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2023 Groundwater and Spring Review, Pakenham Quarry

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was engaged by Holcim (Australia) Pty Ltd (Holcim) to conduct annual monitoring and review of groundwater levels and spring flow/quality at the Mt Shamrock Quarry (WA174) in Pakenham, Victoria (the site) (see **Figure 1**).

This review aims to meet selected requirements of the Mt Shamrock Quarry Environmental Management Plan v3, July 2021 (EMP).

Groundwater monitoring locations included on Appendix 11- Figure 1 in the EMP were replaced in October 2014 to cater for changing pit extent and areas inundated with water, and a revised groundwater monitoring network now exists to replace bores lost (refer to **Figure 2** for current groundwater monitoring bore locations).

The objective of the groundwater monitoring and assessment detailed in Section 2.4.3 of the EMP is:

- To ensure that water discharged from the Quarry does not affect the beneficial uses[1] of the receiving waters; and
- To assess any long-term trends in groundwater levels.

To meet these objectives, the EMP includes the following requirements;

- Water level gauging will be conducted quarterly, and an annual evaluation undertaken, to determine how the groundwater levels respond to the following:
    - Seasonal rainfall changes;
    - Extension of the quarry;
    - Revegetation to parts of the plateau surface; and
    - Progressive rehabilitation of quarry.
- Properties surrounding the quarry will be regularly assessed to confirm that the assessed beneficial uses of groundwater (in accordance with SEPP (Waters)) on the properties is supported by actual practices; and
- Visual inspections of springs as per Section 2.5.4 of the EMP.

2.0 Scope

The scope of works undertaken to meet the requirements of the EMP was the following:

- Quarterly gauging of standing water levels (SWLs) of six groundwater bores in April 2023, June 2023, September 2023 and December 2023. Results of the gauging have been provided to Holcim post every gauging event;
    - An additional round of gauging was conducted alongside the spring assessment in January 2024.
- Annual assessment of 11 springs or seepages in January 2024, including;

[1] Beneficial uses are now termed environmental values under the EPA Environmental Reference Standard 2021

- site walkover to visually assess the condition of each spring;
- Collection of supporting photographs at each spring location;
- Collection of field parameters electrical conductivity (EC - µS/cm), pH, temperature (°C), redox potential (Eh - mV) and dissolved oxygen (DO – mg/L) at each spring location; and

- Provision of this report including an assessment of how groundwater levels respond to the following;
  - Seasonal rainfall changes;
  - Extension of the quarry, revegetation to parts of the plateau surface and progressive rehabilitation of the quarry (through reviewing provided plans indicating any quarterly changes in the extent of the quarry, revegetation and rehabilitation of the quarry completed at the time of groundwater level monitoring);
  - Comparison of current EC data against historical data collected from previous spring monitoring events, which date back to February 2001; and
  - Review of historical data and discussion of results with respect to potential impacts on environmental values.

3.0 Background

The site is located on Mt Shamrock Rd, approximately 5 km north of the Pakenham township and 65 km south-east of the Melbourne CBD. The surrounding land is predominantly used for agricultural purposes.

Topographically, the Site is located at the southern end of an elevated, basalt plateau, which is aligned in an approximate north-south orientation.

Toomuc Valley Road and Toomuc Creek run along the western edge of the plateau, while Pakenham Road is aligned to the south and east of the site.

The site sits at the southern end of a basalt ridgeline (Older Volcanics) which forms one continuous unconfined fracture rock aquifer along the 4 km ridgeline. The basalt overlies Palaeozoic basement, with a thin veneer of unconsolidated Werribee Formation sediments between in some locations. The basalt aquifer is limited in lateral extent by the nature of the valley fill basalt flow.

4.0 Monitoring Networks

4.1.1 Groundwater Bore Network

Six groundwater monitoring bores (MB01, MB02, MB04, MB03 and MB05 and MB06) formed the original groundwater monitoring bore network for the site, installed in 2001. These bores were drilled at four locations around and within the quarry to provide spatial coverage across the site. At two locations (MB03/MB05 and MB02/MB04), nested bores were constructed into different formations (Older Volcanics & Werribee Formation) to allow for groundwater level comparison between the aquifer units.

As documented in previous annual reviews (refer to AECOM, 2020[2] for full details of bore replacements overtime) multiple bores have been damaged or lost over time with pit development or inundation. All the bores have been replaced, with bores replaced as close as practicable to former bores in consideration of the constraints of the ongoing stripping campaigns and extraction[3].

Of the current bore monitoring network, bores MB01 and MB06, installed respectively to the south within the Werribee Formation and to the north within the Older Volcanics, have been operational since the commencement of the monitoring program and therefore there is a consistent set of groundwater levels immediately adjacent to the pit which have been monitored prior to the last approved pit expansion in 2005.

The bore network (including both the existing operational network, and the former bores) is presented on **Figure 2** and **Table A1** summarises the bore locations, screened interval and aquifer.

[2] AECOM, 2020. *2019 Groundwater and Spring Review, Pakenham Quarry,* Letter prepared for Holcim (Australia) Pty Ltd
[3] Replacement bores have been labelled in bore logs and charts as “MB02A, B, C, MB04C, MB05B” etc but for the purposes of clarity in this document they are referred to only by MB02, MB03, MB04, MB05.

4.1.2 Springs

Ten springs[4] surrounding the site have been identified in the groundwater investigations (URS, 2005) to support the Environmental Effects Statement for the pit expansion (SP01 to SP10).

In April 2023, Holcim personnel identified a new, spring (SP11) on the Toomuc Valley (west side of the quarry). It was investigated in January 2024 but there was insufficient outflow present to collect parameters or perform flow assessments.

In the 2005 assessment (URS, 2005), the conceptual site model shows that the quarry is targeting the Older Volcanics, whilst the springs are interpreted as being the result of outcropping saturated Werribee Formation sediments (comprising silts, clays and sands) which allow groundwater to discharge to the surface after rainfall recharge through the overlying basalts.

It was concluded by URS (2005) that springs SP01 to SP05 may be impacted by future dewatering activities, however all the springs were located on quarry property and none of them contribute to the flow or health of the surface water systems in which they are located. In the 2006 Minister's Assessment for the EES, it was stated that the impacts to springs and surface water quality were not significant subject to the implementation of management measures in the form of an environmental management plan (EMP).

The springs are monitored to assess changes to the springs over quarry development.

During the 2014 survey two of the mapped springs (SP09 & SP10) were not considered to be discrete groundwater discharge points due to significant surface water and seepage influences and/or changes in topography and infrastructure at the site (including fire track access construction), however monitoring at these locations has continued and potential seeps have been identified in SP09 area post 2014.

The locations of all mapped seepages/ springs are presented in **Figure 3** and the data is provided in **Table A4**.

5.0 Assessment of environmental values

The Environmental Reference Standard (2021) sets the regulatory framework for the assessment and management of surface water and groundwater. The ERS is a revision of the SEPP (Waters) which in turn was a revision of the SEPP (Waters of Victoria) (2003) which was referenced in the site EMP.

The aim of the ERS (Part 5) is to maintain surface and groundwater water quality sufficient to protect existing and potential environmental values of surface and groundwaters throughout Victoria.

The ERS define the surface waters at the site as belonging to the *Rivers and Streams: Central foothills and coastal plains* segment. It is noted that this is no change from SEPP (Waters).

The environmental values of groundwater in Victoria are defined by the salinity of the water. Table 1 summarises the environmental values based on groundwater salinity segments, as set out by the ERS:

Table 1 ERS – Environmental values that apply to the groundwater segments

Environmental value		Segments (mg/L TDS)						
		A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,400 - 7,100)	E (7,101-10,000)	F (> 10,001)
Water dependent ecosystems and species								
Potable water supply	Desirable							
	Acceptable							
Potable mineral water supply								
Agriculture and irrigation (irrigation)								
Agriculture and irrigation (stock								

[4] A spring is defined as a groundwater discharge or "exit" point

Environmental value	Segments (mg/L TDS)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,400 - 7,100)	E (7,101-10,000)	F (> 10,001)
watering)							
Industrial and commercial							
Water-based recreation (primary contact recreation)							
Traditional Owner cultural values							
Cultural and spiritual values							
Buildings and structures							
Geothermal properties							

Observations of salinity at the springs show a range from 149 mg/l (SP09 in February 2002) to 2,808 mg/L (SP02 in January 2003) as TDS (**see Table A4**). Spring salinity is considered to be a combination of runoff, interflow and groundwater discharge, thus groundwater salinity is likely to be diluted in these measurements and not representative of true groundwater salinity.

A groundwater resource report, generated from Victorian Department of Environment, Land, Water and Planning notes the quarry lies within the Westernport groundwater catchment. Water table salinity is noted to range from 1,001 – 3,500 mg/L (TDS). Groundwater bore development records, associated with drilling of groundwater monitoring bores at the quarry report groundwater salinity to range between 1,140 mg/l (MB03B in October 2014) and 2,318 mg/L (MB04C in January 2017) (see **Table A5**), which is consistent with the groundwater resource report.

This assessment indicates the groundwater quality at the Site can be classified as 'Segment B'. Given the current local activities in the area, consideration of the environmental values of groundwater and the level of protection has been provided:

- **Water dependent ecosystems and species:** Groundwater is known to feed numerous nearby springs in the area (as discussed in Section 4.1.2), which feed nearby surface water body Kennedy Creek (freshwater aquatic ecosystem). Protection of the ecosystems of the nearby surface water body and local springs are considered a relevant environmental value.
- **Potable mineral water supply:** No known mineral water supply use occurs in the vicinity of the quarry and this use is not considered relevant as part of this assessment.
- **Agriculture and irrigation (irrigation):** Agricultural farming is known to occur at a number of properties in the area, water from the springs are used as a water supply for irrigation, this environmental value is considered relevant as part of this assessment.
- **Agriculture and irrigation (stock watering):** Stock and domestic bores are registered in the area and stock grazing is known to occur at a number of properties in the area, water from springs are used as a source of water for stock, and this environmental value is considered relevant as part of this assessment.
- **Industrial and commercial:** There are no industrial zones in the immediate vicinity of the Site. As such, this environmental value is not considered relevant for this assessment.
- **Water-based recreation (primary contact recreation):** The downstream receiving water body, Kennedy Creek, is not expected to support primary contract recreation activities due to the size of the water body. However, based on a review of registered groundwater users on the Water Management Information System (WMIS) maintained by DELWP indicates stock and domestic bores are registered

within 2km of the quarry. Therefore, these bores could be used to fill dams or pools for swimming. Therefore, this environmental value has been considered.

