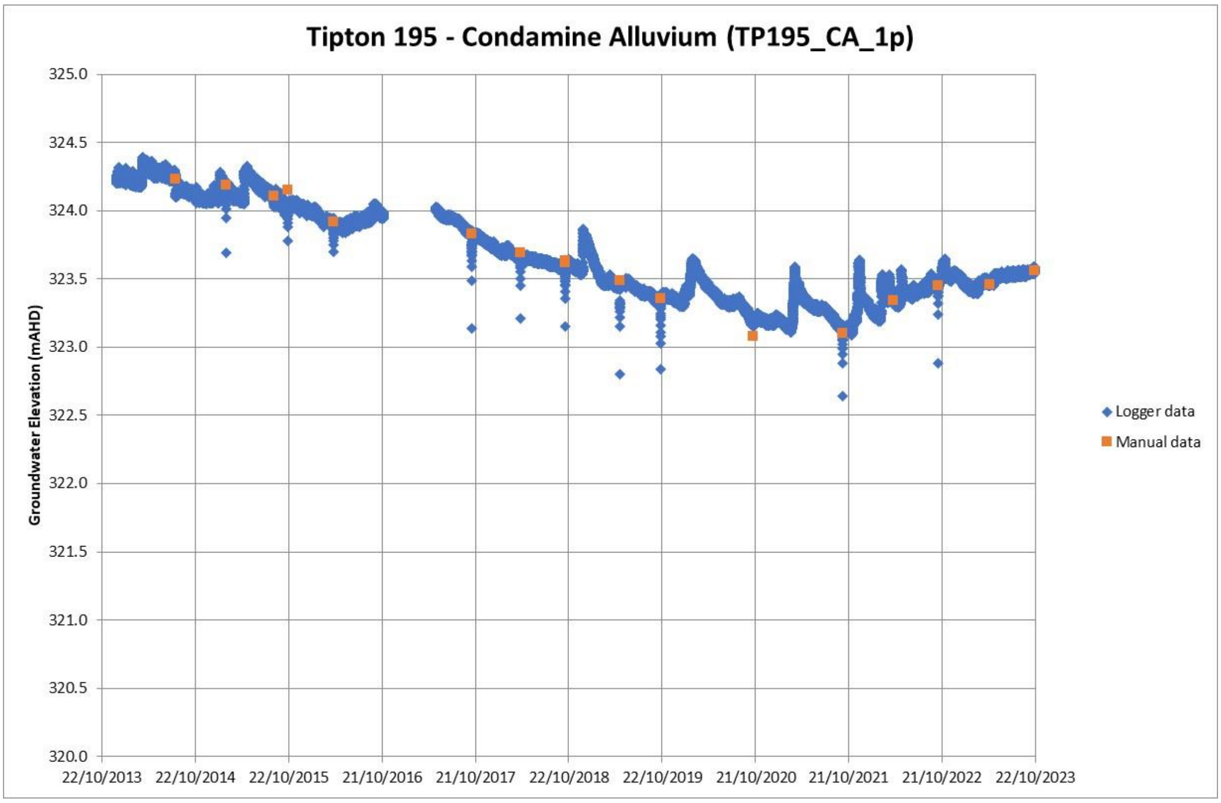

Tipton 153 (TP153_PS_1p)
Groundwater Elevation (mAHD)
176
172
168
164
160
156
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

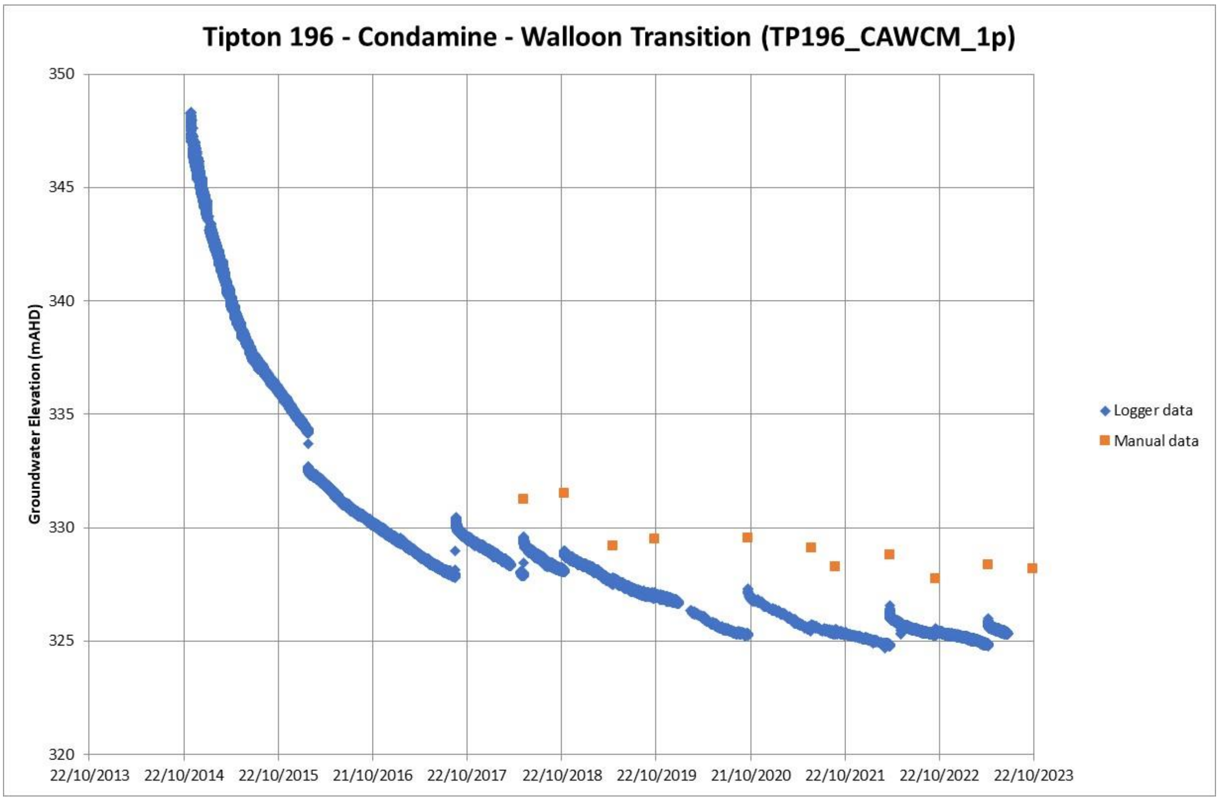

Tipton-157 - Lower Juandah CM (TP157_WCMa_1p)
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

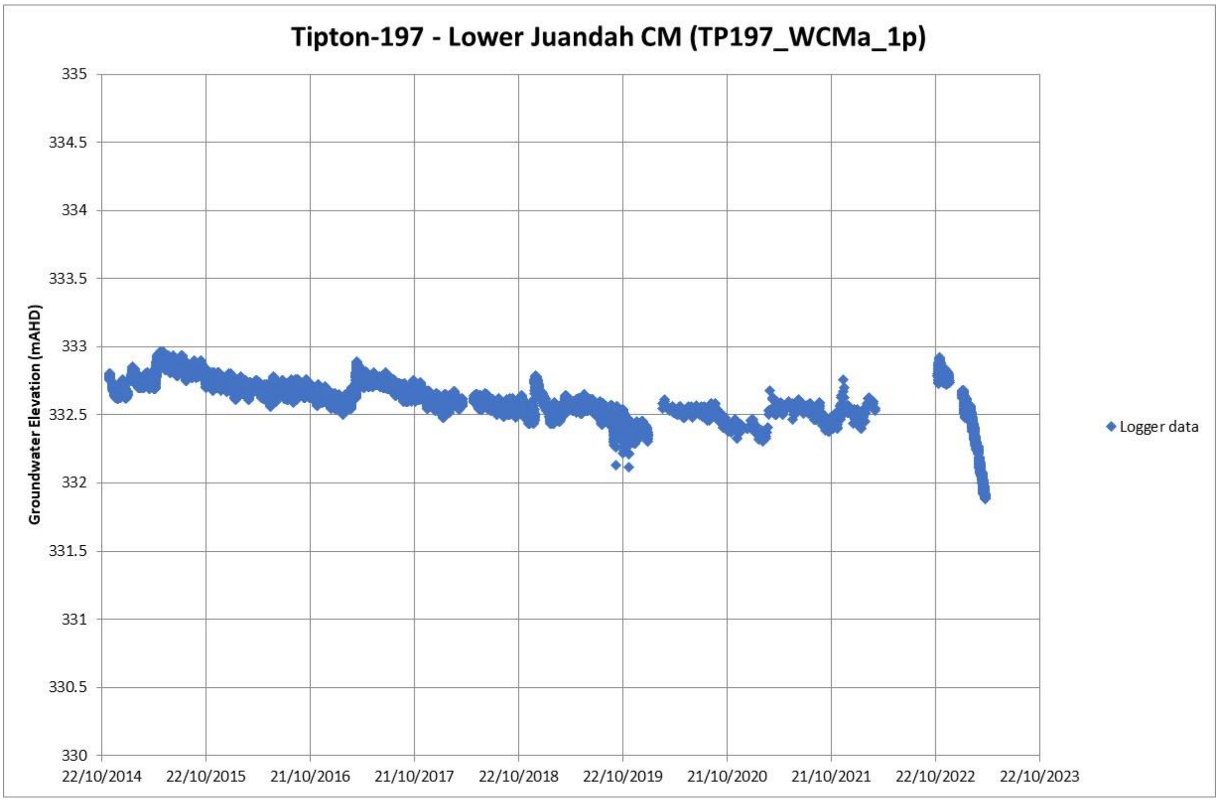

Tipton-157 - Taroom CM (TP157_WCMc_1p)
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
-50
-100
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

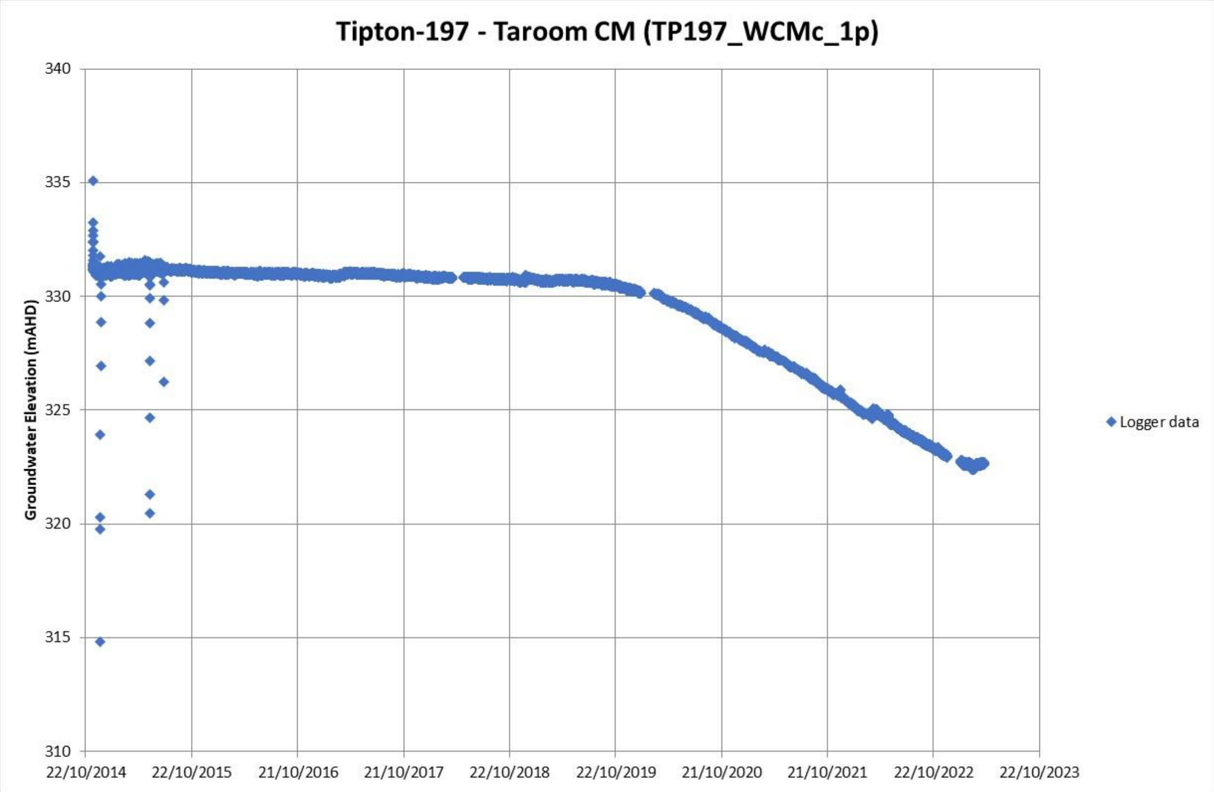

Tipton-157 - Upper Juandah CM (TP157_WCMm_1p)
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

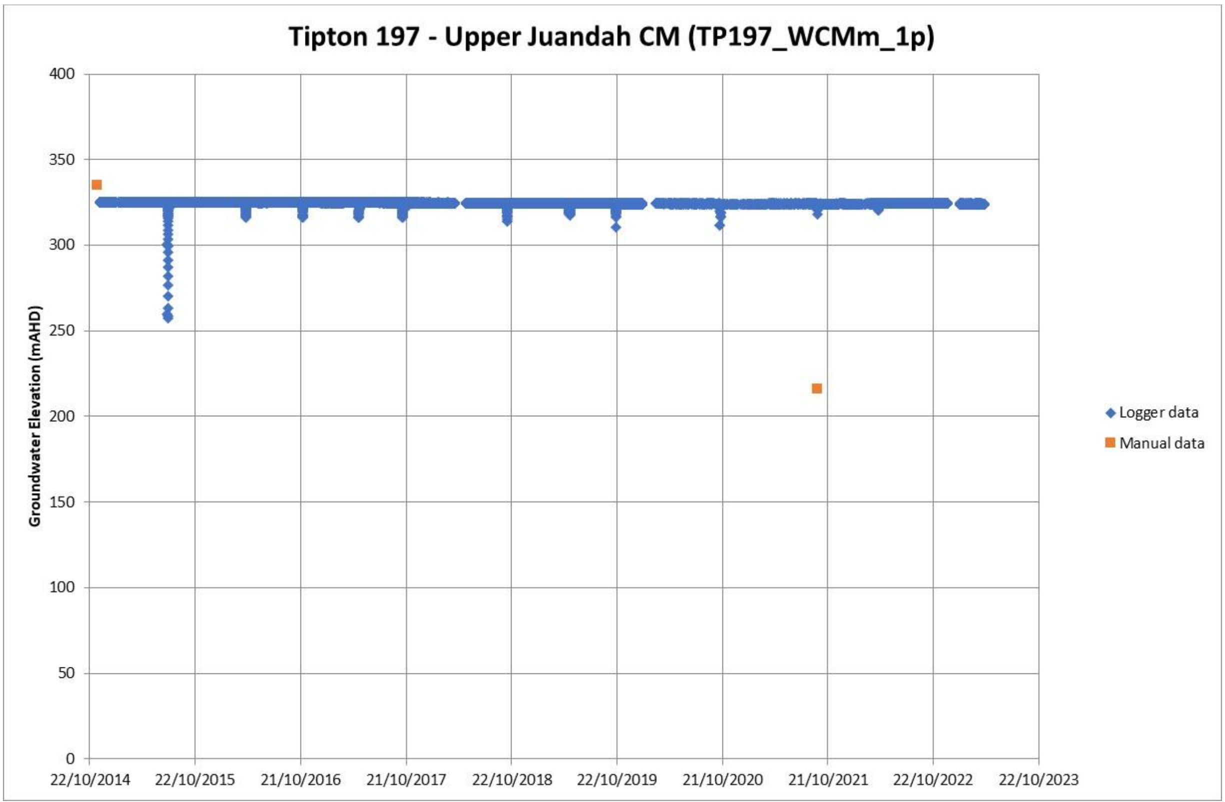

Tipton 194 - Precipice Sandstone (TP194_PS_1p)
Groundwater Elevation (mAHD)
185
180
175
170
165
160
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

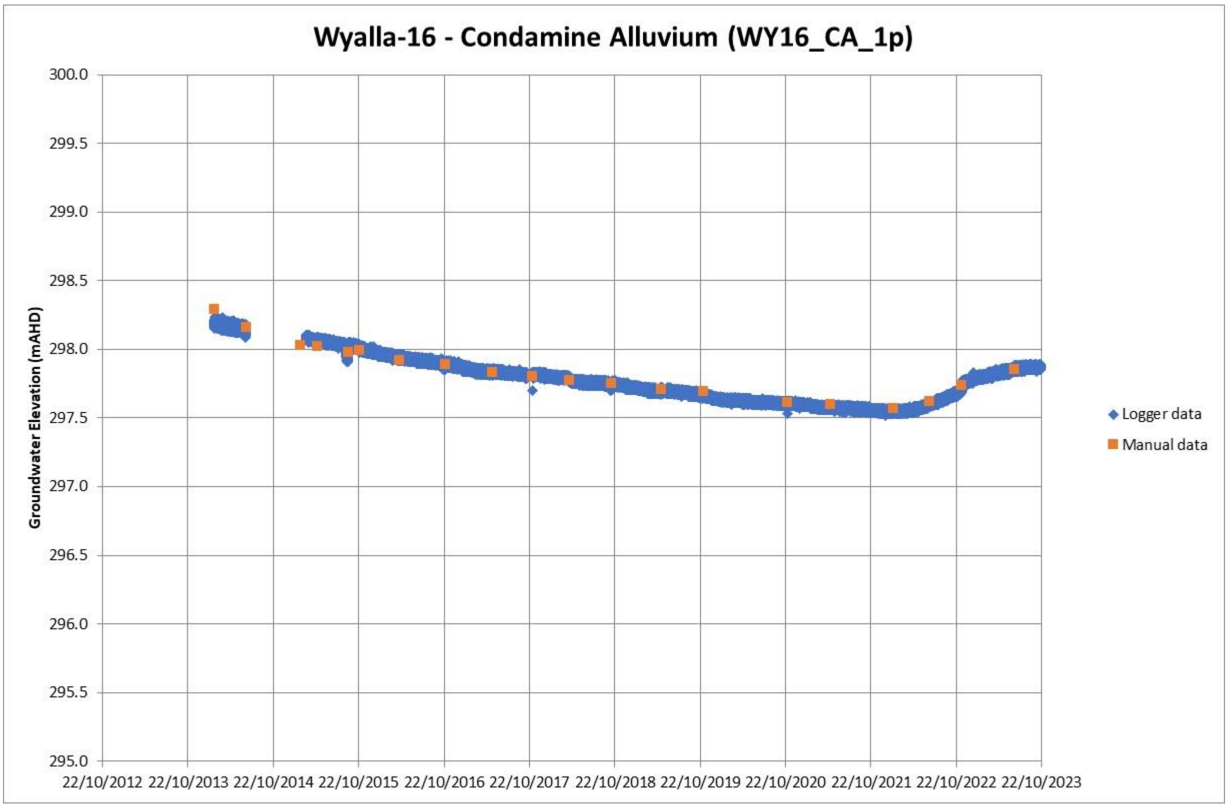

Tipton 195 - Condamine Alluvium (TP195_CA_1p)
Groundwater Elevation (mAHD)
325.0
324.5
324.0
323.5
323.0
322.5
322.0
321.5
321.0
320.5
320.0
22/10/2013
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
21/10/2022
22/10/2023
Logger data
Manual data

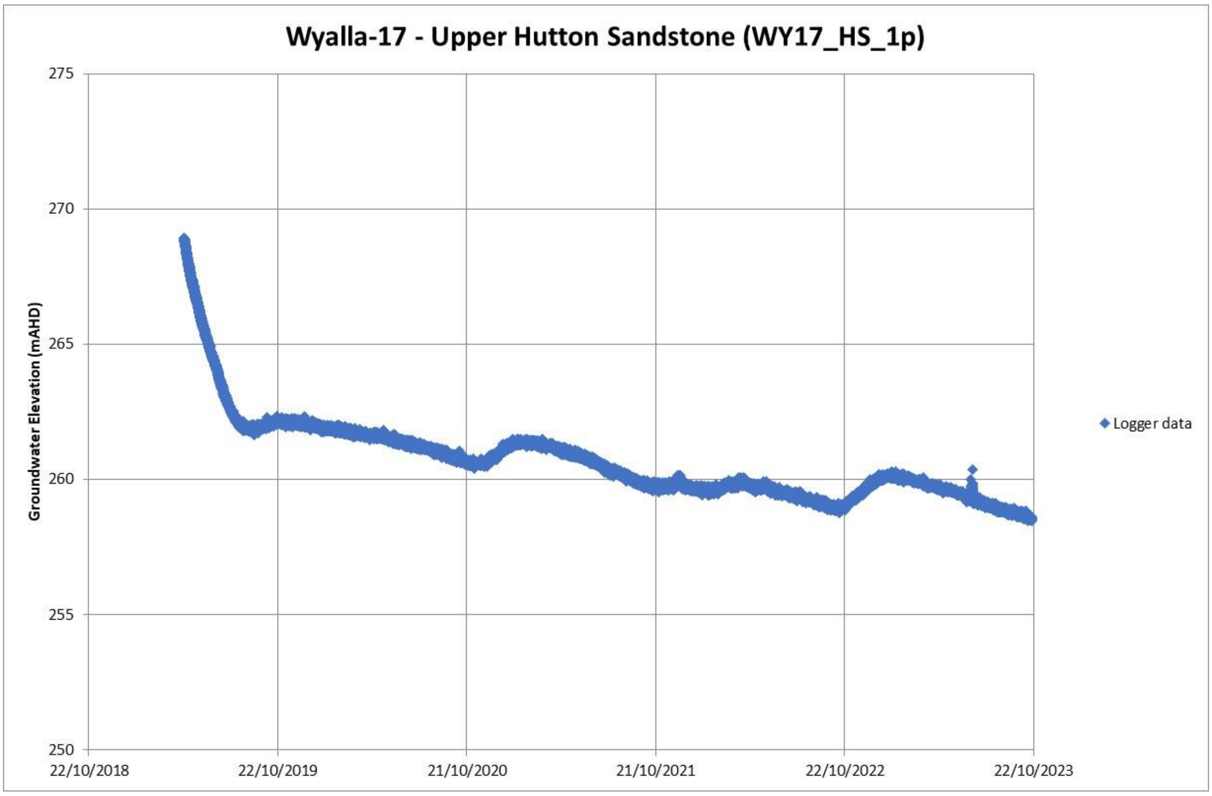

Tipton 196 - Condamine - Walloon Transition (TP196_CAWCM_1p)
Groundwater Elevation (mAHD)
350
345
340
335
330
325
320
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

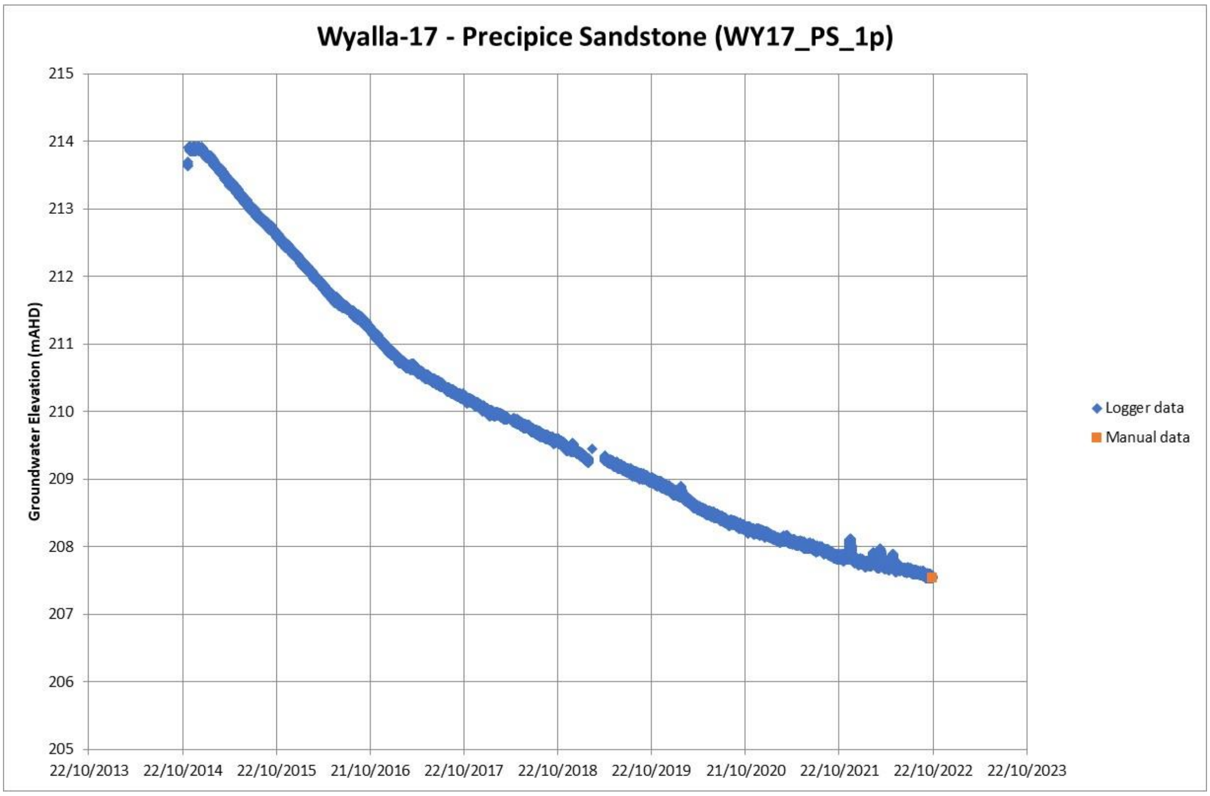

Tipton-197 - Lower Juandah CM (TP197_WCMa_1p)
Groundwater Elevation (mAHD)
335
334.5
334
333.5
333
332.5
332
331.5
331
330.5
330
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
22/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data


Tipton-197 - Taroom CM (TP197_WCMc_1p)
Groundwater Elevation (mAHD)
340
335
330
325
320
315
310
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

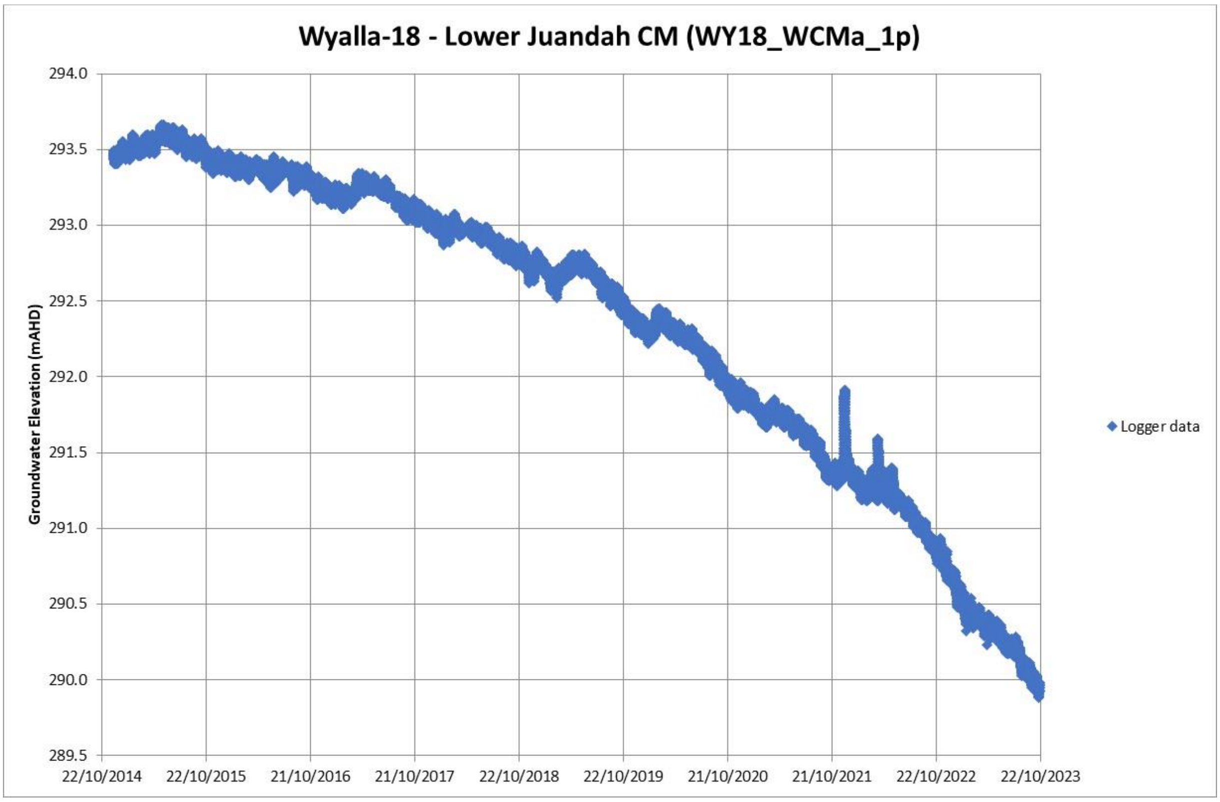

Tipton 197 - Upper Juandah CM (TP197_WCMm_1p)
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
Manual data


Wyalla-16 - Condamine Alluvium (WY16_CA_1p)
Groundwater Elevation (mAHD)
300.0
299.5
299.0
298.5
298.0
297.5
297.0
296.5
296.0
295.5
295.0
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

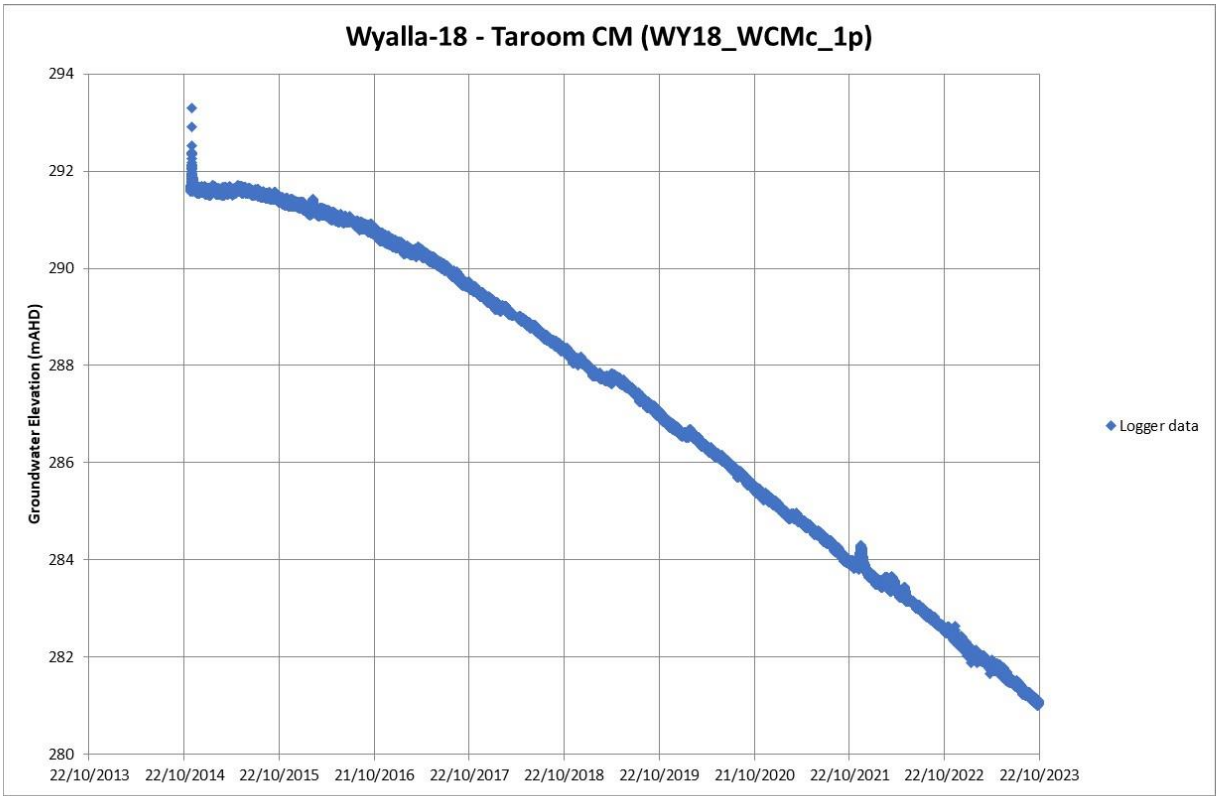

Wyalla-17 - Upper Hutton Sandstone (WY17_HS_1p)
Groundwater Elevation (mAHD)
275
270
265
260
255
250
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

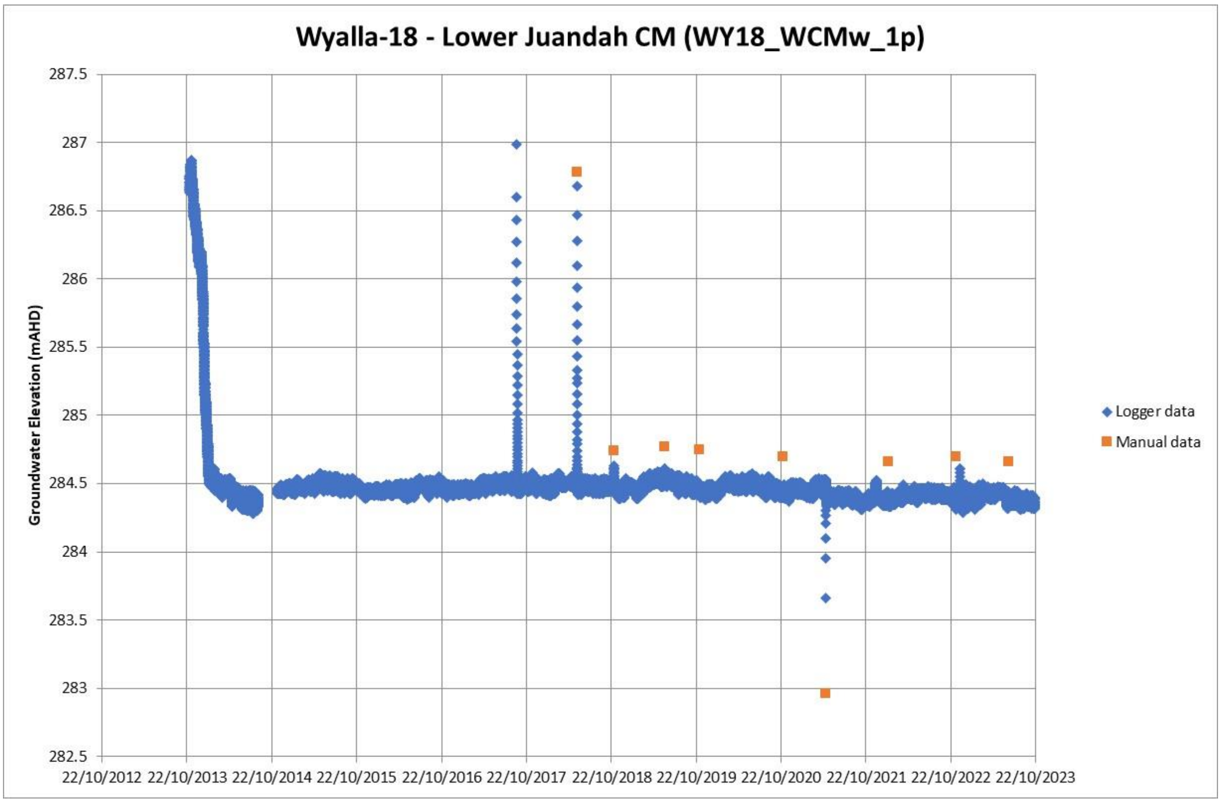


Wyalla-17 - Precipice Sandstone (WY17_PS_1p)
Groundwater Elevation (mAHD)
215
214
213
212
211
210
209
208
207
206
205
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