- **Traditional Owner cultural values:** This environmental value relates to cultural and spiritual values held by communities such as baptisms, water-based festivals and cultural celebrations. There are no objectives specified in the ERS. In the absence of site-specific criteria, the objectives for water dependent ecosystems and species to be protective of the environmental value of surface water have been considered.
- **Cultural and spiritual values:** This environmental value relates to the cultural values of Traditional Owners, which may include traditional aquaculture, fishing, harvesting, cultivation of freshwater and marine foods, fish, grasses, medicines and filtration of water holes. There are no objectives specified in the ERS. In the absence of site-specific criteria, the objectives for other environmental values of surface water to be protective of this environmental value for surface water in the vicinity of the site, and the objectives for water dependent ecosystems and species to be protective of the environmental value at the point of groundwater discharge to surface water have been considered.
- **Buildings and structures**: Current land use around the site is agricultural and rural residential. Buildings associated are not expected to have deep footings; this environmental value is not considered relevant at this time.
- **Geothermal properties:** No known geothermal uses exist in the vicinity of the quarry and this environmental value is not considered relevant as part of this assessment.

As per the water management flow chart within the EMP, all water collected in the quarry pits is contained and reused on-site or discharged via a v-notch to surface water under licence from EPA. As stated in Section 3.3.6 of the statement from the Minister of Planning on the 2006 Environmental Effects Statement for the quarry expansion, the quarry operations were not expected to impact on groundwater and surface water systems, however groundwater inflows into the pit and the water system may increase the total dissolved solids (TDS) within the water system.

As part of this review, the available water quality (based on field EC collected from the springs) has been reviewed against the water quality guideline criteria for TDS as summarised in Table 2 below.

Table 2 Adopted groundwater environmental value guidelines

Beneficial use	Adopted guideline
Water dependent ecosystems and species	Rivers and streams: Central foothills and coastal plains (slightly to moderately modified)
Agriculture	Criteria for Livestock Water Supply: ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Water Quality.
Irrigation	Criteria for Irrigation Water Supply: ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Water Quality.

5.1 Summary of groundwater environmental value criteria

The adopted Groundwater Screening Criteria (GSC) are summarised below in Table 3.

Table 3 Groundwater Screening Criteria

Analyte	Water dependent ecosystems (95% Protection)	Irrigation	Stock Watering
Salinity (mg/L TDS)	250	Specific to crop species*	4,000#

Livestock watering considers horses, dairy cattle and sheep. Adopted criteria considers loss of production and a decline in animal conditional and health.

*ANZECC (2000) presents a range of acceptable water salinities for variation crops with regard to *Average root zone salinity thresholds*. It is expected that farming crop choice in area would consider the available water salinity (among other climatic factors) and as such the assessment of groundwater as a supply for irrigation should consider more any changing trends in water salinity.

6.0 Results and Discussion

6.1.1 Groundwater monitoring

Quarterly groundwater level gauging from the bore network was undertaken by AECOM during 2023 and January 2024.

The historic data set of groundwater elevations for the bore network is presented as **Table A2**. Additional, gauging data collected by Holcim in 2023 has also been added to **Table A2**.

For simplicity, bores and replacement bores have been plotted as one monitoring location to produce time series hydrographs (**Charts 1a – 1d**). These hydrographs are produced at two different time scales (2002 – 2024 and 2015 – 2024) and show all of the well data as well as focusing on the upgradient well (MB06) and downgradient well (MB01).

The data from 2015 to January 2024 is the most reliable and this indicates:

- elevations in the Older Volcanic wells (MB04, MB05, MB06) vary from approximately 177 m AHD (highest elevation – MB06 in January 2023) to approximately 167 m AHD (lowest elevation- MB05 in March 2023).
- elevations in the Werribee Formation wells (MB01, MB02, MB03) are more consistent and vary from approximately 173 m AHD (highest elevation) to approximately 167 m AHD (lowest elevation).

<u>Upgradient - MB06 (Older Volcanics)</u>

- groundwater levels reached the highest elevation since 2015 (177.80 m AHD) in January 2023, due to high rainfall amounts in October and November 2022.
- groundwater levels then decreased in elevation through 2023, presumably due to lower than average rainfall from June to November 2023.
- the groundwater level in January 2024 is consistent with groundwater levels in January 2022, 2021 and 2015 indicating that the water levels in MB06 are consistent with historical trends.

<u>Downgradient – MB01 (Werribee Formation)</u>

- the same pattern as that observed in MB06 has been seen in MB01, located downgradient of the quarry, albeit in a more subdued fashion (see Chart 1c). This suggests that the trends are a regional as they are displayed in both aquifers.

<u>Nested in-pit bores – MB02 and MB04</u>

- MB04 (Older Volcanics) and MB02 (Werribee Formation) are located in the centre of the quarry.
- they displayed very little variation in elevations over 2023 and followed a similar pattern with 1 m difference between the two aquifer's elevations.

<u>Nested bores to southwest of quarry – MB03 and MB05</u>

- MB05 (Older Volcanics) and MB03 (Werribee Formation) are located just outside the southwest boundary of the quarry.
- these wells displayed a consistent decrease in water levels, to the lowest levels recorded since monitoring began, in March 2023 (approximately 167 m AHD). Discussions with Holcim (February 2024) indicate that extraction occurred in the western corner of the quarry (Area 2 in Plate 1) close to these bores in late 2022/early 2023 which is likely to be the cause of the reduction in water levels.
- in April 2023 this area was backfilled and the water levels have begun to recover, however they remain lower than levels measured from 2015 to end 2022 and lower than the other wells in the same aquifers i.e. MB05 is 3.5 m lower than MB04 and MB03 is approximately 2.7 m lower than MB02.

6.1.2 Response to rainfall totals

Rainfall data obtained from the nearest meteorological station with a complete rainfall dataset over the total monitoring period (Dandenong Station number 86224 - refer to **Table A3**) has recorded data from 1961 and 2023, with the following key points:

- overall average annual rainfall is approximately 798 mm/ year, calculated from data from 2002 to the end of 2023.
- since 2002, rainfall has ranged between 587 mm (2008) and 1136 mm (2020).
- 2023 represents a slightly below average year (719 mm), with a dry winter (likely due to the El Niño weather system) and an unusually wet December (134.6 mm).
- historically, rainfall totals were below the average annual rainfall value of 798 mm/year between 2002 and 2008 but increased between 2010 and 2012 (a trend which was consistent with regional groundwater level observations). From 2013 to present, the annual rainfall has generally fluctuated both above and below the annual average, 2020, 2021 and 2022 have all been above the long term annual average rainfall volume, but 2023 was below annual average rainfall volume (see **Table A3**).
- the data from the wells which have been replaced in 2009 (MB02 and MB04) is not considered as reliable as MB01 and MB06 as the elevations in the replaced wells before and after replacement (between December 2008 and June 2009) are significantly different (14 m).
- data from 2015 appears more reliable in all wells.

Charts 2a-2d (attached) present the groundwater level data from Charts 1a -1d with the monthly rainfall totals.

Charts 3a-3d (attached) present groundwater level data and the Accumulative Monthly Residual Rainfall (AMRR). The plots indicate the following key points:

<u>2005 to 2009</u>

- groundwater levels dropped significantly (6 to 7 m in MB01 and MB06) in the time of reduced rainfall between 2005 and 2009.

<u>2010 to 2015</u>

- the groundwater levels in most wells began to increase between 2010 and 2011 due to the increase in rainfall associated with the breaking of the drought, apart from MB01 and MB06, located outside of the pit which remained stable throughout a continued upward AMRR trend.

<u>2015 to current</u>

- since 2015 elevations in all of the wells are much more consistent temporally and also between wells, potentially indicating that the groundwater levels have re-equilibrated since the drought broke.
- the AMRR plot (Chart 3a) has been trending upwards since 2020 to a maximum in November 2022 before levelling off and then decreasing through the latter half of 2023 (due to the dry winter). The AMRR began to rise again slightly in December 2023 but has not reached November 2022 levels.
- chart 3d shows the AMRR since 2020 plotted with groundwater levels from MB01 and MB06. Groundwater in both wells appear to reflect the AMRR with some degree of lag time, as the December 2023 upward trend in AMRR has not yet been observed in the groundwater wells.
- bores screened in the Werribee Formation respond at comparable times and trends to the bores in the Older Volcanics aquifer wells suggesting hydraulic connection between the two systems – refer to Chart 3b which shows that MB06 (Older Volcanics basalt) and MB01 (Werribee Formation display the same trends but with the underlying aquifer (MB01) showing a slightly subdued version of the overlying aquifer trend.

6.1.3 Response to quarry extensions

The following summarises the stripping/extraction campaigns that have taken place since the expansion of the quarry in 2005:

- 2009:
  - An excavation of approximately 50m² to the southwest corner (towards MB03 and MB05);
  - An excavation of approximately 100m² to the north (towards MB06);
  - Vegetation and surface material removal of approximately 200m² to the south (west of MB01); and
  - Vegetation and surface material removal of approximately 200m² to the south (east of MB01).
- 2012 - Extension of the western area of the quarry. Material from here was being placed in the northern extent of the quarry.
- 2015 - Further excavation of the southwestern quarry area.
- 2016 - Further excavation of the southwestern quarry area.
- 2017 - Continued excavation of the quarry in the southwest portion of the site.
- 2018 - Continued excavation in the southwestern area of the quarry.
- 2019 – Removal of overburden in the western portion of quarry
- 2020 – Continued stripping and excavation in the western portion of the site area
- 2021 – Continued stripping in the western portion of the site area, backfill and progressive rehabilitation in the southwestern corner of the site, topsoil placement in the south of the site with 0.8 ha of hydroseeding and planting of 1250 plants.
- 2022 - Continued mining of the western side of quarry, focusing on the southwestern corner (Area 2). New land bridge was constructed across the northern pit to reduce hauling distance, constructed from rocky overburden. No reclamation works occurred during the period, however 1.25ha of a previously backfilled area was topsoiled, hydroseeded and planted.
- 2023 – Extraction and pumping from Area 2 in late 2022/early 2023. From April 2023, removed 210,000 m^3 of clay and rocky overburden from Area 1 (Plate 1) and emplaced into Area 2.
- Area 3, the mining focus area for most of 2023, was mined down to approximately 165 mAHD RL.
- Approximately 63,000 m^3 of rocky overburden and clay was removed from the truck parking area and emplaced onto Area 4.
- Topsoil was removed from Area 1 and directly placed into a new 1.1 Ha revegetation area outlined below in Plate 2. Hydroseeding and planting of trees was conducted post topsoiling.
- MB03B and MB05B which are located close to Area 2 displayed a consistent decrease in water levels, to the lowest levels recorded since monitoring began, in March 2023 (approximately 167 m AHD). This appears to be related to the extraction which occurred in the western corner of the quarry (Area 2 in Plate 1).
- There is no obvious impact of these activities on the other groundwater levels at site.

Plate 1 Areas of works 2023 (image from October 2023)

Plate 2 1.1 Hectare revegetation zone

6.1.4 Response to revegetation/progressive rehabilitation across plateau surface

Holcim continued revegetation and progressive rehabilitation works at the quarry in 2023 as shown in Plate 2 (blue shading). There continues to be no observable trend in levels that can be attributed to revegetation. Revegetation areas are relatively minor in comparison to the overall quarry footprint and any change in infiltration from an increase in evapotranspiration is likely to be minor at this time.

6.1.5 Comparison with pit water levels

Pit level data from October 2020 has been provided by Holcim for the northern and southern pit dams (**Table A6**). The northern dam averages a pit water level of 173 m AHD and the Southern Dam 165 m AHD. Over the monitoring period, water levels in the northern dam have varied by 2 m and in the southern dam by 1 m. These dam levels have been plotted on Charts 1b, 1d, 2d, 3c to show their relationship with groundwater levels.

The water level in the northern pit is generally reflective of the water levels in the Older Volcanics wells MB06 and MB04 (although MB06 is more influenced by rainfall levels than the pit water levels). There is a hydraulic gradient from the northern pit to the southern pit. MB01 (Werribee Formation) has a higher water level than the southern pit indicating that the pit is acting as a groundwater sink with the hydraulic gradient flowing towards the southern pit.

A cross section showing the water levels in the pits and bores is provided as **Figure 4**. The base of the quarry is at approximately 160 m AHD.

6.2 Spring Survey

Historically ten seeps were identified as being groundwater fed springs. A spring survey was conducted on 15 January 2024. A survey was planned for December 2023 but was cancelled due to excessive rainfall.

A new spring was identified in April 2023 (SP11), but insufficient water was present for parameters to be collected during the January 2024 survey.

Photographs taken for each location during the survey are presented in **Attachment 4**.

Results of the spring survey completed in January 2024 are summarised in **Table 4** below. Historical spring parameters are presented in **Table A4** and a chart of measured EC over time is presented as **Chart 4**.

Rainfall vs the measured EC is also plotted as **Chart 5** and **5a** and AMRR vs the measured EC is also plotted in **Chart 6** and **6a**.

Table 4 2023 Spring Survey Results

SPRING ID/Use (if any)	Location/history/use/changes	EC (µS/cm) January 2024	Observations January 2024	Flow rate January 2024 (m^3/day)	Flow rate December 2022 (m^3/day)
SP01	West of quarry Provides irrigation and stock water to a number of properties in the local area	724	Water flowing into bin, losing some water which misses the capture system.	10.3	19
SP02	West of the quarry historically been observed to be a small dam fed by groundwater and surface water runoff from a relatively steep slope above Previous rounds underestimated flow at the bore due to the addition of a pipe to divert flow from the spring to the tank which was not taken into account. Flow is now measured at the pipe outflow to the tank.	1892	Audible flow, healthy and thick veg around spring.	15.1	2.5
SP03	West of the quarry Vegetation has historically, and continues to be, healthy	768	Water flowing around bin. Heavily vegetated.	0.3	3.0

SPRING ID/Use (if any)	Location/history/use/changes	EC (µS/cm) January 2024	Observations January 2024	Flow rate January 2024 (m^3/day)	Flow rate December 2022 (m^3/day)
	bin was installed since November 2020 to manage overflow				
SP04	Northwest of the quarry Spring is historically observed to be dry or with damp seep with healthy vegetation.	1041	Thick vegetation, clear water, algae, no flow from spring. Audible flow on bank above spring but not visible through vegetation or without soil disturbance.	Not recorded	Not recorded
SP05	South of quarry Spring is historically observed to be dry with healthy vegetation	Dry	Vegetation healthy. Wet ground with water present on upper bank.	Not flowing	Not flowing
SP06	Northwest of quarry Generally displays as turbid standing water. Accessible by livestock	397	Light brown, medium turbidity, healthy veg. Standing water at spring. Audible flow on slope beneath spring, not visible through vegetation or without soil disturbance. Saturated ground below spring.	Not recorded	Not recorded
SP07	Furthest north spring with lower elevation than the other mapped springs Discharge is towards the bottom of a significant and moderately steep drainage line, indicating that surface water runoff could be a partial contributor to the water logging of the ground surface. This location has been intermittently dry or had very little flow since May 2014 (when accessible)	Not taken	Reclassified as seep in EES. No longer observed.		
SP08	North of quarry Spring is a wetland with a lot of reeds. Flow has increased in this spring from standing/stagnant water prior to 2020 to clear and flowing water. Vegetation is consistently healthy.	431	Healthy vegetation, medium turbidity.	13	9.0

SPRING ID/Use (if any)	Location/history/use/changes	EC (µS/cm) January 2024	Observations January 2024	Flow rate January 2024 (m^3/day)	Flow rate December 2022 (m^3/day)
	Recommendation to install means of measuring flow such as v-notch or elevated pipe.				
SP09	East of the quarry Has gone from being dry in 2009 to low flow in 2014. Since approximately 2016 the spring has become a wetland with healthy vegetation. Has historically been mislabelled as Spring 10 but this has been rectified by December 2022.	457	Thick veg, clear water, Outflow rate may be influenced by recent heavy rain.	21.6	1.2
SP10	East of the quarry, close to Spring 9. area has been recorded as dry since 2014, including in the recent December 2022 monitoring event when only a damp seep in the exposed embankment was observed.	Not taken	Reclassified as seep in EES. No longer observed.		
SP11	Newly identified spring west of quarry on embankment near stand of trees.	Not taken	Area of perpetually saturated ground and perennial green grass. Insufficient standing water for parameters to be collected.	Not flowing	Not clearly discernible

6.2.1 Spring changes in comparison to rainfall totals and quarry development

- Higher EC values generally reflect lower levels of recharge/rainfall and lower EC values reflect higher levels of recharge/rainfall. EC (on its own), EC versus rainfall and EC versus AMRR is shown for all springs in Charts 4, 5, 5a (2015 onwards), 6, 6a (2015 onwards) respectively.
- The spring EC measurements have been plotted against the rainfall data (**Chart 5)** and against the AMRR (**Chart 6**). Rainfall in 2023 (719.8 mm) is slightly below the BOM rainfall annual average (782.9 mm) but is less than the minimum reported rainfall since monitoring commenced in 2001 (587.4 mm in 2008).
- The annual accumulative monthly residual rainfall (AMRR) reached a maximum in November 2022 after two years of steady increase and then declined through 2023. However, an exceptionally wet December 2023 appears to have reversed this declining trend.
- There is not a strong seasonal pattern in EC in the springs although generally the EC is higher during the summer monitoring events, expected to be commensurate with lower rainfall and may be more reflective of seepage. The influence of rainfall is most observable in SP02, particularly since mid-2018 and is clearly seen in Chart 6 which shows that the EC in SP08 has decreased as the AMRR has increased. SP02 also consistently has the highest EC concentrations, which appears to also reflect a groundwater influence.

- A qualitative assessment of the flow observed in the springs (see comments in Table 4) against the significant upwards trend in the AMRR since January 2020 indicates:
    - SP01 in the western corner of the quarry (near Area 2 in Plate 1) reported a slight decline in flow (19 m^3/day to 10 m^3/day) as did SP03 (3 m^3/day to 0.3 m^3/day), located slightly further to the north of Area 2;
    - SP02, southeast of SP01, has reported significantly increased flow during sampling in January 2024;
    - Combined, SP01, SP02 and SP03 were measured to have marginally increased flow in January 2024. In line with the GHD recommendations (Pakenham Quarry, Hydrogeological Review June 2023) metering devices fitted to these piped springs and more frequent capture of this flow data will assist in giving confidence around this data;
    - SP04 and SP06 had free standing ponds, which were this year measured against survey pegs to be at RL 166.83 and RL 165.83 respectively. Audible flow was present again at both springs however any flow was diffuse beneath vegetation and unable to be recorded without extensive soil disturbance;
    - SP05 and SP08 observations are in line with the previous year with SP05 being typically dry since 2009 and SP08 flowing in line with previous measurements; and
    - SP09 and SP10 have been influenced by creation of dams/ wetlands in the vicinity of the springs. These make flow data more susceptible to influence from any surface water runoff from recent rain which is inferred to be the case this year.

6.3 Assessment of impacts to environmental values

Quarrying operations at the site began mid-1970s, monitoring of groundwater levels and of spring water quality (electrical conductivity and other field parameters) has been conducted at the Site since 2001.

As an overview, water is managed at the site via a pump and containment system around the site, with water that is collected in north and south pits, used on site for either dust suppression or in the processing plant.

For management of excess water, Holcim hold an off-site discharge licence from EPA for the discharge of water to Kennedy Creek via the v-notch at Donazzan's Dam.

As part of this licence, Holcim undertake testing during discharge for the parameters defined within the licence, including flow and water quality- primarily TDS. Monitoring of off-site discharge to Kennedy Creek is undertaken weekly during discharge for water quality and flow as per the EPA licence and Holcim maintain records.

Should quality not comply with the limits set in the EPA licence, then discharge does not occur. Therefore, the impacts on the creek system (environmental values of water dependent ecosystems) is considered to be met.

Observations of groundwater levels continuing to remain within historic measurements and indicates that the access to groundwater for the purpose of environmental values outlined in Section 4.0 has not been impinged by decreasing water levels. Further, groundwater seepage and flow has continued to be observed in the springs since the commencement of monitoring. Therefore, where surrounding land users access water, in particular for stock watering, this does not appear to be affected by quarry operations.

Quarry operations are not expected to impact on surrounding groundwater quality, as local groundwater flow is inferred to be towards the pit, and any inflows are captured as part of the on-site water management network. Groundwater quality monitoring is not required by the EMP, as discussed above the key indicators of impact to surrounding environmental values are flows at the spring monitoring locations.

A brief review of available water quality records for the site including groundwater bore development records (2014 – 2017), and field measurements at the springs indicate that TDS (based on field measured EC readings) is likely to remain as Segment B of the ERS (1201 – 3100 mg/L), suggesting that groundwater is suitable for the environmental values noted in Section 5.0.

Inspection of the data presented in **Chart 7** shows a relatively stable salinity at most springs since monitoring commenced. SP02 has historically has a higher salinity than other springs (2808 mg/l) but has

been recently influenced by increased rainfall (957 mg/l). Groundwater quality measured in bore development and expressed by the springs is considered suitable for livestock watering and has been since monitoring commenced.