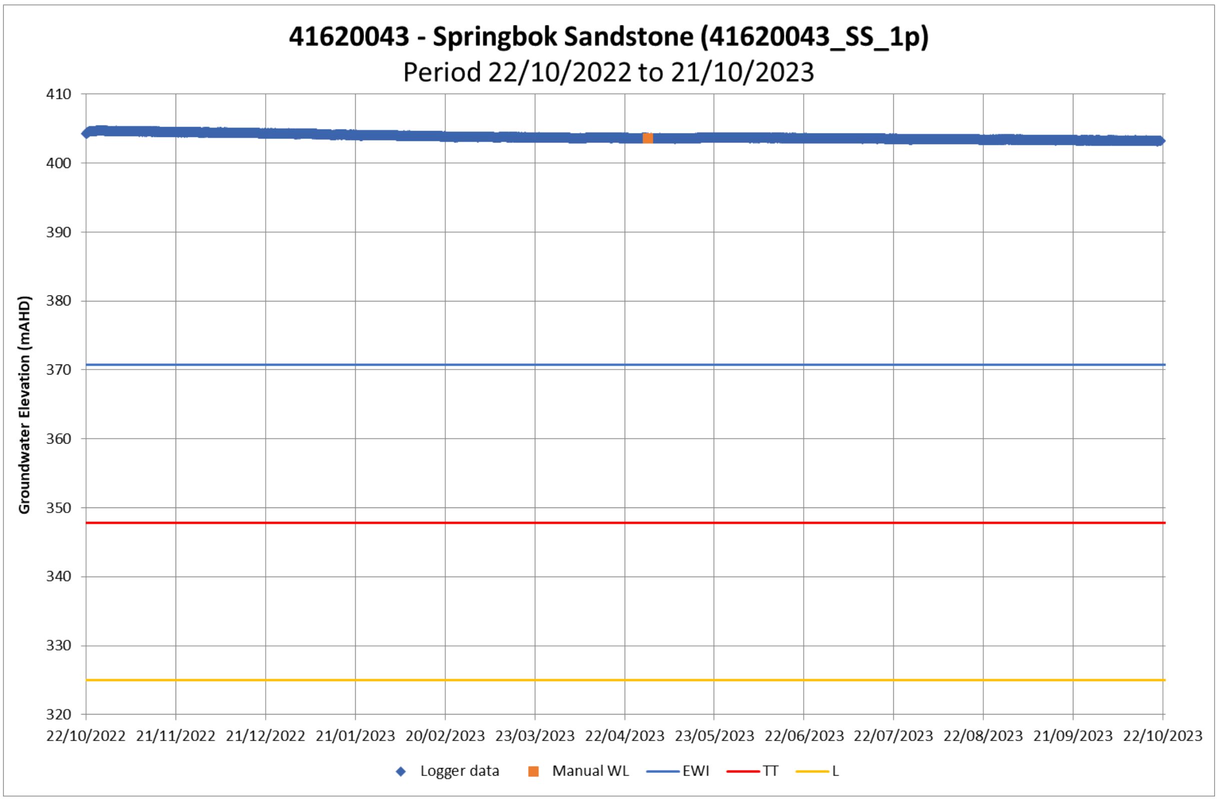


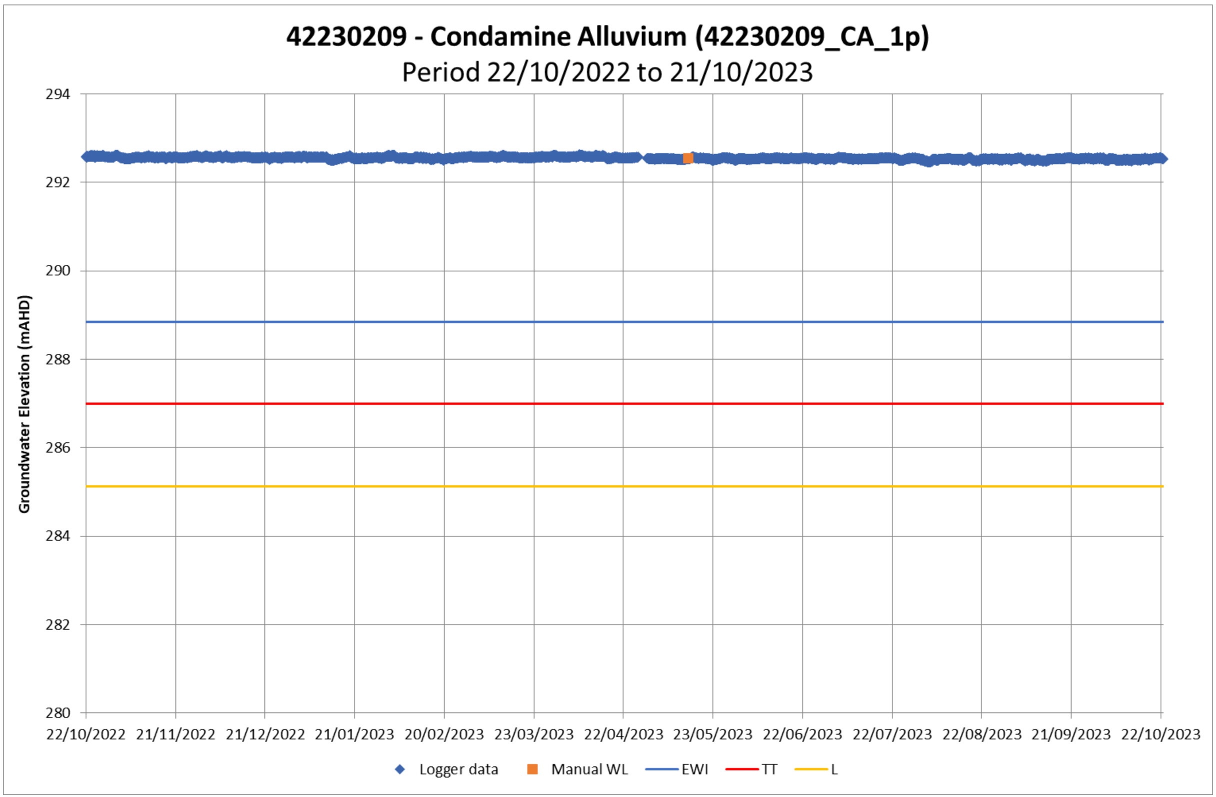
Wyalla-18 - Lower Juandah CM (WY18_WCMa_1p)
Groundwater Elevation (mAHD)
294.0
293.5
293.0
292.5
292.0
291.5
291.0
290.5
290.0
289.5
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data

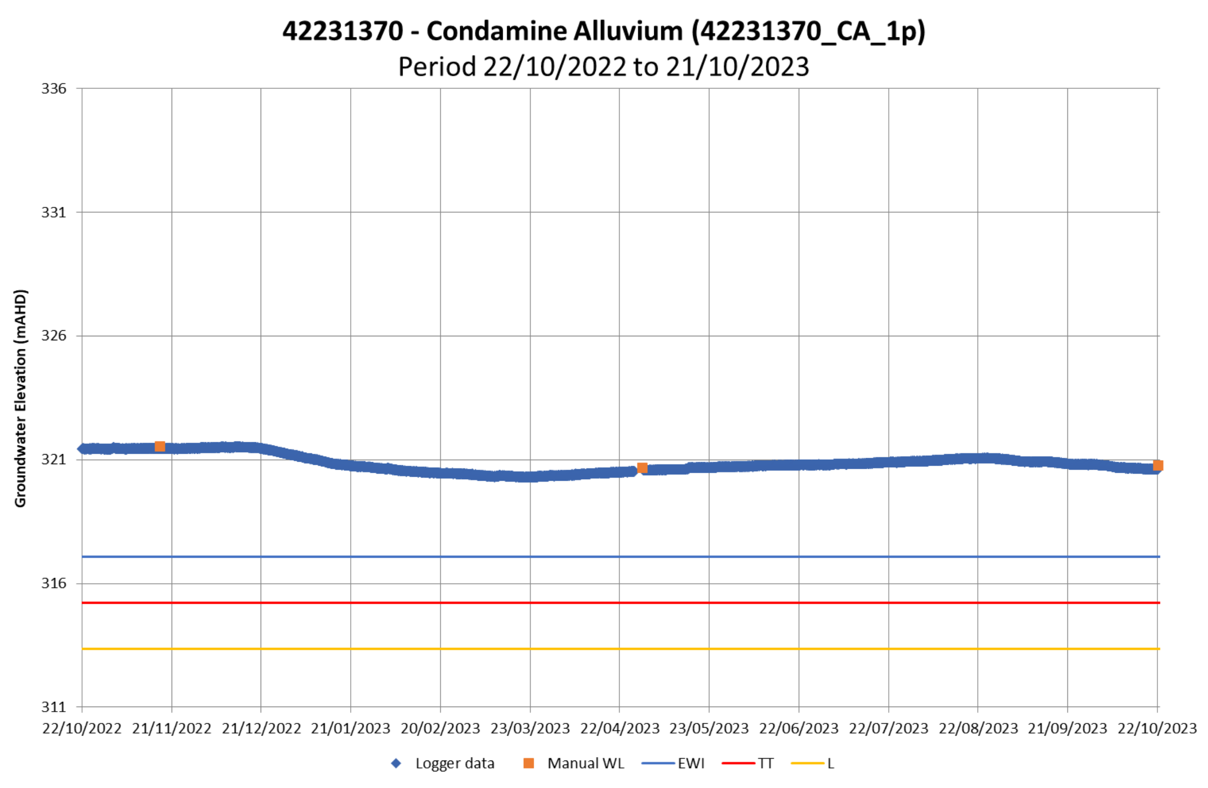

Wyalla-18 - Taroom CM (WY18_WCMc_1p)
Groundwater Elevation (mAHD)
294
292
290
288
286
284
282
280
22/10/2013
22/10/2014
22/10/2015
21/10/2016
22/10/2017
22/10/2018
22/10/2019
21/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data

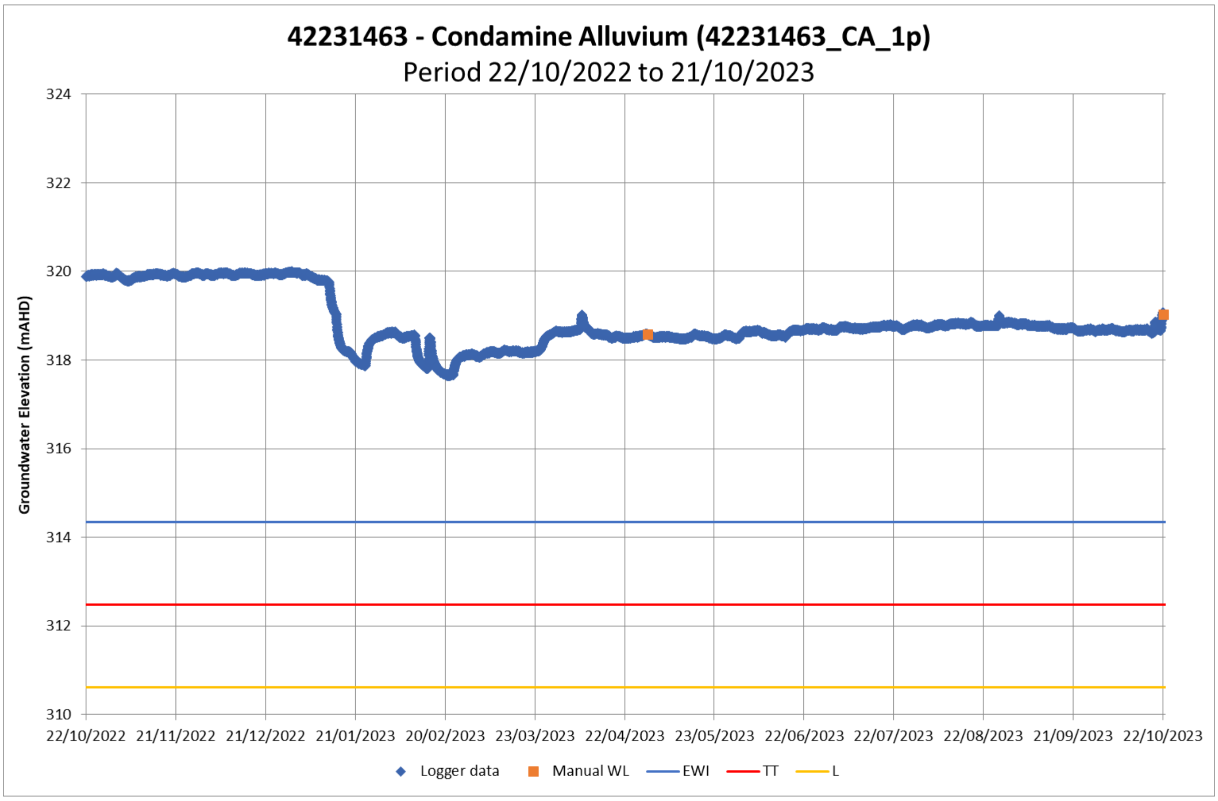

Wyalla-18 - Lower Juandah CM (WY18_WCMw_1p)
Groundwater Elevation (mAHD)
287.5
287
286.5
286
285.5
285
284.5
284
283.5
283
282.5
22/10/2012
22/10/2013
22/10/2014
22/10/2015
22/10/2016
22/10/2017
22/10/2018
22/10/2019
22/10/2020
22/10/2021
22/10/2022
22/10/2023
Logger data
Manual data

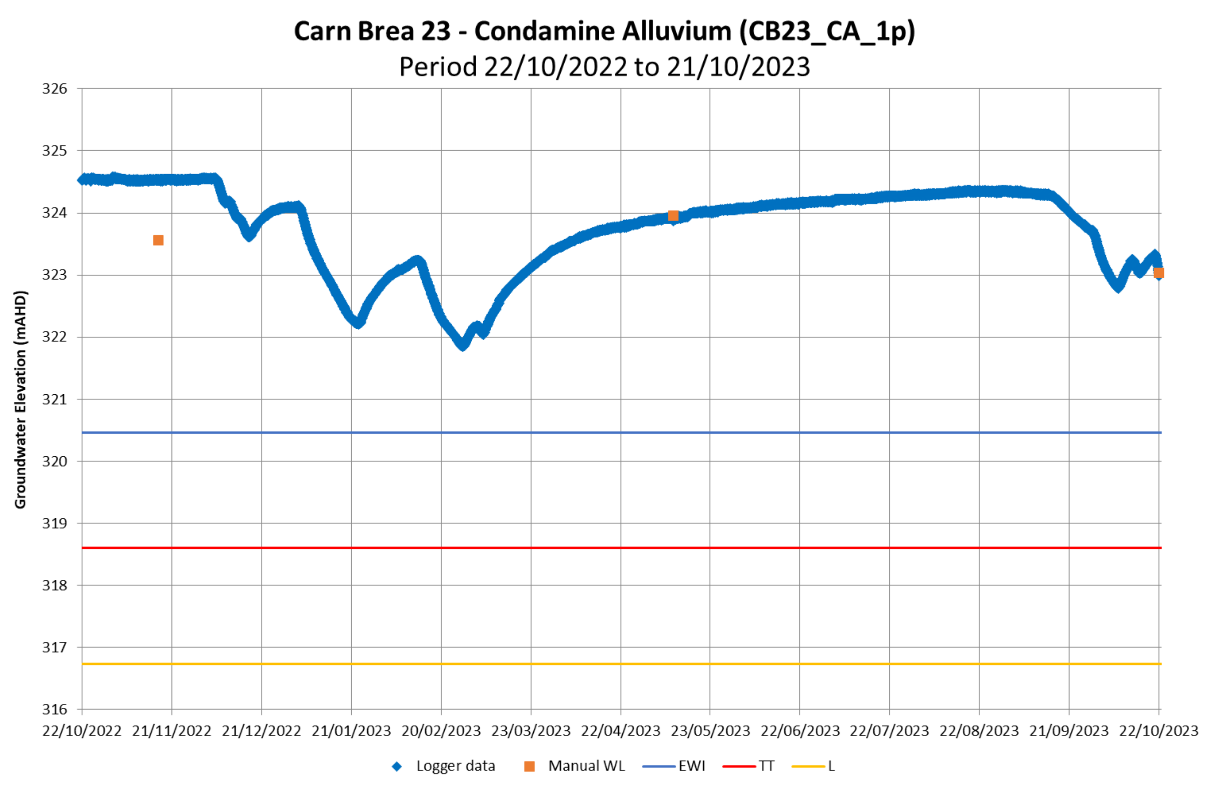
Early Warning Management System Hydrographs

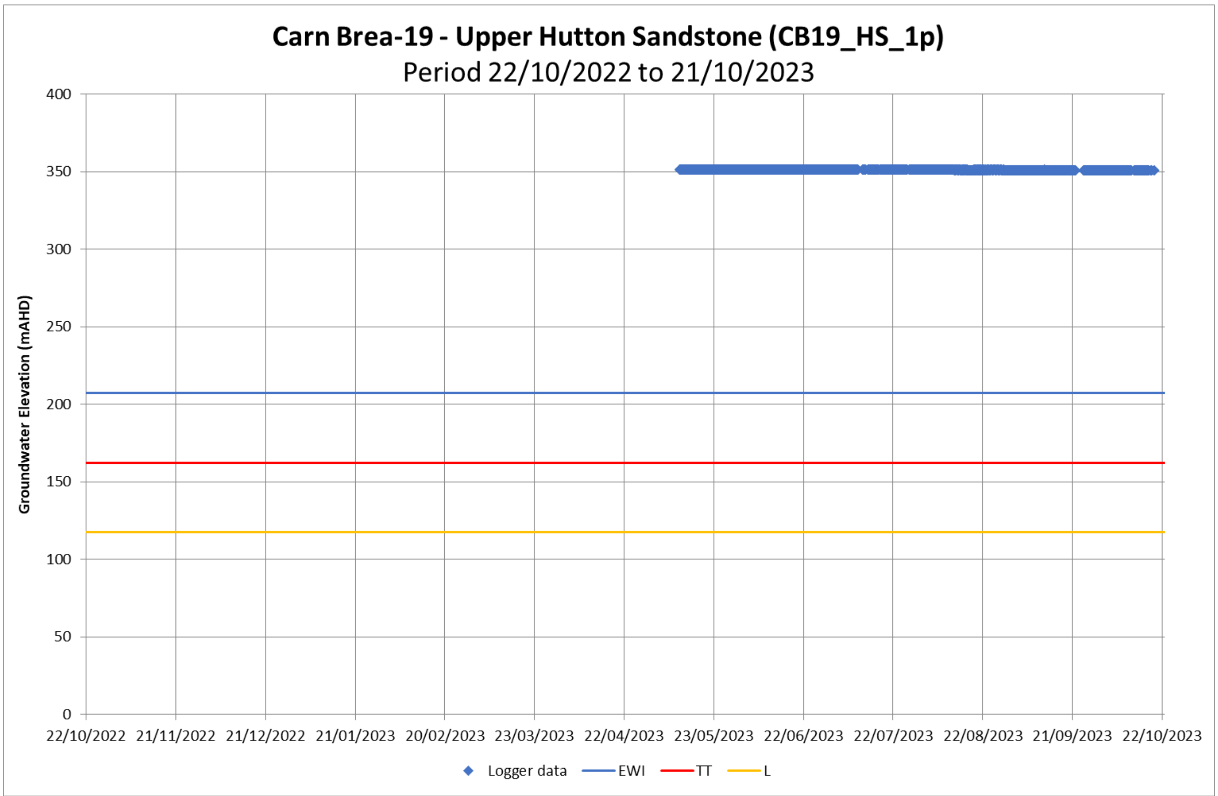


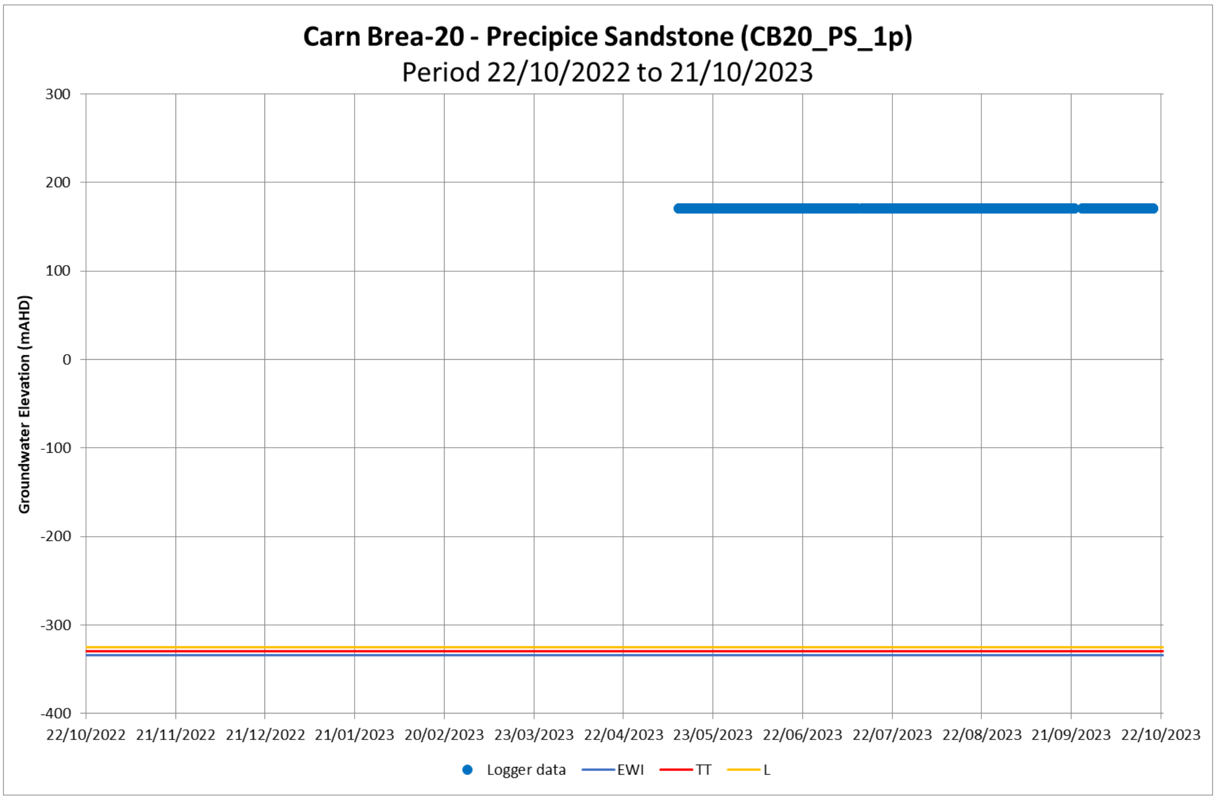


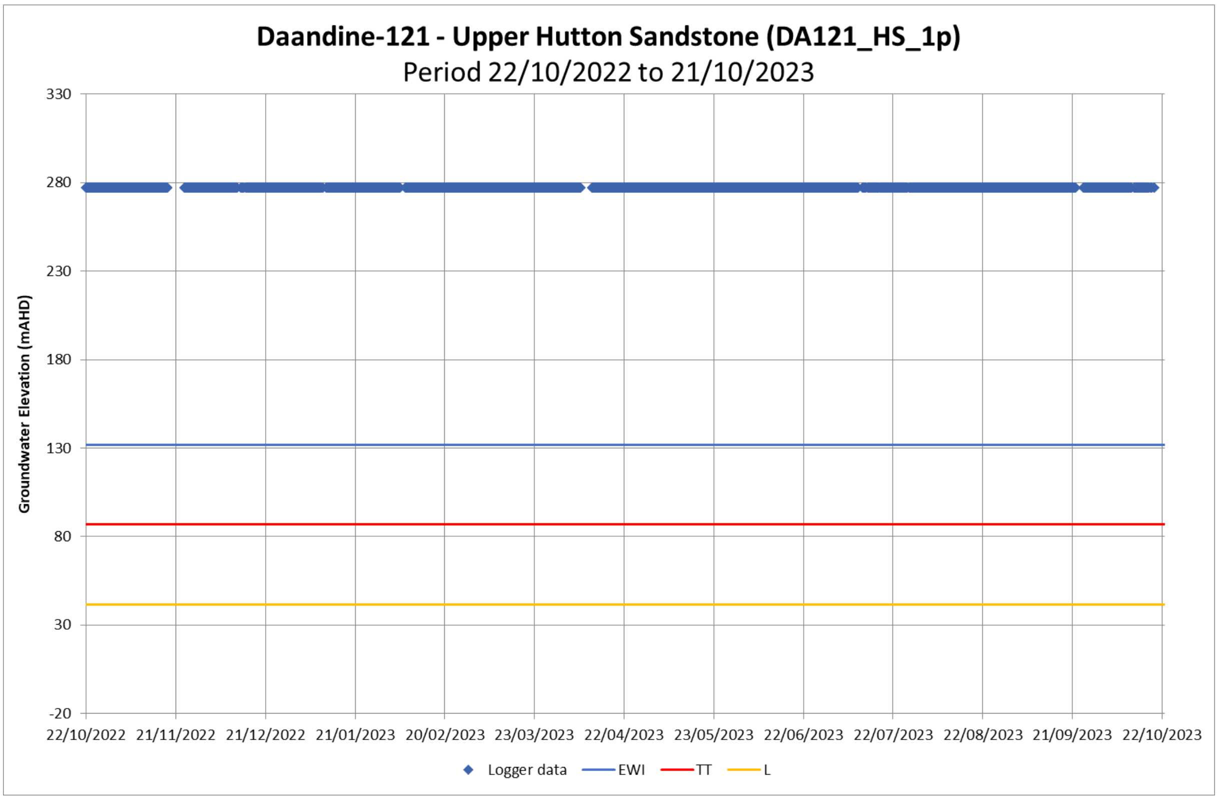

42231370 - Condamine Alluvium (42231370_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Water Elevation (mAHD)
336
331
326
321
316
311
22/10/2022
21/11/2022
21/12/2022
21/01/2023
20/02/2023
23/03/2023
22/04/2023
23/05/2023
22/06/2023
22/07/2023
22/08/2023
21/09/2023
22/10/2023
Logger data
Manual WL
EWI
TT
L

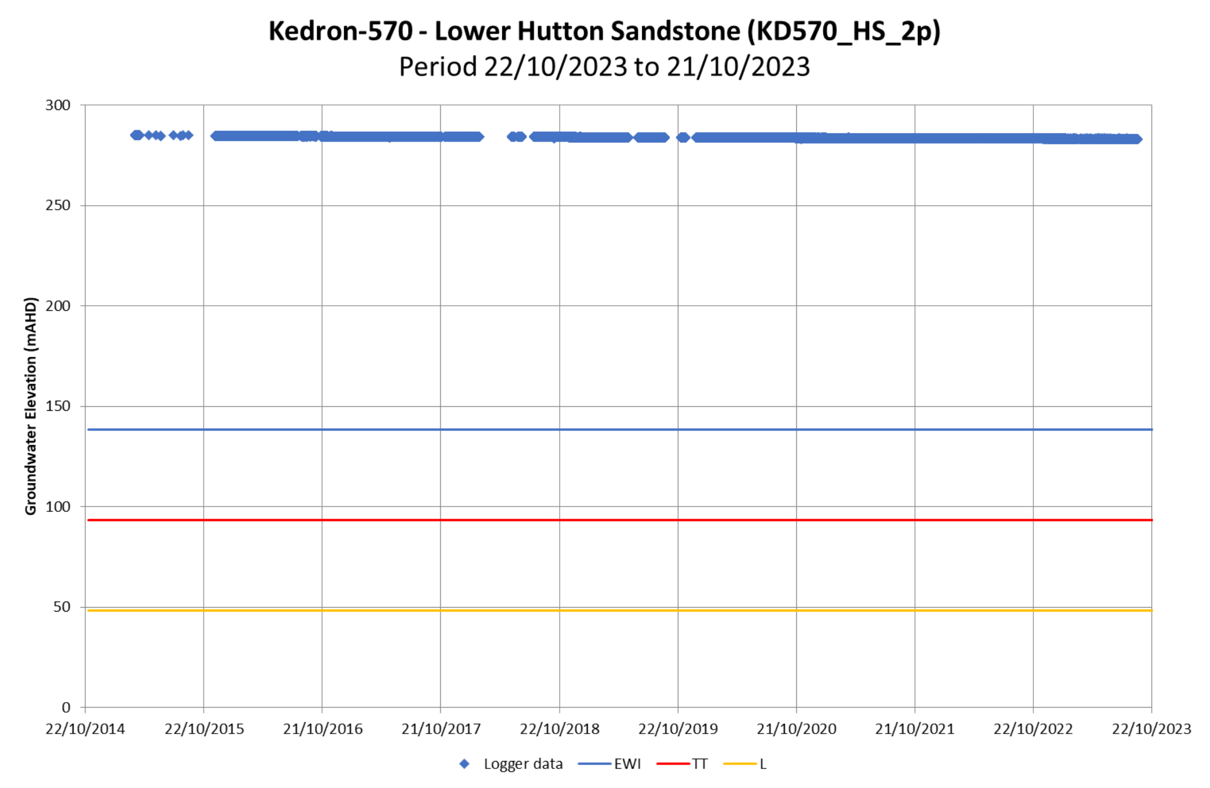

42231463 - Condamine Alluvium (42231463_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Water Elevation (mAHD)
324
322
320
318
316
314
312
310
22/10/2022
21/11/2022
21/12/2022
21/01/2023
20/02/2023
23/03/2023
22/04/2023
23/05/2023
22/06/2023
22/07/2023
22/08/2023
21/09/2023
22/10/2023
Logger data
Manual WL
EWI
TT
L

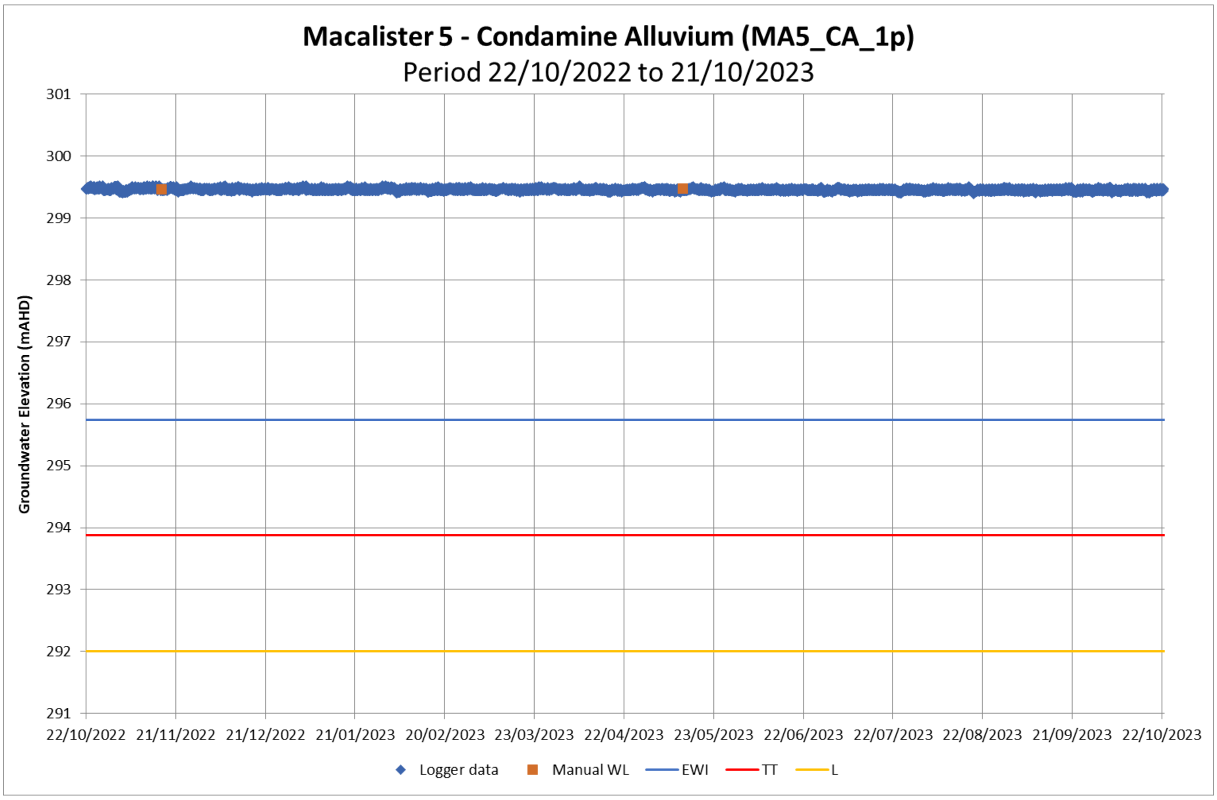

Carn Brea 23 - Condamine Alluvium (CB23_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
326
325
324
323
322
321
320
319
318
317
316
22/10/2022 21/11/2022 21/12/2022 21/01/2023 20/02/2023 23/03/2023 22/04/2023 23/05/2023 22/06/2023 22/07/2023 22/08/2023 21/09/2023 22/10/2023
Logger data
Manual WL
EWI
TT
L

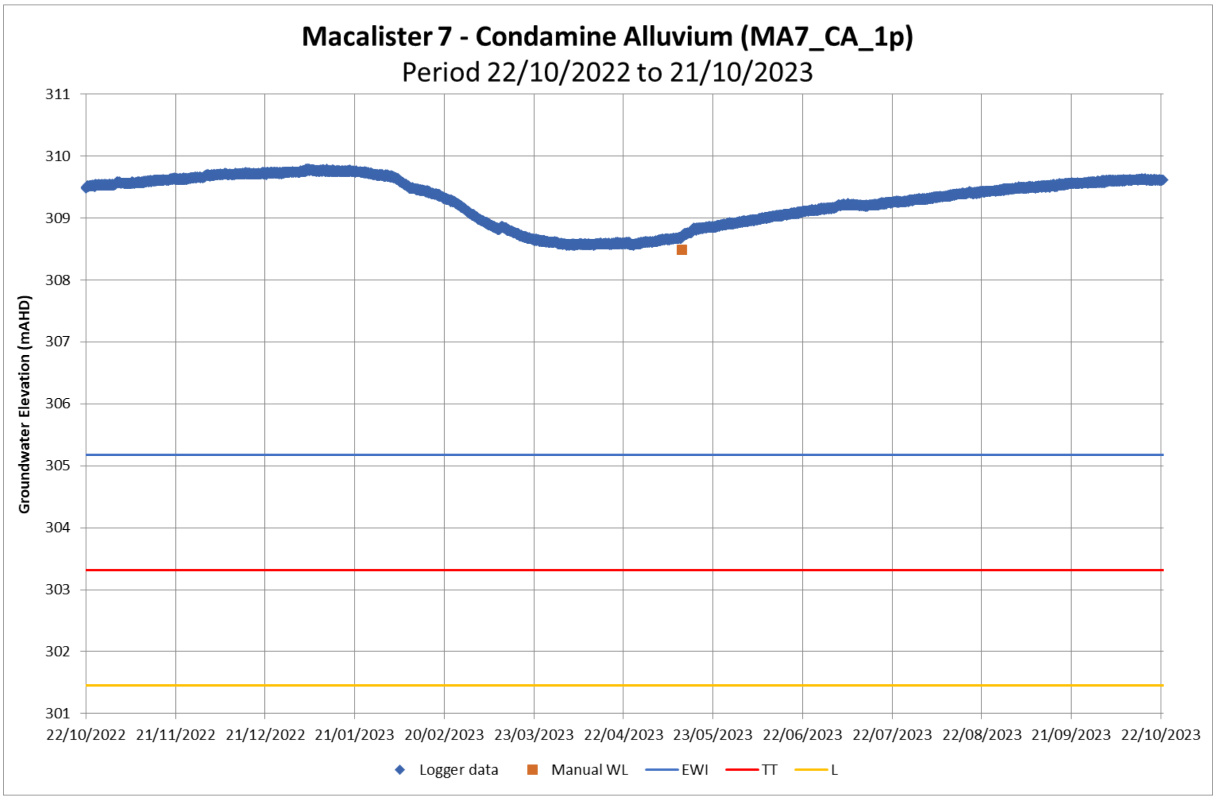

Carn Brea-19 - Upper Hutton Sandstone (CB19_HS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
400
350
300
250
200
150
100
50
0
22/10/2022 21/11/2022 21/12/2022 21/01/2023 20/02/2023 23/03/2023 22/04/2023 23/05/2023 22/06/2023 22/07/2023 22/08/2023 21/09/2023 22/10/2023
Logger data
EWI
TT
L

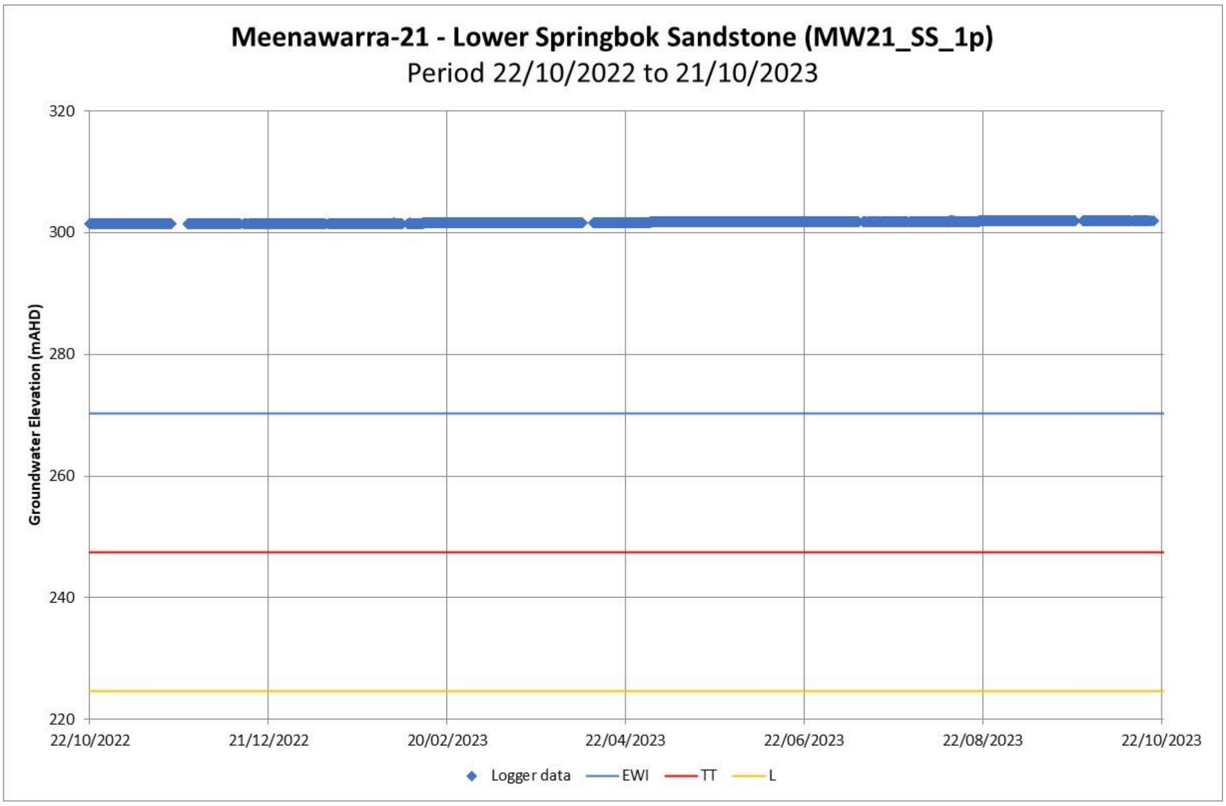

Carn Brea-20 - Precipice Sandstone (CB20_PS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
300
200
100
0
-100
-200
-300
-400
22/10/2022 21/11/2022 21/12/2022 21/01/2023 20/02/2023 23/03/2023 22/04/2023 23/05/2023 22/06/2023 22/07/2023 22/08/2023 21/09/2023 22/10/2023
Logger data
EWI
TT
L