Groundwater quality observed during bore development suggests that salinity varies and exceeds the adopted criteria for water dependent ecosystems. This is also the case for water quality monitored at adjacent springs. However, this is considered to be the background quality within the aquifers.

Groundwater discharge via springs is considered a natural hydraulic process in the area and as such slightly saline groundwater expression from some springs in the area is considered natural and not an impediment to ecosystem maintenance given the dilution occurring at the spring sites. Further, the key environmental value of the surface water environment, is managed via the EPA licence as discussed above, whereby, water quality parameters must be met prior to discharge.

Suitability of groundwater for crop irrigation will depend on the crop chosen, based on average root zone salinity thresholds presented in Table 4.2.5 of the ANZECC (2000) guidelines, water quality is likely suitable for most/many field crops fruits, pastures and vegetables, with the exception of some low tolerance species. The stable trend observed in the spring data shows that suitability for crop irrigation has not degraded since monitoring commenced in 2001 and is not likely impeding adjacent land holder environmental values. TDS is also below the adopted criteria for stock watering (4,000 mg/L).

Based on the available data, the water quality and spring flow observations suggest that recent activities (post 2001) at the quarry have had not impacted on the current surrounding environmental values of groundwater.

6.4 Registered groundwater bores

A search of registered groundwater bore users on the Water Management Information System (WMIS) maintained by DELWP for registered bores within 2 km of the WA174 boundary was undertaken by AECOM in 2020, provided in a summary letter dated 26 May 2020 (AECOM, 2020a). This was completed to understand potential changes in the local groundwater use since the last approved development of the quarry in 2005.

At that time, a total of 16 registered groundwater bore users were located within 2 km of the site, with 12 bores registered for stock or domestic consumptive use. A further 4 bores were registered for observation or unknown purposes.

A review of the WMIS via the Visualising Victoria's Groundwater map portal was undertaken in January 2024 for the purposes of updating this report. Table 5 shows the bores which were identified within a 2 km radius.

Table 5 Registered bore (WMIS search January 2024)

WMIS Number	Parish	Depth (m)	Constructed date	Use
114867	NAR-NAR-GOON	103	10/04/1992	
114934	GEMBROOK	65.5	24/10/1992	Domestic and Stock
115444	GEMBROOK	79	12/03/1993	
121918	GEMBROOK	74	24/11/1992	
124394	WORANGA	38.5	20/03/1995	Stock
132497	GEMBROOK	91	10/11/1997	Domestic
84069	NAR-NAR-GOON	55	14/04/1977	
84072	NAR-NAR-GOON	58	23/08/1977	
84073	NAR-NAR-GOON	30.5	25/08/1977	
84074	NAR-NAR-GOON	88	31/08/1977	
84106	NAR-NAR-GOON	14.9	30/04/1990	
WRK057121	Not provided	5	19/05/2010	Observation

WMIS Number	Parish	Depth (m)	Constructed date	Use
WRK057122	Not provided	5	19/05/2010	Observation
WRK057123	Not provided	5	19/05/2010	Observation
WRK082149	Not provided	12	22/10/2014	Observation- In quarry
WRK082152	Not provided	1.5	22/10/2014	Observation- In quarry
WRK990207	NAR-NAR-GOON	25	Not provided	In quarry

7.0 Summary

The key conclusions of this annual review are as follows:

- MB06 groundwater levels reached the highest elevation since 2015 (177.80 m AHD) in January 2023, due to high rainfall amounts in October and November 2022 and has declined since.
- MB01, MB02 and MB04 showed little variation in water levels over 2023.
- MB03 and MB05 displayed a consistent decrease in water levels, to the lowest levels recorded since monitoring began, in March 2023 (approximately 167 m AHD). Discussions with Holcim (February 2024) indicate that extraction occurred in the western corner of the quarry (Area 2) close to these bores in late 2022/early 2023 which is likely to be the cause of the reduction in water levels.
- Salinity (based on EC levels) of the springs monitored were within historical levels.
- SP01 in the western corner of the quarry (near Area 2 in Plate 1) reported a slight decline in flow (19 m^3/day to 10 m^3/day) as did SP03 (3 m^3/day to 0.3 m^3/day), located slightly further to the north of Area 2.
- SP02, southeast of SP01, has reported significantly increased flow during sampling in January 2024.
- SP04 and SP06 had free standing ponds with audible flow at both springs however any flow was diffuse beneath vegetation and unable to be recorded without extensive soil disturbance.
- SP05 and SP08 observations are in line with the previous year with SP05 being typically dry since 2009 and SP08 flowing in line with previous measurements.
- SP09 and SP10 have been influenced by creation of dams/ wetlands in the vicinity of the springs. These make flow data more susceptible to influence from any surface water runoff from recent rain which is inferred to be the case this year.
- A new spring (SP11) was observed over the course of 2023, but insufficient water to collect parameters was present on the day of surveying.
- The spring monitoring in January 2024 does not show any observable influence based on quarry operations. However, if flow data is to be used to determine influence then further metering would be required to increase confidence in the data set.
- The groundwater monitoring data for MB03 and MB05 indicates that these wells were influenced by extraction from Area 2 in early 2023 but are recovering.
- Based on the available data, the water quality and spring flow observations suggest that activities at the quarry since 2001 have not impacted on the environmental values of groundwater.
- No additional groundwater bore users registered for consumptive uses were identified within 2 km of the quarry since the last approved development of the quarry in 2005 and associated environmental values assessment.

8.0 Recommendations

Based on the 2023 groundwater and spring survey events, the following is recommended:

- Continue monitoring the new spring SP11 in June 2024 and on an annual basis going forward.

- Continue to monitor water levels in the northern and southern pits and update cross section as required.

9.0 References

AECOM, 2023. 2022 Groundwater and Spring Review, Pakenham Quarry, Letter prepared for Holcim (Australia) Pty Ltd

AECOM, 2022. 2021 Groundwater and Spring Review, Pakenham Quarry, Letter prepared for Holcim (Australia) Pty Ltd

AECOM, 2021. 2020 Groundwater and Spring Review, Pakenham Quarry, Letter prepared for Holcim (Australia) Pty Ltd

AECOM, 2020. 2019 Groundwater and Spring Review, Pakenham Quarry, Letter prepared for Holcim (Australia) Pty Ltd

Holcim (Australia) Pty Ltd, 2015. Pakenham Quarry Environmental Management Plan, version 3: August 2015.

URS, 2005. Final Report Mount Shamrock Quarry (Pakenham) Proposed Extension Environment Effects Statement Groundwater. Prepared for Readymix Holdings Ltd.

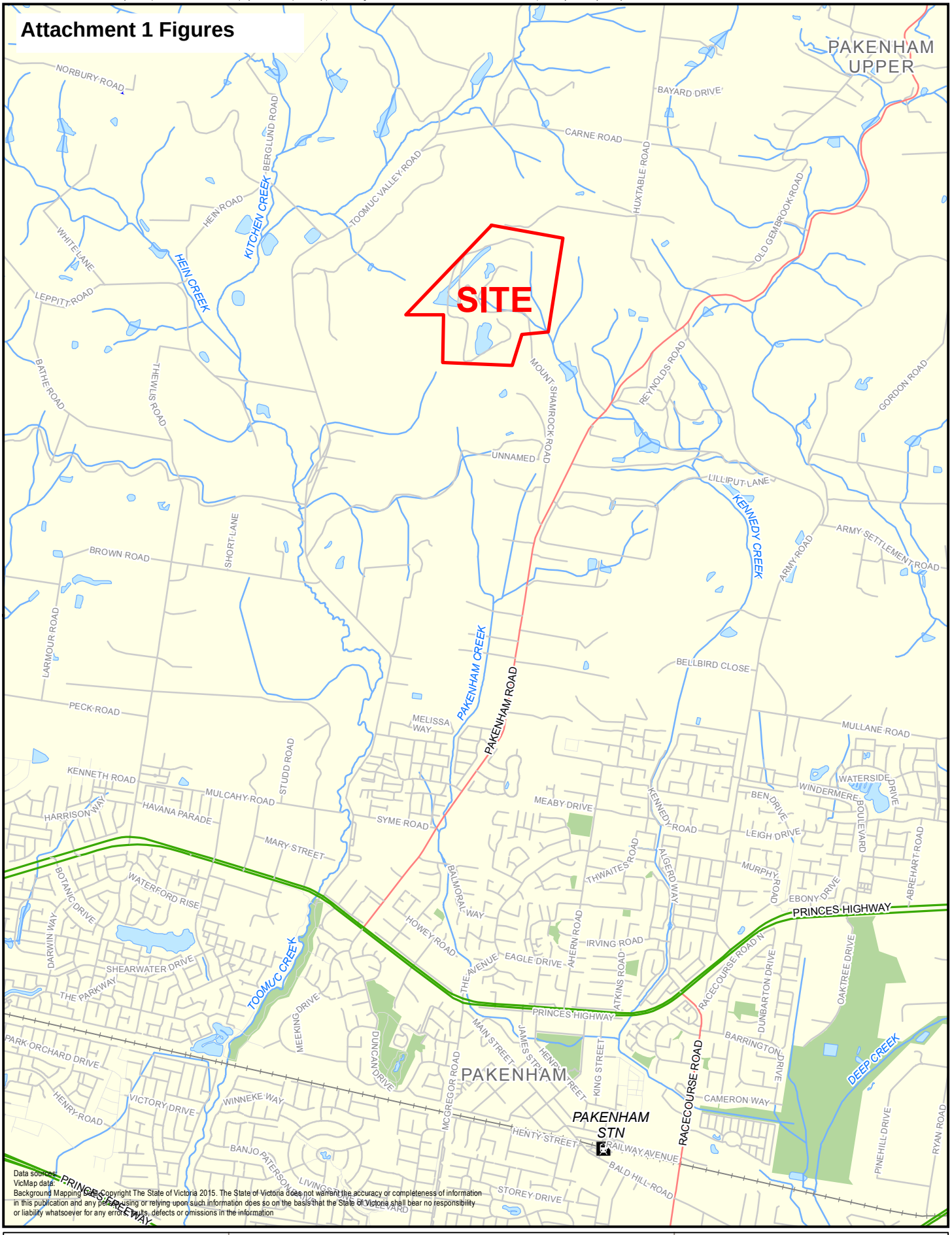
Yours faithfully

Mobile +61 415 381 814

Attachments

Attachment 1	*Figures*
Attachment 2	*Tables (A1- A6)*
Attachment 3	*Charts*
Attachment 4	*Site photographs*

Attachment 1 Figures



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VicMap data:

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LAST MODIFIED T SMITH 05 FEB 2019
AECOM www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 55

0 270 540 810 1,080
metres

1:35,000 when printed at A4

Legend

Site Boundary

SITE LOCATION PLAN

Holcim (Australia) Pty Ltd

Groundwater and Spring Review

Mt Shamrock Road, Pakenham

Figure 1

Map Document: (\\aumel1fp003.au.aecomnet.com\GIS\Jobs\43283833\GIS\MXD\2018 Survey\Figure 1.mxd)

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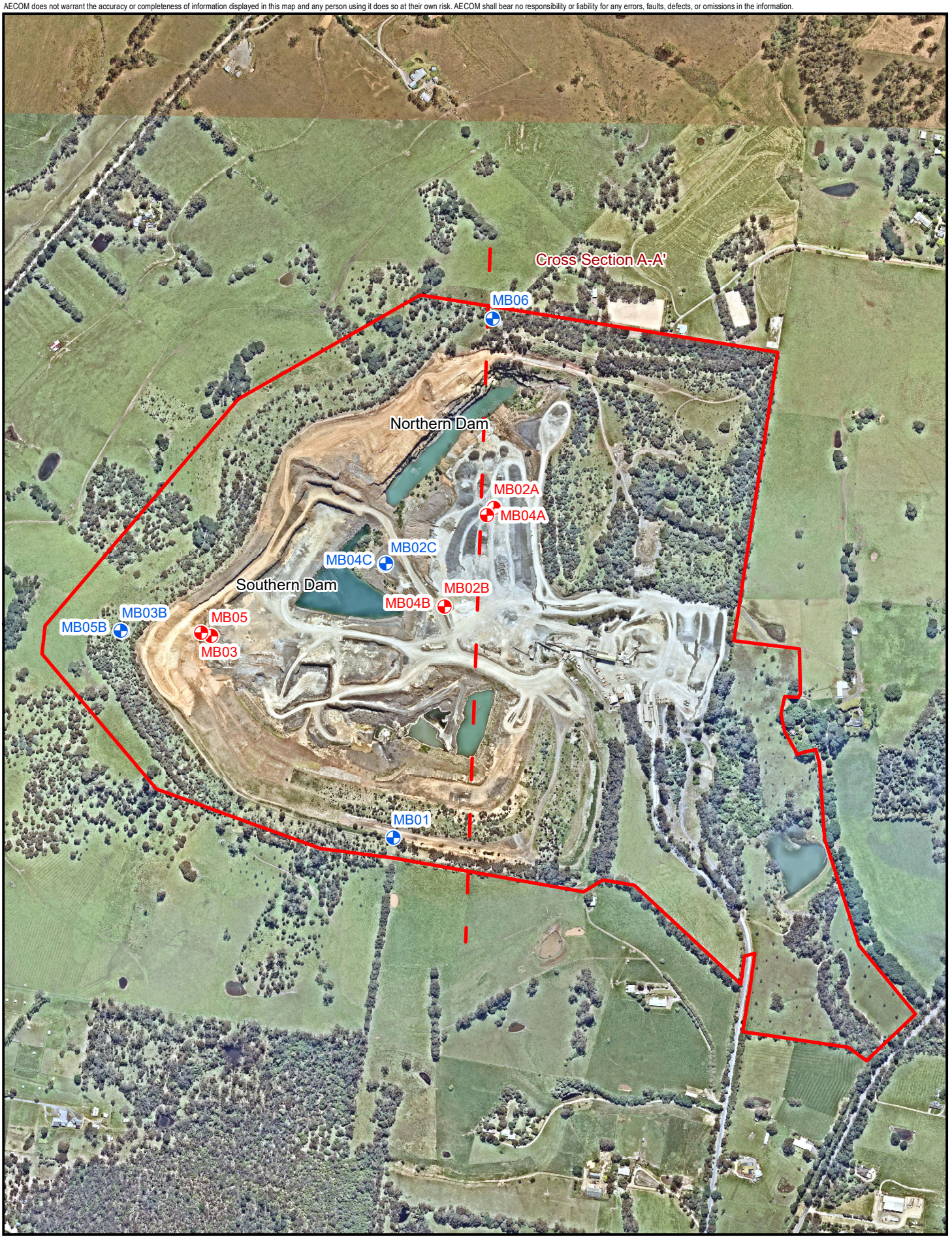

PROJECT ID 60451395
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LAST MODIFIED StuttA 22 FEB 2024

AECOM
www.aecom.com

N

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metres

1:9,249 when printed at A4

Legend

- Monitoring Bore Location
- Monitoring Bore (Decommissioned)
- Mining Tenement WA174

NOTE:
* Location not surveyed- approximate only.

Data sources:
VicMap data:

GROUNDWATER MONITORING LOCATIONS

Holcim (Australia) Pty Ltd

Groundwater and Spring Review

Mt Shamrock Road, Pakenham

Figure 2

Map Document: (L:\Legacy\Projects\L.URS\43283833\5 WIP\Deliverables\Groundwater 2024\GHD Points 7 and 8 Recommendations\GIS\MXD\2024\Figure 2.mxd)

A4 size

PROJECT ID 60451395
CREATED BY DJB
LAST MODIFIED StuttA 31 JAN 2024

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 55

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metres

1:9,200 when printed at A4

Legend

- Spring Location (EC (uS/cm) Jan 2024)
- Mining Tenement WA174

SPRING LOCATIONS AND ELETRICAL CONDUCTIVITY RESULTS

Holcim (Australia) Pty Ltd

Groundwater and Spring Review

Mt Shamrock Road, Pakenham

Figure

3

Map Document: (L:\Legacy\Projects\L.URS\43283833\5 WIP\Deliverables\Groundwater 2024\GHD Points 7 and 8 Recommendations\GIS\MXD\2024\Figure 3.mxd)

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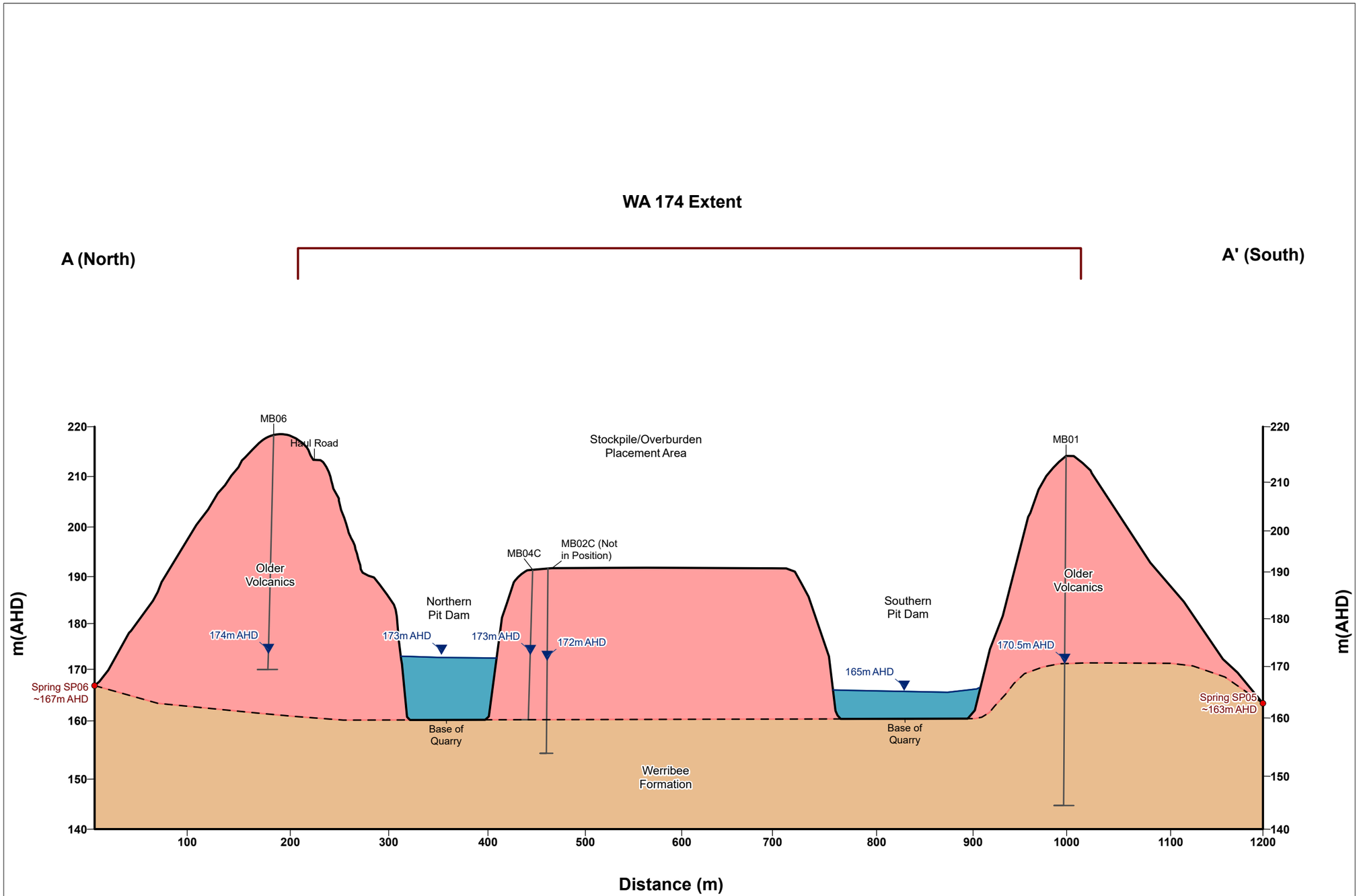
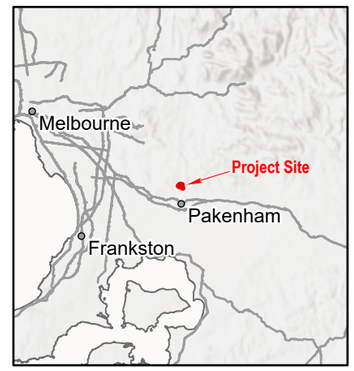


NOT TO SCALE

Legend

- Spring (SP)
- Interface between Tov abd Tw
- Tertiary Older Volcanics (Tov)
- Tertiary Werribee Formation (Fw)