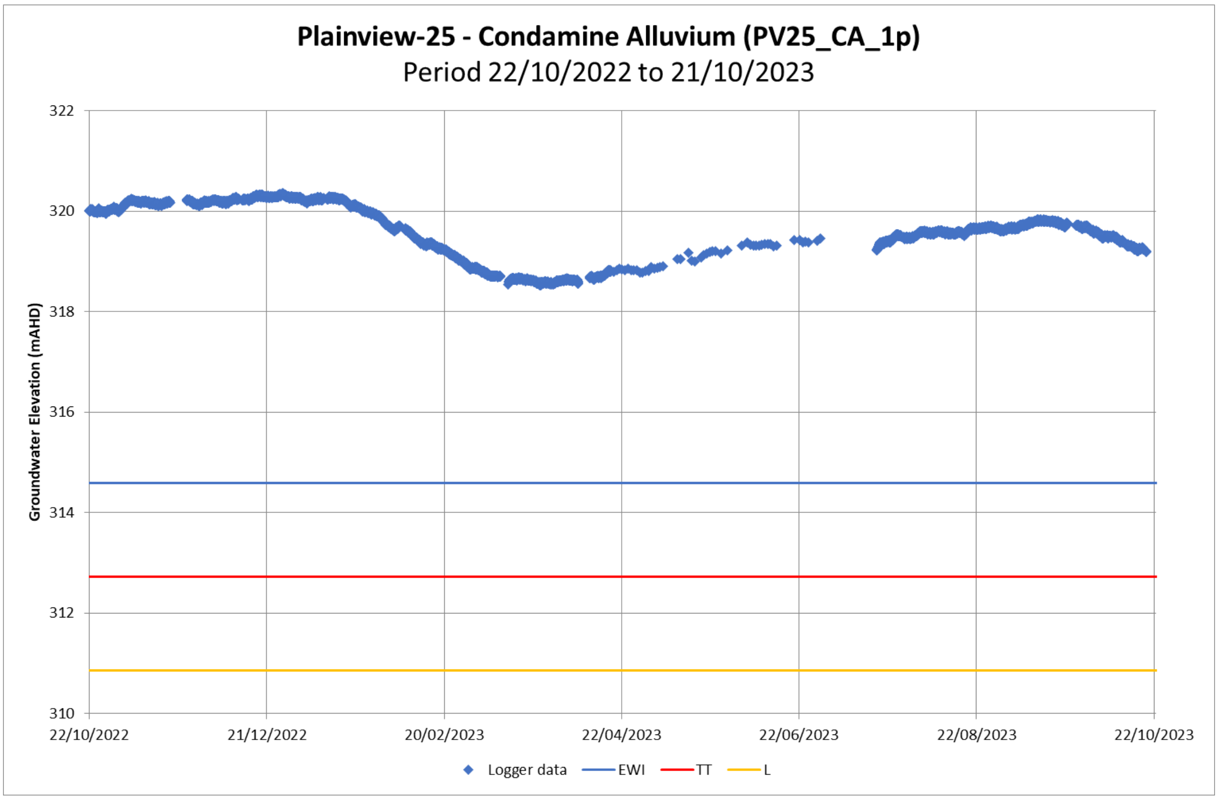

Daandine-121 - Upper Hutton Sandstone (DA121_HS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
330
280
230
180
130
80
30
-20
22/10/2022 21/11/2022 21/12/2022 21/01/2023 20/02/2023 23/03/2023 22/04/2023 23/05/2023 22/06/2023 22/07/2023 22/08/2023 21/09/2023 22/10/2023
Logger data
EWI
TT
L

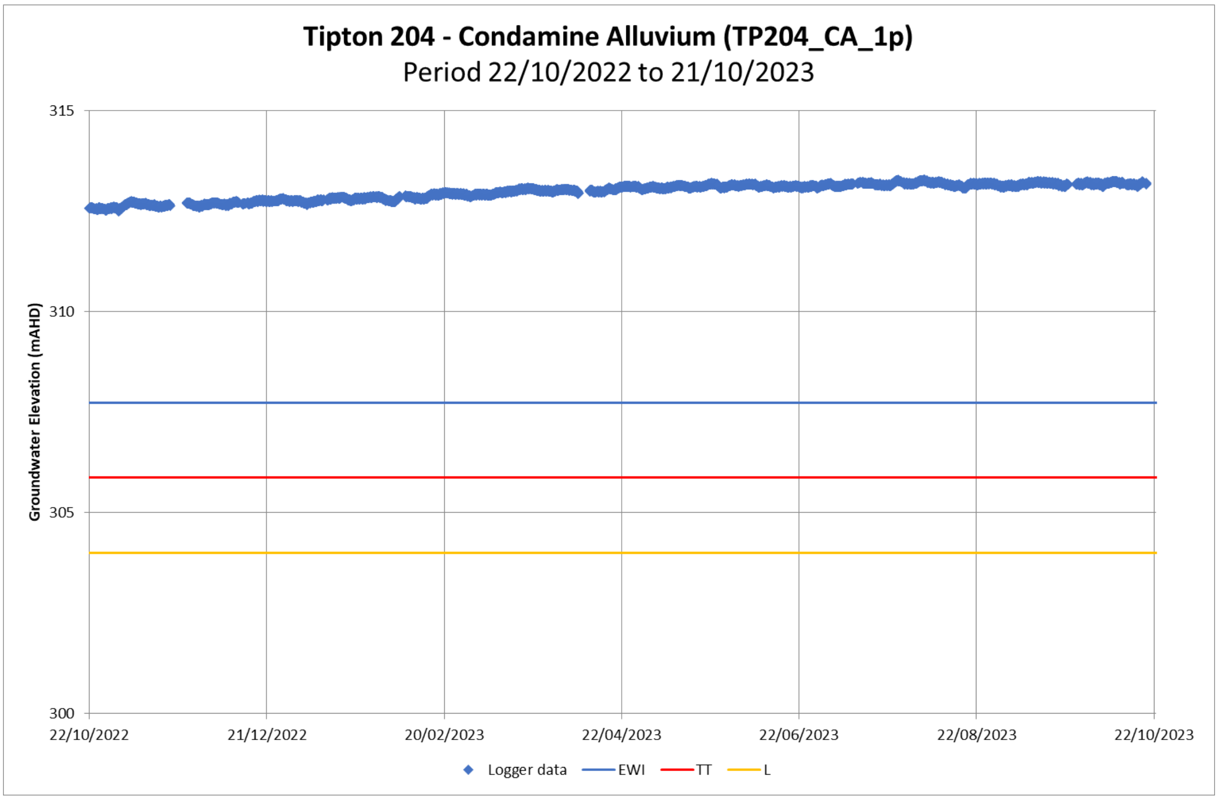

Kedron-570 - Lower Hutton Sandstone (KD570_HS_2p)
Period 22/10/2023 to 21/10/2023
Groundwater Elevation (mAHD)
300
250
200
150
100
50
0
22/10/2014
22/10/2015
21/10/2016
21/10/2017
22/10/2018
22/10/2019
21/10/2020
21/10/2021
22/10/2022
22/10/2023
Logger data
EWI
TT
L

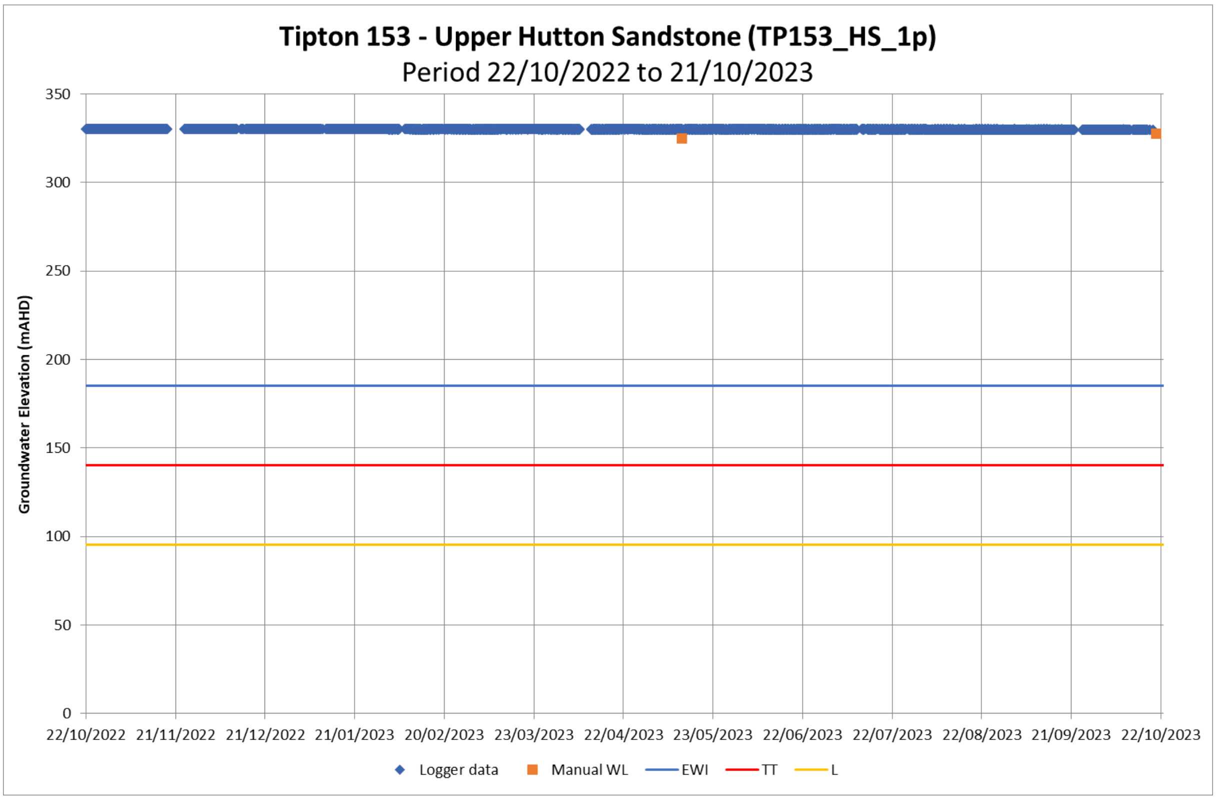

Macalister 5 - Condamine Alluvium (MA5_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
301
300
299
298
297
296
295
294
293
292
291
22/10/2022
21/11/2022
21/12/2022
21/01/2023
20/02/2023
23/03/2023
22/04/2023
23/05/2023
22/06/2023
22/07/2023
22/08/2023
21/09/2023
22/10/2023
Logger data
Manual WL
EWI
TT
L

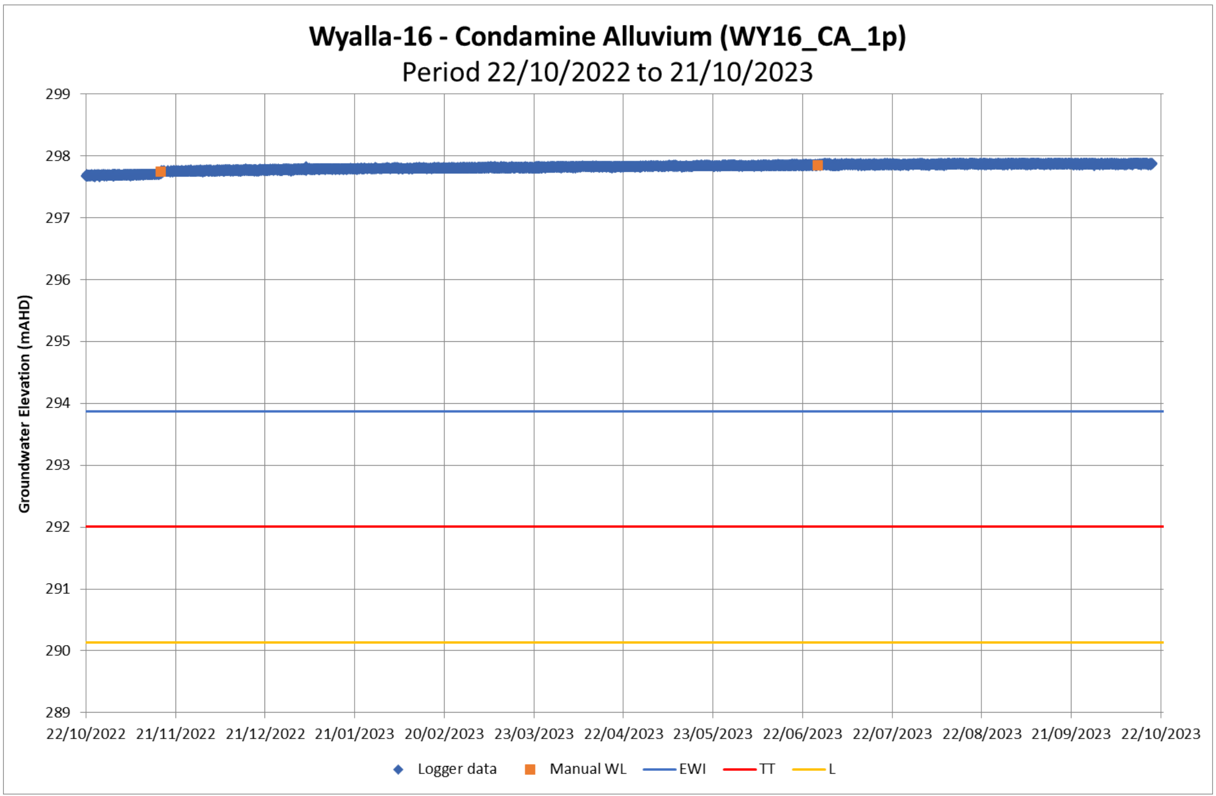

Macalister 7 - Condamine Alluvium (MA7_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
311
310
309
308
307
306
305
304
303
302
301
22/10/2022
21/11/2022
21/12/2022
21/01/2023
20/02/2023
23/03/2023
22/04/2023
23/05/2023
22/06/2023
22/07/2023
22/08/2023
21/09/2023
22/10/2023
Logger data
Manual WL
EWI
TT
L

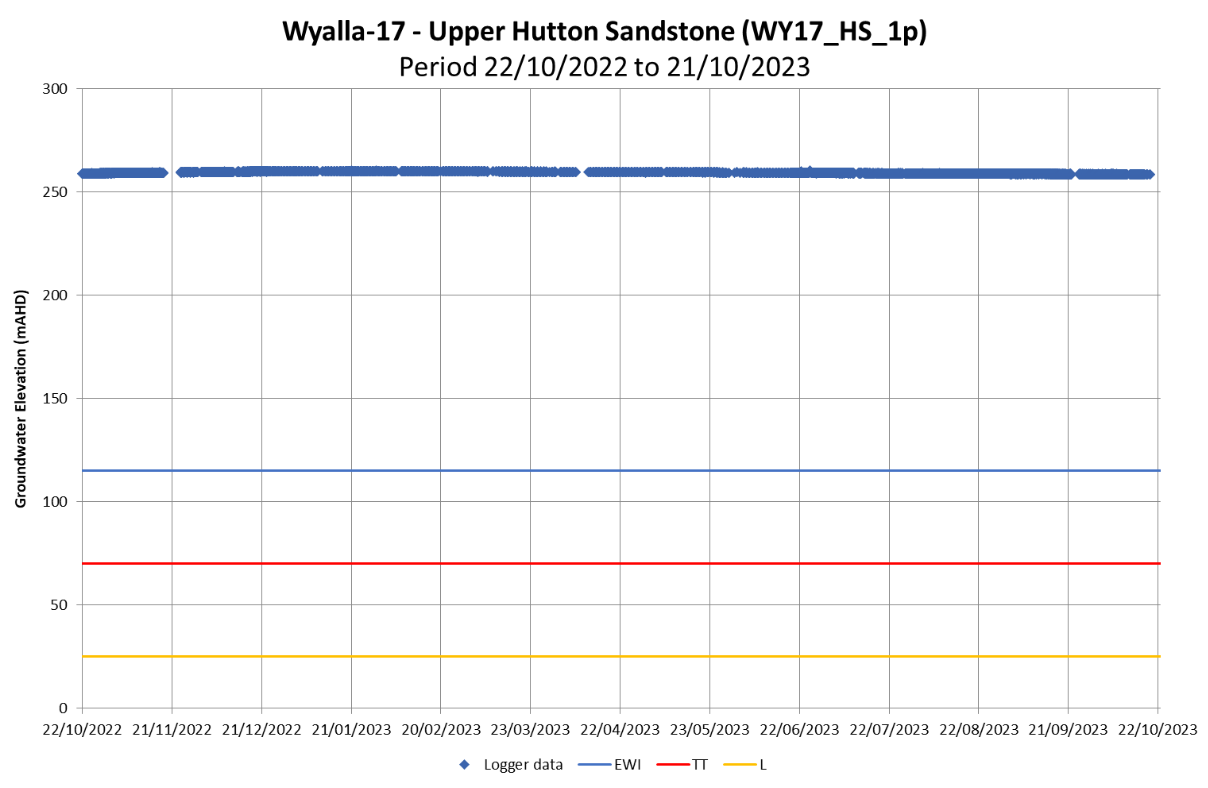

Meenawarra-21 - Lower Springbok Sandstone (MW21_SS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
320
300
280
260
240
220
22/10/2022
21/12/2022
20/02/2023
22/04/2023
22/06/2023
22/08/2023
22/10/2023
Logger data
EWI
TT
L

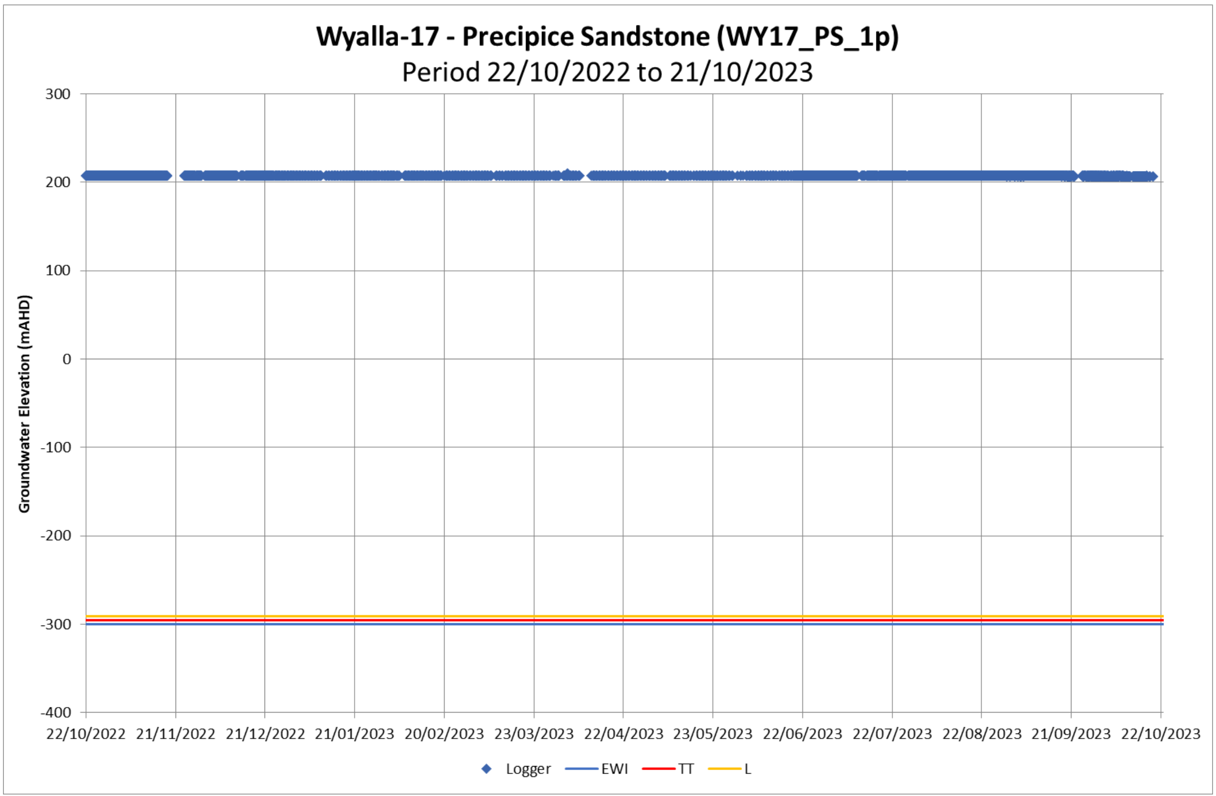

Plainview-25 - Condamine Alluvium (PV25_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
322
320
318
316
314
312
310
22/10/2022
21/12/2022
20/02/2023
22/04/2023
22/06/2023
22/08/2023
22/10/2023
Logger data
EWI
TT
L