Cross Section A-A1 North - South

Water Levels and Topography Data from January 2024

Client: Holcium Australia
Job: Pakenham Quarry
Job#: 60685659

Horizontal Scale 1 : 5,000
Vertical Scale 1 : 1,100

Attachment 2 Tables

Table A1
Current Monitoring Bore Network

Well ID	Installation Date	Top of Well Casing mAHD [1]	Eastings (AMG)	Northings (AMG)	Top of Well Screen mbgl	Top of Well Screen mAHD	Bottom of Well Screen mbgl	Bottom of Well Screen mAHD	Aquifer	Status
MB01	7-Mar-01	216.518	366135.13	5789516	67	149.54	72.5	144.04	WERRIBEE FORMATION	Operational
MB2a	13-Mar-09				14		17		WERRIBEE FORMATION	Destroyed
MB02b	22-Oct-14	174.64	366344.3	5790135.03	8.8	165.84	11.8	162.84	WERRIBEE FORMATION	Decomissioned
MB02c	17-Jan-17	191.68	366232.07	5790211.78	33.77	157.91	36.77	154.91	WERRIBEE FORMATION	Operational
MB03	6-Mar-01	229.69	365817.18	5789879.64	71	158.69	77	152.69	WERRIBEE FORMATION	Destroyed
MB03b	24-Oct-14	209.9	365739.25	5790087.04	49	160.9	52	157.9	WERRIBEE FORMATION	Operational
MB04a	13-Mar-09				8.7		11.7		OLDER VOLCANICS	Destroyed
MB04b	22-Oct-14	174.7	366342.72	5790133.59	1	173.7	1.5	173.2	OLDER VOLCANICS	Decomissioned
MB04c	17-Jan-17	191.84	366233.33	5790213.41	30.4	161.44	30.9	160.94	OLDER VOLCANICS	Operational
MB05	6-Mar-01	229.84	365820.83	5789879.07	51	178.84	57	172.84	OLDER VOLCANICS	Decomissioned
MB05b	27-Oct-14	209.55	365736.94	5790087.88	40	169.55	46	163.55	OLDER VOLCANICS	Operational
MB06	13-Mar-01	219.84	366321.06	5790488.4	44	175.56	50	169.56	OLDER VOLCANICS	Operational

mAHD meters above Australian Height Datum
AMG Australian Map Grid

Table A2
Historic Groundwater Elevation Monitoring Data

Date	MB01 (Werribee)- Relative Water Level mAHD	MB02, MB2a, MB2b, Mb2c (Werribee)- Relative Water Level mAHD	MB03, MB3b (Werribee) - Relative Water Level mAHD	MB04, MB4a, MB4b, MB4c (Older Volcanics)- Relative Water Level mAHD	MB05, MB05b (Older Volcanics)- Relative Water Level mAHD	MB06 (Older Volcanics)- Relative Water Level mAHD
30/3/01	175.84	163.35	180.16	163.55	183.76	177.84
6/4/01		163.35		163.39		
7/5/01	175.75	163.63	180.26	163.56	183.55	177.21
24/5/01	175.94	163.67	180.40	163.55	183.46	177.00
31/5/01	175.92	163.62	180.32	163.57	183.36	176.87
7/6/01	175.96	163.63	180.33	163.50	183.34	176.87
14/6/01	176.04	163.70	180.32	163.75	183.30	176.77
21/6/01	176.01	163.87	180.25	163.68	183.23	176.78
28/6/01	175.95	163.75	180.18	163.51	183.04	176.62
5/7/01	176.00	163.73	180.23	163.48	183.13	176.61
12/7/01	175.96	163.73	180.14	163.59	183.02	176.56
19/7/01	175.95	163.75	180.11	163.56	182.95	176.52
26/7/01	175.95	163.74	5789879.07	163.45	182.87	176.54
2/8/01	175.93	163.76	180.02	163.63	182.85	176.52
9/8/01	175.94	163.75	180.05	163.48	182.84	176.46
16/8/01	175.91	163.57	180.00	163.45	182.75	176.51
23/8/01	175.86	163.85	179.94	163.77	182.68	176.33
30/8/01	175.86	163.78	179.91	163.60	182.60	176.38
6/9/01	175.74	163.82	179.94	163.53	182.53	176.38
13/9/01	175.91	163.89	179.82	163.53	182.55	176.36
20/9/01	175.89	163.87	179.75	163.46	182.50	176.51
27/9/01	175.89	163.75	179.70	163.54	182.55	176.56
4/10/01	175.89	163.64	179.78	163.53	182.65	176.68
11/10/01	175.93	163.63	179.80	163.55	182.69	176.78
18/10/2001	175.94	163.60	179.82	163.60	182.75	176.79
25/10/2001	175.95	163.66	179.82	163.61	182.79	176.80
1/11/2001	175.93	163.99	179.75	163.55	182.77	176.74
8/11/2001	175.93	163.92	179.72	163.53	182.76	176.71
15/11/2001	175.93	163.95	179.70	163.57	182.73	176.69
22/11/2001	175.98	164.00	179.74	163.50	182.78	176.70
30/11/2001	176.03	163.89	179.74	163.44	182.77	176.71
7/12/2001	176.00	163.79	179.94	163.58	182.79	176.65
20/12/2001	176.01	163.66	179.63	163.06	182.70	176.67
11/01/2002	176.00	163.47	179.48	163.03	182.56	176.61
18/01/2002	175.99	163.46	179.47	163.03	182.54	176.62
25/01/2002	175.96	163.42	178.99	163.37	182.44	176.50
1/02/2002	175.97	163.41	179.29	163.02	182.41	176.46
11/02/2002	175.94	163.59	179.20	163.43	182.35	176.32
20/02/2002	175.85	163.52	179.17	163.40	182.27	176.29
28/02/2002	175.81	163.32	179.11	163.08	182.14	176.17
11/06/2002	175.61	163.13	178.41	162.54	180.94	
16/10/2002	175.33	163.32	177.60	163.20	179.77	175.02
30/01/2003	175.02	162.79	176.81	162.14	178.77	174.59
27/06/2003	174.54	163.06	175.75	162.65	177.55	174.06
9/07/2003	174.44	163.08	175.54	162.44	177.44	174.00
11/09/2003	174.77	163.40	175.28	162.71	177.06	174.04
1/11/2003		162.93	175.06	162.87	177.10	176.52
27/02/2004	174.64	162.37	175.51	162.66	177.99	175.87
19/05/2004	174.51	162.98	175.90	162.76	178.74	175.01
21/07/2004	175.00	163.55	177.20	162.89	178.85	175.02
3/09/2004	175.22	163.70	176.72	163.11	180.55	176.44
10/11/2004	176.32	163.60	179.57	163.32	187.29	179.90
13/01/2005	177.30	163.49	181.33	162.89	188.74	179.78
20/03/2008	170.70	164.01	174.59	163.46	177.18	172.31
18/07/2008	169.00	164.52	174.04	163.53	176.59	172.35
29/09/2008	171.77	164.62	173.59	163.53	174.92	172.26
22/12/2008	173.10	Bore Destroyed	173.29	Bore Destroyed	175.50	171.81
2/04/2009	173.54	MB2a commences	172.59	MB4a commences	174.14	171.56
18/06/2009	174.04	*178.60*	172.99	*177.00*	174.84	171.56
18/08/2009	174.94	*178.60*	173.09	*177.70*	174.84	171.56
29/09/2009	175.54	*178.80*	172.99	*178.66*	174.74	171.46
13/12/2009	176.10	*178.84*	173.29	*179.00*	174.94	170.86
11/03/2010	176.05	*179.14*	173.31	*179.15*	173.92	171.44
15/06/2010	176.19	*179.03*	173.35	*179.53*	174.89	171.46
3/08/2010	176.34	*179.31*	173.51	*180.10*	175.02	171.43
25/11/2010	177.34	*180.57*	175.27	*181.58*	178.79	172.36
26/01/2011	177.24	*182.38*	178.07	*181.30*	177.54	173.46
1/03/2011	178.31	*180.40*	176.49	*183.60*	182.49	173.92
14/06/2011	178.25	Bore Destroyed	179.91	Bore Destroyed	184.35	174.85
8/09/2011	176.44		Bore Destroyed		Bore Destroyed	174.76
14/12/2011	173.64					
14/01/2012	173.74					176.56
29/02/2012	174.74					176.28
12/04/2012	175.44					175.81
10/05/2012	175.34					175.66
9/07/2012	174.94					175.83
3/08/2012	172.84					175.81
12/09/2012	174.94					175.86
10/10/2012	175.04					175.96
14/02/2013	175.19					176.06
12/03/2013	175.08					176.30
8/04/2013	175.04					175.81
4/06/2013	174.89					176.06
2/07/2013	174.54					175.81
5/08/2013	172.79					177.91
9/09/2013	175.04					175.81
7/10/2013	175.04					175.81
12/11/2013	172.47					177.41
10/12/2013	174.29					175.44
13/01/2014	175.04					175.91
11/02/2014	175.04					178.11
10/03/2014	176.04					176.96
8/04/2014	174.04					175.32
15/05/2014	174.39					175.46

Table A2
Historic Groundwater Elevation Monitoring Data

Date	MB01 (Werribee)- Relative Water Level mAHD	MB02, MB2a, MB2b, Mb2c (Werribee)- Relative Water Level mAHD	MB03, MB3b (Werribee) - Relative Water Level mAHD	MB04, MB4a, MB4b, MB4c (Older Volcanics)- Relative Water Level mAHD	MB05, MB05b (Older Volcanics)- Relative Water Level mAHD	MB06 (Older Volcanics)- Relative Water Level mAHD
10/06/2014	175.04	MB2b commences	MB3b commences	MB4b commences	MB5b commences	176.23
19/02/2015	No access	No access	170.92	No access	171.28	
28/03/2015	172.51	173.15	170.61	173.09	170.98	174.88
25/05/2015	172.52	173.29	170.17	173.08	170.52	174.34
23/06/2015	172.69	173.29	170.20	173.37	170.56	174.30
23/07/2015	172.46	173.29	170.08	173.21	170.42	174.12
31/08/2015	172.25	173.45	169.92	173.26	170.26	173.84
29/09/2015	172.12	173.48	169.98	173.32	170.32	173.77
30/10/2015	171.86	173.30	170.04	173.20	170.39	173.71
27/11/2015	171.56	173.21	169.92	173.11	170.26	173.59
17/12/2015	171.47	173.10	169.87	173.03	170.22	173.53
26/02/2016	173.23	172.70	169.46	172.85	169.78	173.11
17/06/2016	171.14	173.24	169.22	Dry, bore damaged	169.54	172.78
28/09/2016	171.16	173.24	170.36	172.66	170.79	172.83
15/12/2016	171.22		170.78	172.28	171.21	173.41
16/01/2017		MB02C commences		MB04C commences		
8/05/2017	171.86	172.08	170.10	171.96	170.50	173.29
9/08/2017	171.74	171.62	170.24	171.46	170.69	172.90
9/10/2017	171.49	171.52	170.92	171.26	171.44	171.75
8/12/2017	171.27	171.18	170.69	170.97	171.16	172.61
12/04/2018	170.78	171.32	170.26	170.82	170.70	172.36
3/07/2018	170.04	171.10	170.92	170.89	171.52	172.11
9/10/2018	169.88	171.17	171.71	170.99	172.31	171.95
8/01/2019	169.78	171.24	172.03	171.00	172.57	171.81
5/04/2019	169.35	170.39	170.39	170.30	170.82	171.67
18/07/2019	168.93	170.64	171.58	170.70	172.14	171.38
16/12/2019	169.33	171.69	172.52	171.81	173.04	171.71
31/03/2020	169.39	171.68	172.54	171.94	173.08	171.86
14/08/2020	169.81	172.46	172.01	172.90	172.47	172.67
24/09/2020	169.66	172.30	172.20	172.84	172.59	172.68
30/10/2020	170.89	172.62	172.81	173.24	173.28	174.23
6/11/2020	170.13	172.65	172.99	173.22	173.53	174.35
21/12/2020	170.2	172.36	172.54	172.79	172.99	174.89
10/03/2021	170.36	171.86	171.54	172.21	172.00	174.59
19/04/2021*	169.96	171.76	171.29	172.38	171.7	174.6
25/05/2021*	170.81	171.82	171.27	172.54	171.7	174.3
17/06/2021	170.29	172.01	171.44	172.71	171.92	173.87
28/07/2021*	170.04	172.13	171.35	172.85	171.79	173.71
27/08/2021*	169.96	172.01	171.24	172.69	171.66	173.285
14/09/2021	170.34	172.23	171.48	171.88	172.01	173.29
27/10/2021*	170	172.46	172.3	173.18	172.8	173.52
23/11/2021*	170.30		172.95	173.17	173.50	173.03
20/12/2021	170.89	172.46	172.47	173.06	172.94	173.90
21/01/2022*	170.68	172.07	171.37	172.65	171.70	174.31
21/02/2022*	170.68	171.77	170.78	172.32	171.10	174.44
22/03/2022*	170.58	171.58	170.54	172.16	170.65	173.76
26/04/2022	170.65	171.53	170.28	172.08	170.65	174.29
24/05/2022*	171.07	171.62	170.41	172.21	170.86	174.39
17/06/2022	170.50	171.87	170.50	172.49	170.98	174.22
20/07/2022*	170.49	171.84	170.47	172.66	170.89	174.03
24/08/2022*	170.56	171.98	170.19	172.85	170.45	173.91
12/09/2022	170.52	172.25	170.75	173.09	171.05	173.93
17/10/2022*	170.87	172.31	170.27	173.17	170.55	174.56
23/11/2022*	171.42	172.43	171.55	173.14	171.91	176.33
19/01/2023*	171.97	171.65	169.90	172.71	170.15	177.80
20/02/2023*	171.89	171.29	169.03	172.55	169.36	177.33
23/03/2023	171.65	171.05	167.32	172.36	167.58	176.93
6/04/2023*	172.37	171.20	168.19	172.45	168.39	176.82
18/05/2023*	171.47	171.60	168.49	172.52	168.47	176.16
22/06/2023	171.28	171.87	168.91	172.73	169.03	175.66
13/07/2023*	171.30	171.97	169.33	172.57	169.45	175.49
3/08/2023*	171.21	171.92	169.43	172.83	169.59	175.26
7/09/2023	171.09	171.77	169.42	172.67	169.57	174.91
25/10/2023*	170.97	171.93	169.53	172.84	169.67	174.54
20/11/2023*	170.92	171.88	169.45	172.68	169.62	174.38
13/12/2023	170.97	171.82	169.35	172.54	169.54	174.26
15/01/2024	170.52	172.05	169.32	173.02	169.47	174.10
Highest Elevation (whole dataset)	178.31	182.38	5789879.07	183.60	188.74	179.90
Lowest Elevation (whole dataset)	168.93	162.37	167.32	162.14	167.58	170.86
Highest Elevation since 2015	173.23	173.48	172.99	173.37	173.53	177.80
Lowest Elevation since 2015	168.93	170.39	167.32	170.30	167.58	171.38
Difference	4.30	3.09	5.66	3.07	5.95	6.42

* Additional gauging data provided by Holcim site

Groundwater level gauging was not undertaken between May 2005- January 2008

All bores inside the pit were submerged between June 2011 and February 2012

Bores MB02a and MB04b were not surveyed to relative levels, and therefore relative elevations from gauging data measured between June 2009- March 2011 is based on the TOC elevation collected by

A blockage in MB04a at 6.2mbgl was identified in August 2009, not long after replacement. This is inferred to have impacted the gauging data collected between August 2009- end of 2011, when the bore was

PVC of bores MB02b and MB04b were extended during placement of overburden in mid-2016 by around 12 metres, however were damaged during the extension process and not re-surveyed, hence relative

In May 2022 MB01 levels all updated to 216.54 Mahd

In May 2022 MB06 levels all updated to 219.56 Mahd

Table A3

Annual Rainfall Dandenong (Station 086224) Monthly totals (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1960	null	null	null	null	null	null	null	null	null	60.2	138.4	13.2	null
1961	32.6	42.3	48.4	91.4	72.3	80.5	74.9	106.8	41.3	55.1	26.6	44.5	716.7
1962	54	41.4	21.4	30.2	143.4	75.4	69	94.4	69	106.1	24.8	52.3	781.4
1963	157.6	38.6	47	13.5	91.9	63.1	87.8	66.3	95.1	79.1	38	23.8	801.8
1964	11	112.5	41.4	83.9	76	55.6	90.2	81.9	108.1	111.7	55.6	125.6	953.5
1965	20.3	3	42.1	128.4	58.4	16.9	98.4	87.2	42.9	28.5	74.5	49.3	649.9
1966	50	null	null	null	null	null	null	null	null	null	null	null	null
1967	null	null	27.7	29	56.9	56.9	38.6	104.2	81.4	22.9	45.2	60.3	null
1968	26.7	4.9	18.7	114.5	131.7	83.5	68.2	64.2	47.9	64.8	71.3	72.6	769
1969	37.5	104.1	65	33.2	120	20	65.7	56.1	93.6	24.9	51.8	67.1	739
1970	101.9	16.5	5789879	107.5	126	58.4	62.2	123.4	56.2	58.4	72.2	109.7	1046.2
1971	56	63.2	26.4	83.8	139.8	84.8	41.7	53.4	64.4	133.7	116.9	79.2	943.3
1972	52.3	172.2	14	92.6	52	17.3	64.8	60.8	49.3	null	null	null	null
1973	57.2	198.7	101.1	44.7	74.1	73.2	44.6	76.7	54.0	98.1	60.2	56.1	938.7
1974	54.2	27.0	68.8	119.0	149.6	16.9	97.2	94.8	83.7	74.4	35.0	76.7	897.3
1975	41.2	10.6	55.6	31.6	63.6	54.4	67.6	116.9	109.8	143.4	60.4	47.0	802.1
1976	26.6	9.3	51.8	37.0	27.4	43.6	22.1	71.4	85.9	66.0	89.2	69.4	599.7
1977	46.0	57.3	22.4	88.2	89.0	135.0	80.0	41.7	49.6	41.0	38.5	24.8	713.5
1978	43.4	86.4	45.4	56.0	86.3	28.1	94.8	101.7	90.0	63.4	113.6	131.3	940.4
1979	53.0	47.6	26.2	52.2	92.6	50.0	30.2	84.6	96.7	105.9	27.8	23.9	690.7
1980	46.0	8.2	14.7	88.1	52.8	71.6	64.8	54.2	36.0	116.8	48.6	47.6	649.4
1981	44.6	17.2	63.8	55.6	93.8	91.0	95.4	101.8	28.4	61.8	84.2	44.0	781.6
1982	59.2	14.0	52.2	74.2	73.8	56.3	28.8	24.9	49.8	42.2	12.0	46.0	533.4
1983	48.8	3.6	39.6	46.4	72.0	75.4	67.0	74.6	93.6	92.8	107.4	24.0	745.2
1984	54.0	38.2	89.4	50.4	28.0	41.2	63.2	80.2	130.0	57.6	63.8	48.2	744.2
1985	17.6	6.6	42.0	83.0	58.4	69.8	75.4	82.1	36.8	105.0	73.4	113.6	763.7
1986	35.9	19.0	13.2	66.0	90.6	53.0	106.8	53.2	52.0	81.4	27.4	74.2	672.7
1987	49.6	45.8	68.0	34.4	76.6	76.2	88.6	34.0	45.8	47.4	52.8	72.0	691.2
1988	61.6	16.8	28.6	28.4	78.2	83.8	77.8	58.6	70.8	39.8	111.0	77.4	732.8
1989	45.7	11.8	78.8	91.6	64.6	87.9	70.4	72.3	66.0	120.4	28.8	37.3	775.6
1990	0.8	65.3	24.3	80.0	23.8	68.2	94.4	79.6	62.8	90.0	61.4	26.1	676.7
1991	131.7	0.6	33.0	43.9	28.3	141.0	97.2	79.6	100.5	21.3	33.0	79.0	789.1
1992	33.0	27.4	55.5	64.5	86.8	53.2	44.1	64.5	140.6	92.1	122.4	92.8	876.9
1993	120.8	99.7	42.8	22.1	39.2	81.0	54.4	76.5	153.1	107.2	91.1	160.4	1048.3
1994	52.9	108.1	null	46	41.3	48.8	18.6	30.8	73.2	35.2	65.7	10.8	null
1995	94.2	21.6	93.2	118.3	93.2	101	96.8	60.8	49.6	84	null	47.5	null
1996	98.8	89.2	null	null	null	null	null	null	null	null	null	null	null
2002	51.2	81.8	26.0	60.6	70.6	62.6	39.8	46.2	63.8	47.8	28.8	34.2	613.4
2003	33.0	31.2	70.0	110.2	45.8	38.4	117.4	77.0	59.2	104.4	57.0	49.0	792.6
2004	42.2	22.0	22.6	50.4	51.2	129.8	58.4	91.4	96.0	57.2	163.0	45.4	829.6
2005	30.2	171.8	23.6	34.2	26.6	47.0	45.6	93.0	79.8	52.0	92.2	88.0	784.0
2006	59.6	90.2	26.2	108.0	58.6	18.2	43.8	47.4	31.8	17.4	43.0	58.6	602.8
2007	34.0	11.6	50.8	21.6	62.6	62.6	91.8	40.0	50.6	29.6	76.6	161.6	693.4
2008	17.4	31.6	27.4	33.0	60.4	45.0	66.6	76.2	31.6	26.2	90.6	81.4	587.4
2009	4.6	2.2	51.2	79.4	16.4	36.4	78.8	69.0	113.2	59.0	113.4	45.4	669.0
2010	40.4	27.2	90.8	61.4	65.8	107.6	41.8	101.8	63.6	147.0	121.4	98.2	967.0
2011	113.8	205.4	61.0	77.6	99.1	49.6	69.8	32.6	94.9	91.1	134.8	78.3	1108.0
2012	45.2	69.8	76.6	107.0	110.8	135.6	77.0	**64.8**	73.2	62.1	58.4	57.4	937.9
2013	5.6	73.0	71.4	22.2	68.0	116.0	85.2	95.4	**79.1**	78.3	106.6	69.8	870.6
2014	27.2	24.4	26.0	97.3	52.2	101.7	59.2	48.0	60.4	59.2	73.4	49.8	678.8
2015	51.6	43.0	41.4	62.6	75.0	32.6	85.4	81.7	48.0	20.4	50.4	42.0	634.1
2016	71.0	13.4	32.2	69.0	95.4	88.4	95.6	67.2	86.0	107.2	63.2	65.2	853.8
2017	28.0	92.2	60.0	119.8	42.4	35.0	30.2	81.8	48.4	54.8	30.8	131.8	755.2
2018	86.2	7.5	29.0	21.8	97.2	71.6	63.2	54.2	41.0	54.8	135.4	*94.2*	756.1
2019	*13.4*	*22.6*	*45.6*	23.6	88.8	83.4	81.0	*82.0*	75.6	56.6	75.4	17.4	665.4
2020	*113.6*	123.4	78.6	*192.2*	72.8	55.0	62.4	*97.2*	80.4	115.0	76.6	*69.6*	1136.8
2021	86.4	*21.0*	64.0	*92.2*	*67.4*	*69.4*	*44.8*	*60.1*	*73.6*	*133.0*	*105.0*	*104.0*	920.9
2022	23.2	*6.4*	63.6	*94.2*	*42.6*	*93.5*	*57.0*	*125.1*	*62*	*171.6*	*173.5*	*49.6*	962.3
2023	27.8	36.6	84.8	53.4	78.6	62.1	34.8	38	16.6	88.4	64.1	134.6	719.8