Tipton 204 - Condamine Alluvium (TP204_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
315
310
305
300
22/10/2022
21/12/2022
20/02/2023
22/04/2023
22/06/2023
22/08/2023
22/10/2023
Logger data
EWI
TT
L


Tipton 153 - Upper Hutton Sandstone (TP153_HS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
350
300
250
200
150
100
50
0
22/10/2022
21/11/2022
21/12/2022
21/01/2023
20/02/2023
23/03/2023
22/04/2023
23/05/2023
22/06/2023
22/07/2023
22/08/2023
21/09/2023
22/10/2023
Logger data
Manual WL
EWI
TT
L


Wyalla-16 - Condamine Alluvium (WY16_CA_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
299
298
297
296
295
294
293
292
291
290
289
22/10/2022
21/11/2022
21/12/2022
21/01/2023
20/02/2023
23/03/2023
22/04/2023
23/05/2023
22/06/2023
22/07/2023
22/08/2023
21/09/2023
22/10/2023
Logger data
Manual WL
EWI
TT
L


Wyalla-17 - Upper Hutton Sandstone (WY17_HS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
300
250
200
150
100
50
0
22/10/2022 21/11/2022 21/12/2022 21/01/2023 20/02/2023 23/03/2023 22/04/2023 23/05/2023 22/06/2023 22/07/2023 22/08/2023 21/09/2023 22/10/2023
Logger data
EWI
TT
L


Wyalla-17 - Precipice Sandstone (WY17_PS_1p)
Period 22/10/2022 to 21/10/2023
Groundwater Elevation (mAHD)
300
200
100
0
-100
-200
-300
-400
22/10/2022 21/11/2022 21/12/2022 21/01/2023 20/02/2023 23/03/2023 22/04/2023 23/05/2023 22/06/2023 22/07/2023 22/08/2023 21/09/2023 22/10/2023
Logger
EWI
TT
L

Appendix B – Groundwater quality results

	Water quality guidelines			Plainview 36					Stratheden-63					All bores				
Parameter	Stock water	Drinking water (ADWG)	Aquatic (ANZG 95%)	Count	Count below LOR	20th	50th	80th	Count	Count below LOR	20th	50th	80th	Count	Count below LOR	20th	50th	80th
87Sr/86Sr				5	0	0.704073	0.70409	0.704097	1	0	0.70481	0.70481	0.70481	5	0	0.704072	0.704091	0.704258
Arsenic - Dissolved	0.5	0.01	0.013	6	6	0.001	0.001	0.001	9	9	0.001	0.001	0.001	13	13	0.001	0.001	0.001
Barium - Dissolved		2		6	0	0.127	0.131	0.137	9	0	0.4618	0.54	0.6234	13	0	0.1458	0.475	0.6054
Bicarbonate Alkalinity as CaCO3			165-283-677	6	0	411	424	448	9	1	15	46	64	15	1	31.6	66	422.8
Boron - Dissolved	5	4	0.94	6	0	0.15	0.16	0.17	9	0	0.1	0.13	0.184	13	0	0.108	0.16	0.18
Cadmium - Dissolved	0.01	0.002	0.0002	6	6	0.0001	0.0001	0.0001	9	9	0.0001	0.0001	0.0001	13	13	0.0001	0.0001	0.0001
Calcium - Dissolved			2-20-86	6	0	10	10.5	12	9	0	42	66	119	15	0	10.8	40	78.6
Carbonate Alkalinity as CaCO3				6	1	22	25.5	28	9	4	1	5	13.2	15	5	1	12	27.2
Chloride		5	186-737-2939	6	0	185	194	199	9	0	1,072	1,170	1,420	15	0	194	1,030	1,284
Chromium - Dissolved	1	0.05	0.001	6	6	0.001	0.001	0.001	9	9	0.001	0.001	0.001	13	13	0.001	0.001	0.001
Cobalt - Dissolved	1			6	6	0.001	0.001	0.001	9	9	0.001	0.001	0.001	13	13	0.001	0.001	0.001
Copper - Dissolved	0.4 to 5	1	0.0014	6	3	0.001	0.001	0.001	9	9	0.001	0.001	0.001	13	11	0.001	0.001	0.001
Fluoride	2	1.5		6	0	0.2	0.3	0.3	9	0	0.2	0.2	0.24	15	0	0.2	0.2	0.3
Iron - Dissolved		0.3		6	3	0.05	0.06	0.15	9	9	0.05	0.05	0.05	13	10	0.05	0.05	0.062
Lead - Dissolved	0.1	0.01	0.0034	6	6	0.001	0.001	0.001	9	9	0.001	0.001	0.001	13	13	0.001	0.001	0.001
Magnesium - Dissolved			2-8-82	6	0	4	4	4	9	1	7	9	12	15	1	4	6	11
Manganese - Dissolved		0.1	1.9	6	0	0.051	0.058	0.066	9	1	0.002	0.005	0.0094	13	1	0.0024	0.007	0.0552
Mercury - Dissolved	0.002	0.001	0.0006	6	6	1.00E-04	1.00E-04	1.00E-04	9	9	1.00E-04	1.00E-04	1.00E-04	13	13	1.00E-04	1.00E-04	1.00E-04
Methane				6	0	2090	2630	3530	8	0	8538	11600	16800	12	0	2498	8600	13260
Nickel - Dissolved	1	0.02	0.011	6	1	0.002	0.0025	0.005	9	6	0.001	0.001	0.0014	13	6	0.001	0.001	0.0026
Potassium - Dissolved				6	0	4	4	4	9	0	5	6	7	15	0	4	5	7
Selenium - Dissolved	0.02	0.01	0.011	6	6	0.01	0.01	0.01	9	9	0.01	0.01	0.01	13	13	0.01	0.01	0.01
Sodium - Dissolved		180	246-677-1821	6	0	294	298.5	316	9	0	669	712	729	15	0	299.4	653	722.6
Strontium - Dissolved				6	0	0.365	0.3705	0.405	9	0	1.37	1.79	2.83	13	0	0.4222	1.37	2.402
Sulfate as SO4 - Turbidimetric - Dissolved		250	1-8-47	6	5	1	1	1	9	0	10	21	27	15	5	1	9	22.8
Total Alkalinity as CaCO3			195-309-790	6	0	435	446	454	9	0	18	62	77	15	0	41.2	78	444.8
Total Dissolved Solids @180°C	2000 to 5000	600		6	0	727	754	801	9	0	1968	2210	2692	13	0	803.4	1980	2496
Zinc - Dissolved	20	3	0.008	6	0	0.019	0.033	0.08	9	9	0.005	0.005	0.005	13	9	0.005	0.005	0.0202

Note the ADWG adopted is generally for health, in instances where aesthetic or recreational values are lower, these are shown. Irrigation values show a range in some instances representing the long-term and short-term criteria. Where there are multiple values in the aquatic ecosystem column, this represents the 20th percentile – 50th percentile-80th percentile values.

Original Chemical Name	Sample_Id	analysis_date	qualifier	result_value	result_unit	detection_limit	technical_reference
FIELD DISS OX	Plainview 36 19/11/2022 12:41:18_F	19/11/2022 12:41		0.419999987	%		Field Measurement
FIELD EC	Plainview 36 19/11/2022 12:41:18_F	19/11/2022 12:41		1340	us/cm		Field Measurement
FIELD pH	Plainview 36 19/11/2022 12:41:18_F	19/11/2022 12:41		7.96999979			Field Measurement
FIELD REDOX	Plainview 36 19/11/2022 12:41:18_F	19/11/2022 12:41		-118.5	mv		Field Measurement
FIELD TEMP	Plainview 36 19/11/2022 12:41:18_F	19/11/2022 12:41		22.20000076	degree		Field Measurement
87Sr/86Sr	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.704083025		0.01	Sr_ISOTOPE: Ratio of 87Sr and 86Sr analysis
Arsenic - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Barium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.133000001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Bicarbonate Alkalinity as CaCO3	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		461	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Boron - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.180000007	mg/L	0.05	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Butane	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	10	µg/L	10	EP033: C1 - C4 Gases
Butene	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	10	µg/L	10	EP033: C1 - C4 Gases
Cadmium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	1E-04	mg/L	0.0001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Calcium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		12	mg/L	1	ED093F: Major Cations - Dissolved
Carbonate Alkalinity as CaCO3	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		27	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Chloride	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		202	mg/L	1	ED045G: Chloride by Discrete Analyser
Chromium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Cobalt - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Copper - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Ethane	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	10	µg/L	10	EP033: C1 - C4 Gases
Ethene	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	10	µg/L	10	EP033: C1 - C4 Gases
Fluoride	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.200000003	mg/L	0.1	EK040P: Fluoride by Auto Titrator
Hydroxide Alkalinity as CaCO3	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	1	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Ionic Balance	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.209999993	%	0.01	EN055 - PG: Ionic Balance by PCT DA and Turbi SO4 DA
Iron - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.07	mg/L	0.05	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Lead - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Magnesium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		4	mg/L	1	ED093F: Major Cations - Dissolved
Manganese - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.057999998	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Mercury - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	1E-04	mg/L	0.0001	EG035F: Dissolved Mercury by FIMS
Methane	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		2090	µg/L	10	EP033: C1 - C4 Gases
Nickel - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.002	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Potassium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		4	mg/L	1	ED093F: Major Cations - Dissolved
Propane	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	10	µg/L	10	EP033: C1 - C4 Gases
Propene	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	10	µg/L	10	EP033: C1 - C4 Gases
Selenium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	0.01	mg/L	0.01	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Sodium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		330	mg/L	1	ED093F: Major Cations - Dissolved
Strontium - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.405000001	mg/L	0.001	EG020B-F: Dissolved Metals by ICP-MS - Suite B
Sulfate as SO4 - Turbidimetric - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16	<	1	mg/L	1	ED041G: Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser
Total Alkalinity as CaCO3	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		488	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Total Anions	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		15.39999962	meq/L	0.01	EN055 - PG: Ionic Balance by PCT DA and Turbi SO4 DA
Total Cations	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		15.39999962	meq/L	0.01	EN055 - PG: Ionic Balance by PCT DA and Turbi SO4 DA
Total Dissolved Solids @180°C	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		801	mg/L	10	EA015H: Total Dissolved Solids (High Level)
Zinc - Dissolved	Plainview 36 17/11/2022 18:00:00	7/12/2022 6:16		0.018999999	mg/L	0.005	EG020A-F: Dissolved Metals by ICP-MS - Suite A
FIELD DISS OX	Plainview 36 29/04/2023 11:09:33_F	29/04/2023 11:09		0.330000013	%		Field Measurement
FIELD EC	Plainview 36 29/04/2023 11:09:33_F	29/04/2023 11:09		1719	us/cm		Field Measurement
FIELD pH	Plainview 36 29/04/2023 11:09:33_F	29/04/2023 11:09		8.239999771			Field Measurement
FIELD REDOX	Plainview 36 29/04/2023 11:09:33_F	29/04/2023 11:09		-142.6000061	mv		Field Measurement
FIELD TEMP	Plainview 36 29/04/2023 11:09:33_F	29/04/2023 11:09		24.89999962	degree		Field Measurement
Arsenic - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Barium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.165000007	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Bicarbonate Alkalinity as CaCO3	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		411	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Boron - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.170000002	mg/L	0.05	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Butane	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	10	µg/L	10	EP033: C1 - C4 Gases
Butene	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	10	µg/L	10	EP033: C1 - C4 Gases
Cadmium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	1E-04	mg/L	0.0001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Calcium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		12	mg/L	1	ED093F: Major Cations - Dissolved
Carbonate Alkalinity as CaCO3	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		24	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Chloride	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		192	mg/L	1	ED045G: Chloride by Discrete Analyser
Chromium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Cobalt - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A

Copper - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.002	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Ethane	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	10	µg/L	10	EP033: C1 - C4 Gases
Ethene	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	10	µg/L	10	EP033: C1 - C4 Gases
Fluoride	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.300000012	mg/L	0.1	EK040P: Fluoride by Auto Titrator
Hydroxide Alkalinity as CaCO3	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	1	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Ionic Balance	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.560000002	%	0.01	EN055 - PG: Ionic Balance by PCT DA and Turbi SO4 DA
Iron - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.150000006	mg/L	0.05	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Lead - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	0.001	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Magnesium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		4	mg/L	1	ED093F: Major Cations - Dissolved
Manganese - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.050999999	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Mercury - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	1E-04	mg/L	0.0001	EG035F: Dissolved Mercury by FIMS
Methane	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		3530	µg/L	10	EP033: C1 - C4 Gases
Nickel - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.002	mg/L	0.001	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Potassium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		4	mg/L	1	ED093F: Major Cations - Dissolved
Propane	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	10	µg/L	10	EP033: C1 - C4 Gases
Propene	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	10	µg/L	10	EP033: C1 - C4 Gases
Selenium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	0.01	mg/L	0.01	EG020A-F: Dissolved Metals by ICP-MS - Suite A
Sodium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		297	mg/L	1	ED093F: Major Cations - Dissolved
Strontium - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.448000014	mg/L	0.001	EG020B-F: Dissolved Metals by ICP-MS - Suite B
Sulfate as SO4 - Turbidimetric - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50	<	1	mg/L	1	ED041G: Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser
Total Alkalinity as CaCO3	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		435	mg/L	1	ED037-P: Alkalinity by Auto Titrator
Total Anions	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		14.10000038	meq/L	0.01	EN055 - PG: Ionic Balance by PCT DA and Turbi SO4 DA
Total Cations	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		13.89999962	meq/L	0.01	EN055 - PG: Ionic Balance by PCT DA and Turbi SO4 DA
Total Dissolved Solids @180°C	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		807	mg/L	10	EA015H: Total Dissolved Solids (High Level)
Zinc - Dissolved	Plainview 36 29/04/2023 11:00:00	9/05/2023 5:50		0.021	mg/L	0.005	EG020A-F: Dissolved Metals by ICP-MS - Suite A
87Sr/86Sr	Plainview 36 29/04/2023 11:00:00	25/05/2023 7:25		0.704091012		0.01	Sr_ISOTOPE: Ratio of 87Sr and 86Sr analysis

Appendix C – Mann-Kendall Summary

Monitoring Unit	Field	Bore Name	Mann-Kendall Trend	Analyte	No. of data points	Mann-Kendall Statistic (S)
Springbok Sandstone	Plainview	Plainview 36	More data needed	FIELD DISS OX	6	-5
Springbok Sandstone	Plainview	Plainview 36	Increasing	FIELD EC	6	13
Springbok Sandstone	Plainview	Plainview 36	Stable	FIELD PH	6	-8
Springbok Sandstone	Plainview	Plainview 36	Stable	FIELD REDOX	6	-7
Springbok Sandstone	Plainview	Plainview 36	Stable	FIELD TEMP	6	-3
Springbok Sandstone	Plainview	Plainview 36	Increasing	Calcium	6	13
Springbok Sandstone	Plainview	Plainview 36	Stable	Magnesium	6	0
Springbok Sandstone	Plainview	Plainview 36	Increasing	Sodium	6	9
Springbok Sandstone	Plainview	Plainview 36	Stable	Potassium	6	-3
Springbok Sandstone	Plainview	Plainview 36	Increasing	Chloride	6	9
Springbok Sandstone	Plainview	Plainview 36	Stable	Carbonate Alkalinity	6	-1
Springbok Sandstone	Plainview	Plainview 36	More data needed	Bicarbonate Alkalinity	6	3
Springbok Sandstone	Plainview	Plainview 36	More data needed	Total Alkalinity	6	5
Springbok Sandstone	Plainview	Plainview 36	Stable	Sulfate	6	0
Springbok Sandstone	Plainview	Plainview 36	Stable	Fluoride	6	-4
Springbok Sandstone	Plainview	Plainview 36	More data needed	Dissolved Barium	6	7
Springbok Sandstone	Plainview	Plainview 36	Increasing	Dissolved Strontium	6	15

* **Note this only shows results with 4 or more data points**

Appendix D – Field assessment of potential TGDEs related to the SGP WMMP using the 2019 UWIR

FILE NOTE

FROM:	Arrow Energy	REF:	
SUBJECT:	Summary of field verification of Wilkie Creek and Juandah Creek potential terrestrial groundwater dependent ecosystems sites as identified in Updated WMMP desktop assessment		

The purpose of this File Note is to provide a summary of the field assessment undertaken at the two sites identified as potential terrestrial groundwater dependent ecosystems (TGDE) potentially at impact from the Action.

1. Juandah Creek, is located 10 km southeast of Wandoan on PL494 and the potential TGDE is predominantly associated with riparian vegetation flanking a defined reach of Juandah Creek.

2. Wilkie Creek is located 28 km northwest of Dalby on PL194 and PL230 and the potential TGDE is predominantly associated with riparian vegetation flanking

These two sites were identified through the desktop assessment undertaken by Arrow Energy based on the 2019 Underground Water Impact Report (UWIR) and documented in the File Note presented in the 2022 Updated Water Monitoring and Management Plan (WMMP) Annual Report (available at arrowenergy.com.au).

Juandah Creek

An ecological and hydrogeological field survey of the Wilkie Creek mapped TGDE was undertaken over a 2-day period (11 – 13th October 2021). The assessment coincided with a rainfall event in the region with 35.2mm falling at Miles (60km to the south) on the 12th and 13th October, although no rainfall was received at the study site. In total, four targeted sites were assessed during the field assessment.

Field assessment methods

Assessment of the Juandah Creek site comprised a desktop assessment followed by a field assessment which included:

- Descriptions of creek hydrology, geomorphology and ecology;
- Measurements of Leaf Area Index (LAI) using an automated canopy imaging camera (C110 Plant Canopy Imager);
- Pre-dawn leaf water potential (LWP) measurements from mature Forest Red Gum (Eucalyptus tereticornis) using a Scholander LWP Meter;
- Surface water sample collection for measurement of field water quality parameters and laboratory analysis of a standard water quality suite and ^{222}radon;
- Advancement of hand auger holes within alluvium within and on the levees of Juandah Creek using an AMS hand auger, aiming to intersect the groundwater table, or until indurated sedimentary basement rock was intersected;
- Description of the geological profile encountered;
- Collection of groundwater samples from hand auger bores for measurement of field water quality parameters; and

- Collection and analysis of soil, leaf water, surface water and groundwater from hand augers for analysis of stable isotopes of oxygen and deuterium.

Eco-hydrogeological conceptual site model

The reach of Juandah Creek mapped as a potential TGDE has been categorised as a mid-catchment alluvial system. Quaternary alluvial deposits of primarily sand with some clay extend along the Juandah Creek study area, with maximum cross-sectional width of 500 metres and anticipated maximum depths of less than 15 metres, but generally <5m.

Juandah creek traverses and shallowly incises the regionally south-westerly dipping Great Artesian Basin (GAB) sequence, including the Walloon Coal Measures (WCM) at the far northern end of the mapped TDGE, Springbok Sandstone in the central to northern section of the TGDE and Westbourne Formation at the southernmost end of the TDGE.

Available data indicates the basal alluvial system forms a predominantly continuously saturated system (below ground level), likely recharged primarily from rainfall directly infiltrating the alluvium in addition to surface water run off / stream flow.

Regional groundwater pressure monitoring in the upper WCM members (Macalister) across the northern half of the mapped TGDE show that the groundwater pressures are near-surface, respond positively to rainfall recharge events and are therefore likely to locally comprise recharge intake beds during periods of prolonged and above-average rainfall. It is possible that during low rainfall, drying periods, relatively high pressures within the upper WCM may provide an ongoing source of moisture to the alluvium and deeper-rooted vegetation that may extend to the basal alluvium and into the upper WCM. Further assessment during a prolonged dry period would be required to fully test this hypothesis. It however cannot be discounted given heavy rainfall in the months prior to the assessment, which could have resulted in dilution of the geochemical signature of bedrock aquifers at the base of the alluvium.

Shallow groundwater levels of <10 mbGL in the WCM across the northern half of the mapped TDGE (if present) would, in theory, provide a direct water source for vegetation where the WCM sequence outcrops or the shallow alluvium is unsaturated. The salinity of any groundwater leakage into the rooting zone of riparian vegetation may however limit its capacity to stimulate vegetative growth or productivity.

Three eco-hydrogeological conceptualisations of the Juandah Creek site were developed based on the available data and are summarised here:

1. Dry season: this conceptualisation indicates a dry season scenario whereby groundwater perched in the channel sands is being utilised by riparian vegetation along the margins of the drainage. In this scenario, while the potentiometric surface of the bedrock aquifers intrudes into (or above) the base level of the alluvium, there is no leakage due to the tightness of the sandstone bedrock and lack of fracturing. Perched groundwater in the alluvium and GAB aquifers are vertically isolated by a low permeability GAB regolith interburden, and do not mix. Vegetation moisture sources are being supplied by the perched aquifer and soil moisture alone.

2. Dry season with vertical upward leakage: Provides a variation on the dry season conceptualisation, where upward leakage of bedrock aquifers is occurring into the base of the alluvium in the dry season, which is acting to support floodplain vegetation where other sources of moisture have been depleted. The capacity of this leakage to stimulate vegetation growth and vigour is dependent to a degree on the groundwater salinity of the leaking aquifers. It is not possible to predict the

extent to which this is occurring without more detailed assessment during a drier climatic period. It is however conceptualised to be restricted to discrete areas and pockets where the function is supported by underlying geology, rather than occurring more extensively across the landscape.

3. Post-flooding / Wet season: a post-flooding / wet season conceptualisation where the perched aquifer at the base of the Juandah Creek floodplain alluvium has been replenished by seasonal rainfall and / or overbank flow. Any leakage of GAB aquifers into the base of the alluvium would be diluted by the perched groundwater table, making it difficult to differentiate based on groundwater geochemistry.

Any response of riparian vegetation to CSG extraction would be variable and difficult to predict, depending on a number of factors including:

- The extent of bedrock aquifer leakage into the alluvium, including leakage volumes and wetted area;
- Salinity of GAB aquifer leakage; and
- Climatic factors including periods of extended drought and rainfall recharge.

River red gum, and its closely allied species forest red gum (Eucalyptus tereticornis which is the dominant species is the assessment area) is an adaptable species that is adapted to arid and semi-arid environments and will go through alternate phases of shedding and regaining its crown, depending on the availability of water. It is adapted to do so over time and across the flood frequency classes. River red gum have the capacity to self-regulate and adjust their transpiration rates to match the average flood return interval (Colloff 2014). The species is considered opportunistic in its water use, sourcing water according to osmotic and matric water potential and source reliability (Thorburn et al., 1993; Mensforth et al., 1994; Holland et al., 2006; Doody et al., 2009) with the water requirements obtained from three main sources being groundwater, rainfall, and river flooding. Doody et al. (2015) demonstrated that soil moisture alone can sustain the health of Eucalyptus camaldulensis through periods of drought for up to six years before significant decline in tree health is noted. With these ecological considerations, and based on the conceptualisations above, impacts on riparian vegetation are likely to be discrete and difficult to detect above current base levels of tree senescence caused by long-term drought alone.

Conclusions

It is considered highly likely that vegetation within the identified reach of Juandah Creek is dependent on groundwater within the shallow alluvium. The field assessment was undertaken during a relatively wet period and there was no information gathered during the survey that supported the hypothesis that trees were sourcing groundwater from deeper GAB aquifers at the time of the assessment. Most lines of evidence supported that the deeper-rooted trees assessed were utilising relatively fresh and isotopically enriched groundwater from the basal alluvium.

Hypotheses are provided for GDE water requirements as well as likely responses to changes in the groundwater regime through an assessment of water sources and pathways within an eco-hydrogeological conceptual site model. Such hypotheses need further testing through additional assessment during a prolonged dry period to address critical research gaps and subsequent refinement of the eco-hydrogeological conceptual model.

Wilkie Creek

An ecological and hydrogeological field survey of the Wilkie Creek mapped TGDE was undertaken over a 2.5-day period (13th, 14th and 15th October 2021). The assessment coincided with a rainfall event with 44 mm falling in Dalby on the 14th of October (prior to surface water quality sampling) which introduced some ambiguity into the results of water quality and geochemical sampling. Attempts were made throughout 2022 to return to the area for a follow up survey however the above average rainfall experienced throughout the year inhibited the ability to conduct a survey that would not be influenced by recent rainfall.

Field assessment methods

Assessment of the Wilkie Creek site comprised a desktop assessment followed by a field assessment which included:

- Descriptions of creek hydrology, geomorphology and ecology;
- Measurements of Leaf Area Index (LAI) using an automated canopy imaging camera (C110 Plant Canopy Imager);
- Pre-dawn leaf water potential measurements from mature River Red Gums using a Scholander Leaf Water Potential Meter;
- Surface water sample collection for measurement of field water quality parameters and laboratory analysis of a standard water quality suite and ^{222}radon;
- Advancement of hand auger bores within alluvium on each side of the creek using an AMS hand auger to a depth below the groundwater table (if present), or until the indurated sedimentary basement rock was intersected;
- Description of the geological profile encountered;
- Collection of groundwater samples from hand auger bores for measurement of field water quality parameters and laboratory analysis of a standard water quality suite, ^{222}radon; and
- Collection and analysis of soil, leaf water, surface water and groundwater from hand augers for analysis of stable isotopes of oxygen and deuterium.

Eco-hydrogeological conceptual site model

Lines of evidence drawn from data and observations from both the desktop and field assessments has culminated in the preparation of a preliminary eco-hydrogeological conceptual site model for the potential Wilkie Creek TGDE.

The reach of Wilkie Creek mapped as a potential TGDE forms the western margin of the Condamine River Alluvium (CRA) Quaternary alluvial deposits which thicken eastwards and northwards towards the Condamine River.

There is a strong association with the position and orientation of Wilkie Creek and the underlying geology. Notably, the potential TGDE reach of Wilkie Creek follows the contact between elevated regolith of Jurassic bedrock (and associated colluvial cover sediments) to the west which emerges from lower elevation alluvium of the Wilkie Creek and broader Condamine River Alluvium to the east. The current position of Wilkie Creek is relatively hard-up against the toe of the eastward slope off the bedrock regolith, and therefore follows the bedrock/alluvium geological contact in a south-to-north orientation.

A shallow anticline underlies the north-western elevated portion of the mapped TGDE, with the roughly 25m rise in the topography a subdued expression of the underlying subsurface structure. Here, Wilkie Creek runs parallel on the eastern side of the anticline with is intersected by a series of fault-bounded graben block structures and sub-vertical thrust faults, some of which extend through the full Surat Basin sequence to surface. Vertical throws across a number of the faults is interpreted to be up to 40 metres.

North of the Dalby-Kogan Road, WCM groundwater pressures are likely to be >10 mbGL across most of the study area. However, anomalous elevated groundwater levels (above Wilkie Creek) appear to be present across the elevated plateau west of Wilkie Creek, upon which the Wilkie Creek Coal Mine is located. The presence of numerous sub-vertical faults and “keystone structures” are likely to result in complexities and disruptions to the regional groundwater hydraulic regime. Faults may both enhance vertical flow, resulting in cross-formational mixing of groundwater, and also provide barriers to lateral flow resulting in compartmentalisation of the groundwater flow system. Barriers to groundwater lateral flow and enhanced vertical flow in some hydrogeological settings may result in anomalous pressure gradients and vertical discharges of mixed groundwater to surface (springs or stream baseflow).

Supporting the hypothesis for the presence of a mixing zone is groundwater quality and hydrogeochemistry analyses which show distinctive similarities between surface water and WCM and CRA groundwaters north of Dalby-Kogan Road. Supporting the hypothesis of a groundwater discharge zone into Wilkie Creek and/or the Wilkie Creek alluvium is the presence of ^{222}radon in Wilkie Creek surface water.

Also of possible relevance is that the CRA sequence within the study area is relatively thin (shallow depth to bedrock) and is dominated by finer-grained (silt/clay-rich) sediments. This may result in lower recharge infiltration volumes and therefore limited dilution of laterally-discharging saline groundwater from the WCM. This is evident through review of lithological descriptions within bore logs and the lack of high flow rate irrigation bores present within the study area. Relatively low CRA permeabilities and limited extraction may also result in higher CRA and laterally-adjacent WCM pressures.

Given that there is evidence within the DRDMW groundwater database of the presence of both saline groundwater and elevated groundwater pressures in the area prior to the mine operation, it is considered most likely that these anomalies are due primarily to natural structural complexities in the geological setting.

However the onset of vegetation dieback around 1990 coinciding with other activities in the area and drought suggests the possibility of non-CSG stressors causing critical changes in hydrogeological conditions, likely related to shallow groundwater salinity levels.

Conclusions

Prior to commencement of significant identified hydrological and hydrogeological alteration which commenced in 1990, it is considered likely that vegetation within portions of the identified reach of Wilkie Creek and an extension downstream to the north was dependant, at least seasonally, on groundwater. This is consistent with the classification of river red gum as a facultative phreatophyte.

However severe degradation of the ecosystem including widespread mature tree dieback, likely due to exposure to shallow saline groundwater, has resulted in ecosystem collapse. In the current hydrologeological regime, no trees within the affected reach were identified as being groundwater reliant. Elevated groundwater salinity is considered the major factor contributing to the poor ecological health of the reach of Wilkie Creek that is subject to this assessment. The riparian vegetation is still relatively intact immediately north of Dalby-Kogan Road where the preferential source of water appeared to be shallow soil moisture at the time of assessment.

The conceptual model identifies numerous potential stressors to the riparian ecosystem on Wilkie Creek which appear to have commenced from 1990 and are likely a result of activities otherthan Arrow's operations. Such hypotheses require further testing through additional work to address critical research gaps and subsequent refinement of the eco-hydrogeological conceptual model.

References

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Appendix E – Ground Movement Investigation Summary

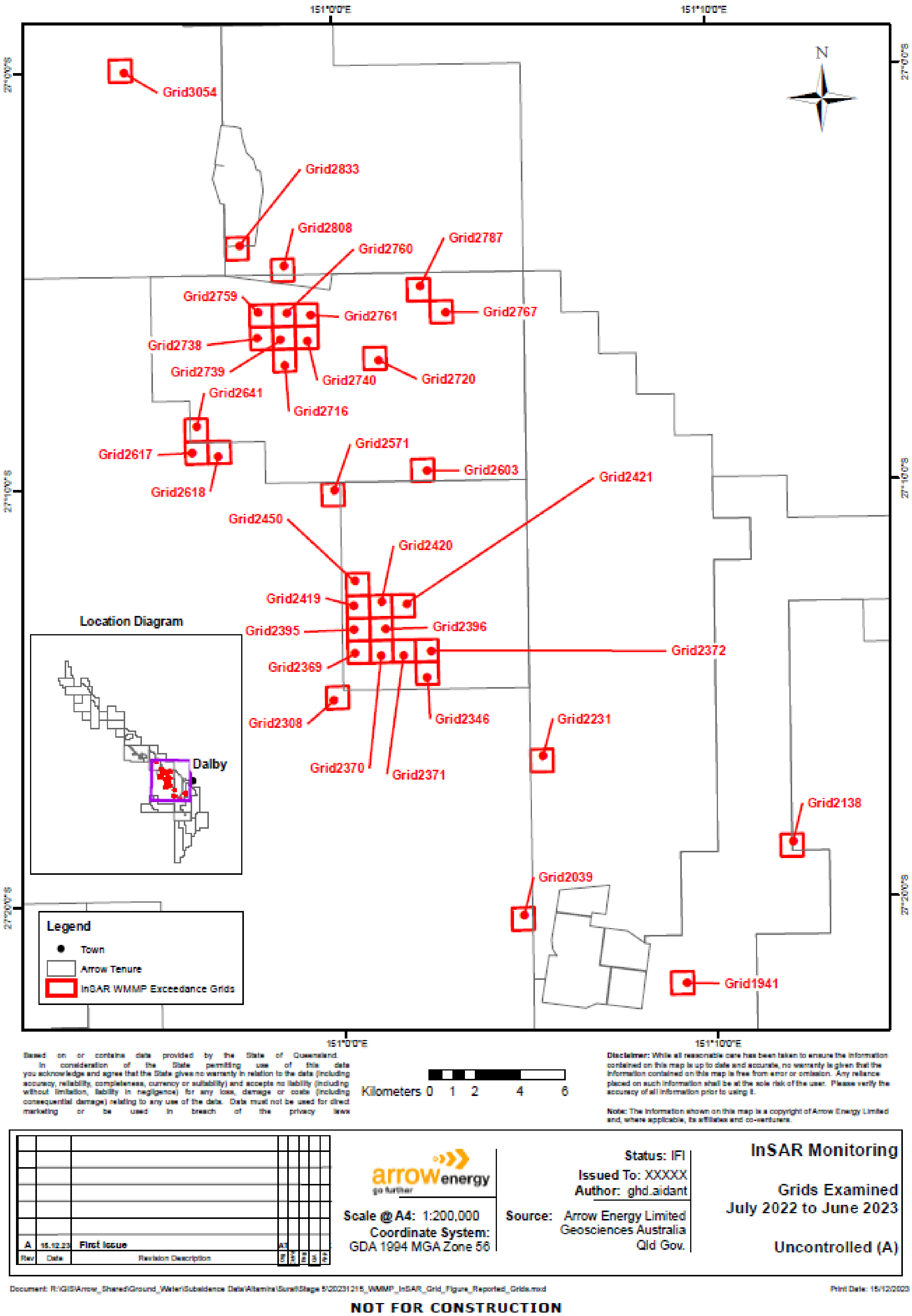

Figure B-1: 1x1km Grid Cells (34 off) subject to investigation level assessment

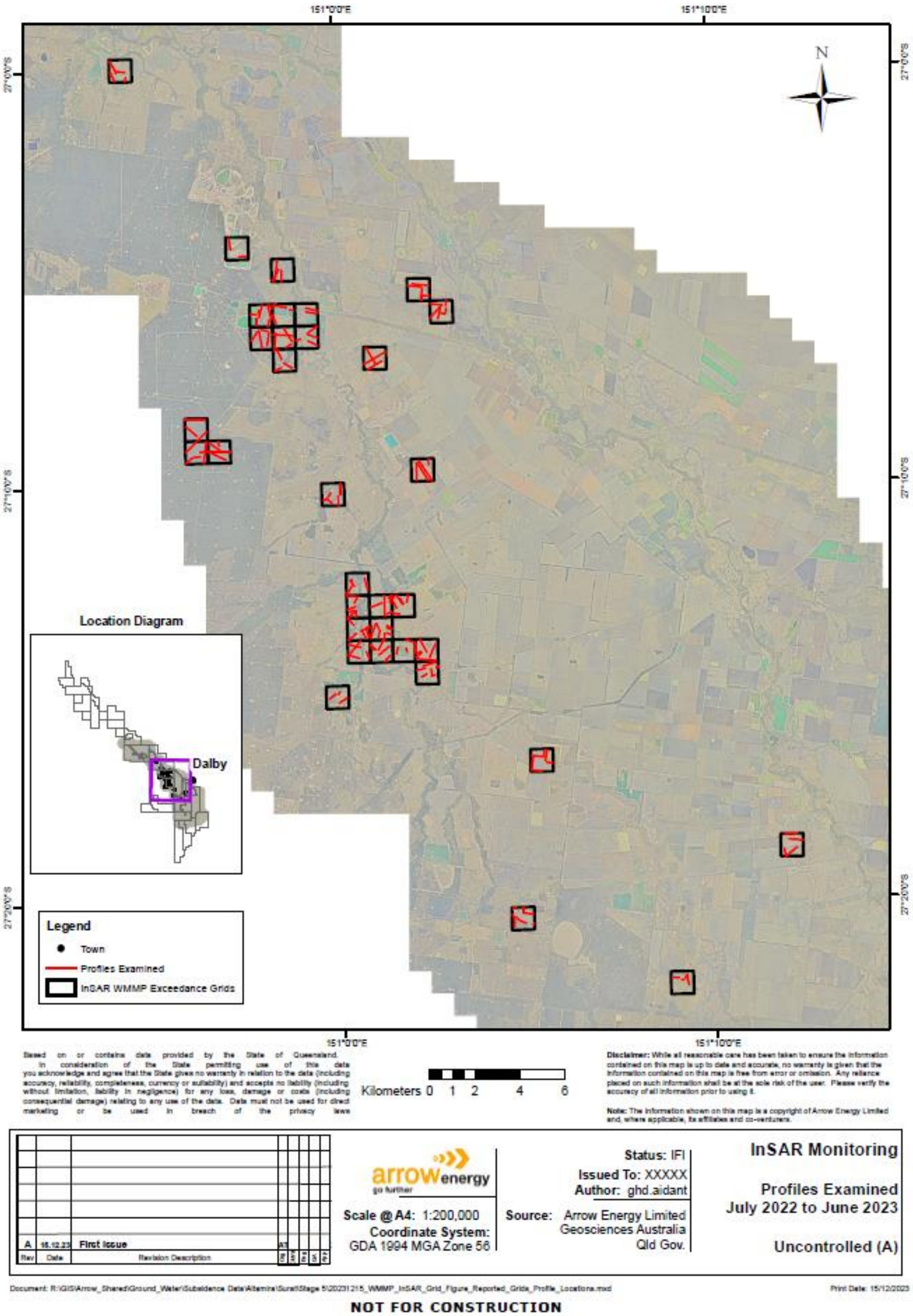

Figure B-2: Transect locations taken within grid cells (156 off) as part of investigation level assessment

Table B-1: Change in average slope 2022 to 2023 along transects (13 June to 17 Aug 2022 LiDAR Capture and 30 May to 26 Jun 2023 LiDAR Capture)

Profile (Line number, Grid ID and DEM year)	% Slope (Least Squares)	% Slope Change (2022 to 2023)	0.1% Slope Change Threshold Exceeded?
1_Grid1941_2022_DEM	0.060%		
1_Grid1941_2023_DEM	0.086%	0.026%	
2_Grid1941_2022_DEM	0.071%		
2_Grid1941_2023_DEM	0.106%	0.035%	
3_Grid1941_2022_DEM	0.043%		
3_Grid1941_2023_DEM	0.025%	-0.018%	
4_Grid1941_2022_DEM	0.116%		
4_Grid1941_2023_DEM	0.131%	0.015%	
1_Grid2039_2022_DEM	-0.082%		
1_Grid2039_2023_DEM	-0.070%	0.012%	
2_Grid2039_2022_DEM	-0.181%		
2_Grid2039_2023_DEM	-0.187%	-0.006%	
3_Grid2039_2022_DEM	-0.077%		
3_Grid2039_2023_DEM	0.039%	0.116%	YES
4_Grid2039_2022_DEM	-0.046%		
4_Grid2039_2023_DEM	-0.030%	0.016%	
5_Grid2039_2022_DEM	-0.139%		
5_Grid2039_2023_DEM	-0.147%	-0.008%	
6_Grid2039_2022_DEM	-0.349%		
6_Grid2039_2023_DEM	-0.344%	0.006%	
1_Grid2231_2022_DEM	0.169%		
1_Grid2231_2023_DEM	0.180%	0.011%	
2_Grid2231_2022_DEM	0.059%		
2_Grid2231_2023_DEM	0.102%	0.043%	
3_Grid2231_2022_DEM	0.069%		
3_Grid2231_2023_DEM	0.142%	0.073%	
4_Grid2231_2022_DEM	-0.067%		
4_Grid2231_2023_DEM	-0.064%	0.003%	
5_Grid2231_2022_DEM	-0.005%		
5_Grid2231_2023_DEM	-0.012%	-0.007%	
6_Grid2231_2022_DEM	-0.302%		
6_Grid2231_2023_DEM	-0.312%	-0.009%	
1_Grid2308_2022_DEM	-0.069%		
1_Grid2308_2023_DEM	-0.060%	0.009%	
2_Grid2308_2022_DEM	-0.299%		
2_Grid2308_2023_DEM	-0.301%	-0.002%	
3_Grid2308_2022_DEM	0.098%		
3_Grid2308_2023_DEM	0.084%	-0.014%	
4_Grid2308_2022_DEM	0.243%		
4_Grid2308_2023_DEM	0.243%	0.000%	
1_Grid2346_2022_DEM	0.142%		
1_Grid2346_2023_DEM	0.138%	-0.004%	
2_Grid2346_2022_DEM	0.035%		
2_Grid2346_2023_DEM	0.030%	-0.005%	
3_Grid2346_2022_DEM	0.356%		
3_Grid2346_2023_DEM	0.373%	0.018%	
4_Grid2346_2022_DEM	0.336%		
4_Grid2346_2023_DEM	0.335%	0.000%	
5_Grid2346_2022_DEM	0.023%		
5_Grid2346_2023_DEM	0.351%	0.328%	YES
6_Grid2346_2022_DEM	0.182%		
6_Grid2346_2023_DEM	0.189%	0.007%	
7_Grid2346_2022_DEM	0.235%		

Profile (Line number, Grid ID and DEM year)	% Slope (Least Squares)	% Slope Change (2022 to 2023)	0.1% Slope Change Threshold Exceeded?
7_Grid2346_2023_DEM	0.252%	0.017%	
8_Grid2346_2022_DEM	-0.092%		
8_Grid2346_2023_DEM	-0.090%	0.002%	
1_Grid2369_2022_DEM	-0.077%		
1_Grid2369_2023_DEM	-0.090%	-0.014%	
2_Grid2369_2022_DEM	-0.207%		
2_Grid2369_2023_DEM	-0.212%	-0.006%	
3_Grid2369_2022_DEM	-0.279%		
3_Grid2369_2023_DEM	-0.284%	-0.006%	
4_Grid2369_2022_DEM	0.036%		
4_Grid2369_2023_DEM	0.032%	-0.004%	
1_Grid2370_2022_DEM	0.118%		
1_Grid2370_2023_DEM	0.123%	0.005%	
2_Grid2370_2022_DEM	-0.032%		
2_Grid2370_2023_DEM	-0.026%	0.005%	
3_Grid2370_2022_DEM	0.041%		
3_Grid2370_2023_DEM	0.040%	-0.001%	
4_Grid2370_2022_DEM	0.071%		
4_Grid2370_2023_DEM	0.076%	0.005%	
5_Grid2370_2022_DEM	0.274%		
5_Grid2370_2023_DEM	0.261%	-0.013%	
1_Grid2371_2022_DEM	0.094%		
1_Grid2371_2023_DEM	0.080%	-0.014%	
2_Grid2371_2022_DEM	0.039%		
2_Grid2371_2023_DEM	-0.021%	-0.061%	
3_Grid2371_2022_DEM	-0.016%		
3_Grid2371_2023_DEM	-0.017%	-0.001%	
1_Grid2372_2022_DEM	0.051%		
1_Grid2372_2023_DEM	0.043%	-0.008%	
2_Grid2372_2022_DEM	0.204%		
2_Grid2372_2023_DEM	0.206%	0.002%	
3_Grid2372_2022_DEM	-0.076%		
3_Grid2372_2023_DEM	-0.074%	0.002%	
4_Grid2372_2022_DEM	-0.353%		
4_Grid2372_2023_DEM	-0.376%	-0.023%	
5_Grid2372_2022_DEM	-0.376%		
5_Grid2372_2023_DEM	-0.383%	-0.007%	
6_Grid2372_2022_DEM	-0.127%		
6_Grid2372_2023_DEM	-0.132%	-0.005%	
1_Grid2395_2022_DEM	-0.327%		
1_Grid2395_2023_DEM	-0.328%	-0.001%	
2_Grid2395_2022_DEM	-0.176%		
2_Grid2395_2023_DEM	-0.180%	-0.005%	
3_Grid2395_2022_DEM	-0.300%		
3_Grid2395_2023_DEM	-0.278%	0.023%	
4_Grid2395_2022_DEM	-0.149%		
4_Grid2395_2023_DEM	-0.161%	-0.012%	
5_Grid2395_2022_DEM	-0.060%		
5_Grid2395_2023_DEM	-0.043%	0.017%	
6_Grid2395_2022_DEM	-0.156%		
6_Grid2395_2023_DEM	-0.141%	0.015%	
1_Grid2396_2022_DEM	-0.054%		
1_Grid2396_2023_DEM	-0.074%	-0.020%	
2_Grid2396_2022_DEM	-0.439%		
2_Grid2396_2023_DEM	-0.450%	-0.012%	
3_Grid2396_2022_DEM	-0.516%		
3_Grid2396_2023_DEM	-0.520%	-0.004%	

Profile (Line number, Grid ID and DEM year)	% Slope (Least Squares)	% Slope Change (2022 to 2023)	0.1% Slope Change Threshold Exceeded?
4_Grid2396_2022_DEM	-0.288%		
4_Grid2396_2023_DEM	-0.297%	-0.009%	
5_Grid2396_2022_DEM	-0.122%		
5_Grid2396_2023_DEM	-0.123%	-0.001%	
6_Grid2396_2022_DEM	-0.080%		
6_Grid2396_2023_DEM	-0.074%	0.006%	
7_Grid2396_2022_DEM	-0.107%		
7_Grid2396_2023_DEM	-0.103%	0.004%	
1_Grid2419_2022_DEM	-0.091%		
1_Grid2419_2023_DEM	-0.083%	0.008%	
2_Grid2419_2022_DEM	0.010%		
2_Grid2419_2023_DEM	-0.003%	-0.013%	
3_Grid2419_2022_DEM	-0.141%		
3_Grid2419_2023_DEM	-0.132%	0.009%	
4_Grid2419_2022_DEM	-0.216%		
4_Grid2419_2023_DEM	-0.229%	-0.013%	
5_Grid2419_2022_DEM	-0.299%		
5_Grid2419_2023_DEM	-0.307%	-0.008%	
6_Grid2419_2022_DEM	-0.175%		
6_Grid2419_2023_DEM	-0.173%	0.002%	
1_Grid2420_2022_DEM	-0.786%		
1_Grid2420_2023_DEM	-0.776%	0.011%	
2_Grid2420_2022_DEM	-0.211%		
2_Grid2420_2023_DEM	-0.214%	-0.003%	
3_Grid2420_2022_DEM	-0.226%		
3_Grid2420_2023_DEM	-0.224%	0.001%	
4_Grid2420_2022_DEM	-0.323%		
4_Grid2420_2023_DEM	-0.318%	0.005%	
5_Grid2420_2022_DEM	-0.426%		
5_Grid2420_2023_DEM	-0.446%	-0.020%	
1_Grid2421_2022_DEM	-0.276%		
1_Grid2421_2023_DEM	-0.278%	-0.002%	
2_Grid2421_2022_DEM	-0.219%		
2_Grid2421_2023_DEM	-0.211%	0.009%	
3_Grid2421_2022_DEM	-0.218%		
3_Grid2421_2023_DEM	-0.201%	0.016%	
4_Grid2421_2022_DEM	-0.225%		
4_Grid2421_2023_DEM	-0.216%	0.009%	
5_Grid2421_2022_DEM	-0.272%		
5_Grid2421_2023_DEM	-0.246%	0.027%	
6_Grid2421_2022_DEM	-0.305%		
6_Grid2421_2023_DEM	-0.293%	0.012%	
1_Grid2450_2022_DEM	-0.152%		
1_Grid2450_2023_DEM	-0.158%	-0.006%	
2_Grid2450_2022_DEM	0.143%		
2_Grid2450_2023_DEM	0.138%	-0.004%	
3_Grid2450_2022_DEM	0.108%		
3_Grid2450_2023_DEM	0.119%	0.012%	
4_Grid2450_2022_DEM	-0.278%		
4_Grid2450_2023_DEM	-0.288%	-0.009%	
1_Grid2571_2022_DEM	-0.110%		
1_Grid2571_2023_DEM	-0.221%	-0.111%	YES
2_Grid2571_2022_DEM	-0.003%		
2_Grid2571_2023_DEM	0.000%	0.003%	
3_Grid2571_2022_DEM	-0.116%		
3_Grid2571_2023_DEM	-0.124%	-0.009%	
4_Grid2571_2022_DEM	-0.017%		

Profile (Line number, Grid ID and DEM year)	% Slope (Least Squares)	% Slope Change (2022 to 2023)	0.1% Slope Change Threshold Exceeded?
4_Grid2571_2023_DEM	-0.023%	-0.006%	
5_Grid2571_2022_DEM	-0.088%		
5_Grid2571_2023_DEM	-0.080%	0.008%	
1_Grid2603_2022_DEM	-0.196%		
1_Grid2603_2023_DEM	-0.191%	0.004%	
2_Grid2603_2022_DEM	-0.731%		
2_Grid2603_2023_DEM	-0.739%	-0.008%	
3_Grid2603_2022_DEM	-0.165%		
3_Grid2603_2023_DEM	-0.159%	0.006%	
4_Grid2603_2022_DEM	-0.201%		
4_Grid2603_2023_DEM	-0.199%	0.002%	
1_Grid2617_2022_DEM	-0.141%		
1_Grid2617_2023_DEM	-0.140%	0.000%	
2_Grid2617_2022_DEM	-0.404%		
2_Grid2617_2023_DEM	-0.401%	0.003%	
3_Grid2617_2022_DEM	-0.497%		
3_Grid2617_2023_DEM	-0.496%	0.001%	
4_Grid2617_2022_DEM	-0.052%		
4_Grid2617_2023_DEM	-0.051%	0.001%	
1_Grid2618_2022_DEM	-0.075%		
1_Grid2618_2023_DEM	-0.078%	-0.003%	
2_Grid2618_2022_DEM	-0.334%		
2_Grid2618_2023_DEM	-0.334%	0.000%	
3_Grid2618_2022_DEM	-0.571%		
3_Grid2618_2023_DEM	-0.573%	-0.002%	
4_Grid2618_2022_DEM	-0.339%		
4_Grid2618_2023_DEM	-0.339%	0.001%	
1_Grid2641_2022_DEM	-0.433%		
1_Grid2641_2023_DEM	-0.431%	0.002%	
2_Grid2641_2022_DEM	-1.457%		
2_Grid2641_2023_DEM	-1.460%	-0.003%	
3_Grid2641_2022_DEM	-1.174%		
3_Grid2641_2023_DEM	-1.173%	0.001%	
1_Grid2716_2022_DEM	-0.205%		
1_Grid2716_2023_DEM	-0.210%	-0.004%	
2_Grid2716_2022_DEM	0.476%		
2_Grid2716_2023_DEM	0.471%	-0.005%	
3_Grid2716_2022_DEM	0.526%		
3_Grid2716_2023_DEM	0.513%	-0.013%	
4_Grid2716_2022_DEM	-0.584%		
4_Grid2716_2023_DEM	-0.602%	-0.018%	
5_Grid2716_2022_DEM	-0.226%		
5_Grid2716_2023_DEM	-0.220%	0.006%	
1_Grid2738_2022_DEM	-0.678%		
1_Grid2738_2023_DEM	-0.678%	-0.001%	
2_Grid2738_2022_DEM	-0.210%		
2_Grid2738_2023_DEM	-0.205%	0.005%	
3_Grid2738_2022_DEM	-0.346%		
3_Grid2738_2023_DEM	-0.343%	0.003%	
4_Grid2738_2022_DEM	-0.328%		
4_Grid2738_2023_DEM	-0.320%	0.008%	
1_Grid2739_2022_DEM	-0.001%		
1_Grid2739_2023_DEM	0.010%	0.011%	
2_Grid2739_2022_DEM	-0.780%		
2_Grid2739_2023_DEM	-0.786%	-0.006%	
3_Grid2739_2022_DEM	-0.123%		
3_Grid2739_2023_DEM	-0.118%	0.005%	

Profile (Line number, Grid ID and DEM year)	% Slope (Least Squares)	% Slope Change (2022 to 2023)	0.1% Slope Change Threshold Exceeded?
4_Grid2739_2022_DEM	-0.860%		
4_Grid2739_2023_DEM	-0.851%	0.009%	
1_Grid2740_2022_DEM	-0.092%		
1_Grid2740_2023_DEM	-0.080%	0.012%	
2_Grid2740_2022_DEM	-0.063%		
2_Grid2740_2023_DEM	-0.059%	0.004%	
3_Grid2740_2022_DEM	-0.059%		
3_Grid2740_2023_DEM	-0.054%	0.005%	
4_Grid2740_2022_DEM	-0.038%		
4_Grid2740_2023_DEM	-0.036%	0.002%	
1_Grid2759_2022_DEM	-0.260%		
1_Grid2759_2023_DEM	-0.256%	0.004%	
2_Grid2759_2022_DEM	0.145%		
2_Grid2759_2023_DEM	0.144%	-0.001%	
3_Grid2759_2022_DEM	0.183%		
3_Grid2759_2023_DEM	0.205%	0.022%	
4_Grid2759_2022_DEM	-0.629%		
4_Grid2759_2023_DEM	-0.606%	0.024%	
5_Grid2759_2022_DEM	0.167%		
5_Grid2759_2023_DEM	0.154%	-0.014%	
6_Grid2759_2022_DEM	0.000%		
6_Grid2759_2023_DEM	-0.007%	-0.006%	
7_Grid2759_2022_DEM	-0.424%		
7_Grid2759_2023_DEM	-0.425%	-0.002%	
1_Grid2760_2022_DEM	-1.422%		
1_Grid2760_2023_DEM	-1.503%	-0.081%	
2_Grid2760_2022_DEM	0.325%		
2_Grid2760_2023_DEM	0.324%	-0.001%	
3_Grid2760_2022_DEM	-0.103%		
3_Grid2760_2023_DEM	-0.074%	0.029%	
1_Grid2761_2022_DEM	-0.171%		
1_Grid2761_2023_DEM	-0.161%	0.011%	
2_Grid2761_2022_DEM	-0.257%		
2_Grid2761_2023_DEM	-0.252%	0.005%	
1_Grid2787_2022_DEM	0.000%		
1_Grid2787_2023_DEM	-0.011%	-0.011%	
2_Grid2787_2022_DEM	0.043%		
2_Grid2787_2023_DEM	0.058%	0.016%	
3_Grid2787_2022_DEM	-0.198%		
3_Grid2787_2023_DEM	-0.194%	0.004%	
4_Grid2787_2022_DEM	-0.046%		
4_Grid2787_2023_DEM	-0.049%	-0.003%	
5_Grid2787_2022_DEM	-0.083%		
5_Grid2787_2023_DEM	-0.084%	-0.001%	
1_Grid2808_2022_DEM	-0.029%		
1_Grid2808_2023_DEM	-0.028%	0.001%	
2_Grid2808_2022_DEM	-0.085%		
2_Grid2808_2023_DEM	-0.090%	-0.004%	
3_Grid2808_2022_DEM	0.338%		
3_Grid2808_2023_DEM	0.331%	-0.007%	
1_Grid2833_2022_DEM	0.300%		
1_Grid2833_2023_DEM	0.300%	0.001%	
2_Grid2833_2022_DEM	3.542%		
2_Grid2833_2023_DEM	3.533%	-0.009%	
1_Grid3054_2022_DEM	-0.610%		
1_Grid3054_2023_DEM	-0.615%	-0.005%	
2_Grid3054_2022_DEM	-0.352%		

Profile (Line number, Grid ID and DEM year)	% Slope (Least Squares)	% Slope Change (2022 to 2023)	0.1% Slope Change Threshold Exceeded?
2_Grid3054_2023_DEM	-0.357%	-0.006%	
3_Grid3054_2022_DEM	-0.930%		
3_Grid3054_2023_DEM	-0.935%	-0.005%	
4_Grid3054_2022_DEM	-0.690%		
4_Grid3054_2023_DEM	-0.691%	-0.001%	
1_Grid2138_2022_DEM	-0.075%		
1_Grid2138_2023_DEM	-0.070%	0.005%	
1_Grid2720_2022_DEM	0.175%		
1_Grid2720_2023_DEM	0.162%	-0.014%	
1_Grid2767_2022_DEM	-0.277%		
1_Grid2767_2023_DEM	-0.284%	-0.007%	
2_Grid2138_2022_DEM	-0.126%		
2_Grid2138_2023_DEM	-0.116%	0.010%	
2_Grid2720_2022_DEM	-0.176%		
2_Grid2720_2023_DEM	-0.180%	-0.004%	
2_Grid2767_2022_DEM	0.228%		
2_Grid2767_2023_DEM	0.234%	0.006%	
3_Grid2138_2022_DEM	-0.032%		
3_Grid2138_2023_DEM	-0.018%	0.013%	
3_Grid2720_2022_DEM	-0.072%		
3_Grid2720_2023_DEM	-0.070%	0.002%	
3_Grid2767_2022_DEM	-0.016%		
3_Grid2767_2023_DEM	-0.055%	-0.039%	
4_Grid2138_2022_DEM	-0.110%		
4_Grid2138_2023_DEM	-0.106%	0.004%	
4_Grid2767_2022_DEM	-0.157%		
4_Grid2767_2023_DEM	-0.164%	-0.007%	
5_Grid2767_2022_DEM	-0.025%		
5_Grid2767_2023_DEM	-0.032%	-0.007%	
6_Grid2767_2022_DEM	-0.364%		
6_Grid2767_2023_DEM	-0.370%	-0.006%	