Italics- data not verified

Data from daily rainfall records

Whole period	51.3	50.7	105317.5	68.2	73.2	67.0	67.3	72.9	70.3	74.6	72.6	68.0	788.5
Since 2002	45.7	54.9	51.0	72.4	65.8	70.1	65.0	71.4	64.9	74.2	87.9	73.9	797.2

Table A4
Historic Field Parameters Recorded at Spring Locations

Spring Number	Date	Electrical Conductivity	pH	Redox Potential	Dissolved Oxygen	Temperature	TDS*	Flow rate (m3/day)	Observations
		µS/cm		mV	mg/L	°C	mg/L		
SP01	13-Feb-01	905	7.53	193	-	22.9	588		
	6-Apr-01	1013	6.65	240	1.03	18.4	658		
	7-May-01	1079	7.21	215	5.67	17.2	701		
	15-Jun-01	886	8.21	151	7.11	16.1	576		
	11-Jul-01	994	7.31	194	**	15.8	646		
	13-Aug-01	1104	7.25	189	8.07	17.0	718		
	17-Sep-01	958	7.16	203	5.91	17.0	623		
	4-Oct-01	1048	7.17	230	**	16.0	681		
	20-Nov-01	721	7.06	320	6.07	16.1	469		
	17-Dec-01	1025	########	190	9.78	18.8	666		
	22-Feb-02	1054	7.36	173	5.28	22.7	685		
	12-Jun-02	946	6.88	8	4.68	14.7	615		
	30-Jan-03	1260	7.21	43	5.98	19.7	819		
	27-Jun-03	1127	7.08	208	6.10	10.6	733		
	21-Jul-04	988	7.57	305	**	12.1	642		
	12-Mar-09	1140	7.11	-	-	-	741		Main irrigation spring, flow ~1.2L/min, sampled from tank inlet
	25-Jun-10	1076	7.80	-	-	-	699		Parameters gauged at source, flow ~3 L/min
	28-Mar-12	1049	***	-	-	19.3	682		
	25-Jun-13	947	7.58	79.9	10.39	14.4	616		
	15-May-14	1043	7.60	18	9.3	15.8	678		Clear, moderate flow
	26-Feb-16	1674	6.42	105	0.25	16.6	1088		Clear, water flow into tank ~4L/s. Wheelie bin where water collects was half full of water
	18-Jan-17	1156	7.99	73	4.33	20.3	751		Clear, no odour. Water is collected in wheelie bin prior to discharge.
	9-Oct-17	1120	6.99	167	6.16	14.9	728	2.0	Vegetation in area in very healthy condition, weeds growing over bin lid. Very boggy in area. Water had been extracted from the tank during the morning and therefore it was recharging. Flowing quickly into tank at approximately 250 mL / 10 seconds. Water clear with suspended solids.
	3-Jul-18	1470	7.01	197	5.70	12.3	956	5.0	Vegetation in area in very healthy condition. Very boggy in area. Flowing from Spring via pipe into tank quickly at approximately 250 mL / 4 seconds.
	8-Jan-19	1323	7.38	73.8	6.15	16.1	860		Grey, no odour, medium turbidity, very overgrown
	18-Jul-19	1218	7.44	71	7.15	12.9	792		Clear, low turbidity, no odour, moderate flow into tank.
	16-Dec-19	1200	7.54	37.2	7.37	15.3	780		Thick vegetation. Flowing water in bin.
	6-Nov-20	814	7.26	20.1	5.92	14.6	529		Overgrown. Flowing into bin. Sign at spring reads Spring 3.
	17-Jun-21	908	7.46	28.2	7.4	13.6	590		Overgrown. Water flowing into bin. Fence maintained. Sign reads Spring 3.
	20-Dec-21	755	7.63	23	5.7	14.8	491	9.0	~100mL/s flowing into bin. (8640 L/day)
	17-Jun-22	928	7.62	-26.4	5.94	14.4	603	10.0	113mL/s flowing from spring (9,792 L/day)
	21-Dec-22	753	7.84	12.8	7.88	13.7	489	19.0	Water flowing into bin, losing some water which misses the capture system. Flow rate = 10L/45 secs
	15-Jan-24	724	6.96	230.6	6.96	17.66	471	10.3	Water flowing into bin - losing some water which misses capture system
SP02	13-Feb-01	3240	8.01	166	-	20.8	2106		
	6-Apr-01	3090	7.24	219	0.00	19.4	2009		
	7-May-01	3030	7.78	187	4.18	13.8	1970		
	15-Jun-01	2450	8.66	130	7.39	14.5	1593		
	11-Jul-01	2510	7.95	166	**	12.5	1632		
	13-Aug-01	2650	8.08	202	7.68	14.2	1723		
	17-Sep-01	2600	8.38	135	8.03	16.4	1690		
	4-Oct-01	2480	7.83	168	**	14.7	1612		
	20-Nov-01	2630	8.32	139	6.14	18.1	1710		
	17-Dec-01	2270	7.07	197	6.87	18.0	1476		
	22-Feb-02	2660	7.04	191	2.02	21.9	1729		
	12-Jun-02	1813	7.41	201	4.59	12.0	1178		
	30-Jan-03	4320	7.15	-40	1.28	21.7	2808		
	27-Jun-03	3230	7.63	183	7.68	10.3	2100		
	21-Jul-04	1829	8.20	311	**	9.9	1189		
	12-Mar-09	2990	7.56	-	-	-	1944		Low flow, sample taken from grassy pool / dam
	25-Jun-10	2209	8.15	-	-	-	1436		Low flow, parameters taken from dam
	28-Mar-12	2342	***	-	-	21	1522		
	25-Jun-13	2029	8.09	106.3	11.09	12.5	1319		
	15-May-14	2140	7.65	39	12.8	12.3	1391		No flow
	26-Feb-16	3130	6.41	199	7.34	17.8	2035		Clear-brown, strong flow with potential to break through wall. Water fed through pipes to trough down slope.
	18-Jan-17	2456	7.38	-18	2.26	20.2	1596		Organic odour. Large pond; water levels managed to prevent bund from collapsing.
	9-Oct-17	2405	7.02	52	2.72	15	1563		Difficult to locate due to healthy vegetation and thick cover of duckweed on pond surface. Troughs that are fed by the spring are full. Pond is deep, no flow
	3-Jul-18	2290	6.05	243	5.66	7.8	1489		Deep pond with large amount of duckweed. This Spring directly feeds into trough and a tank. The flow downhill into the tank was approx. 250ml / 3 sec until was reduced the flow to roughly 250ml / 6 sec
	8-Jan-19	2829	7.19	-107	6.11	17.5	1839		Black, organic odour, medium-high turbidity, overgrown
	18-Jul-19	2070	7.46	86.8	6.26	8.4	1346		No flow, brown, low turbidity, no odour
	16-Dec-19	2838	7.24	41.6	4.87	15.5	1845		Thick grass. Standing water within grass. No visible flow.
	6-Nov-20	2143	7.19	52	-	13.1	1393		Overgrown. Standing water.
	17-Jun-21	2259	7.48	-6.8	12.73	8.3	1468		Fenced off, no cattle access evident. Vegetation healthy. Flow on slope above, no overflow observed.
	20-Dec-21	2420	7.33	-3	0.36	14	1573		Thick vegetation. Standing water. No flow observed.
	17-Jun-22	1995	7.6	-55.1	8.93	10.3	1297	2.3	Thick vegetation. Flow measured at tank downhill - 27mL/s (2,333L/day)
	21-Dec-22	2265	7.23	-60.5	0.39	17.6	1472	2.5	Flow rate 5L/171 secs from second trough outflow, thick veg around spring
	15-Jan-24	1892	7.04	215.3	4.27	20.05	1230	15.1	Audible flow, healthy vegetation
SP03	21-Nov-01	540	6.80	242	0.12	18.2	351		
	17-Dec-01	696	7.32	177	5.01	17.9	452		
	22-Feb-02	592	7.38	187	2.38	22.6	385		
	12-Jun-02	696	7.55	192	2.42	12.7	452		
	30-Jan-03	758	8.57	153	6.28	20.7	493		
	27-Jun-03	727	6.85	203	7.82	12.3	473		
	21-Jul-04	713	7.86	295	**	11.9	463		
	12-Mar-09	899	7.16	-	-	-	584		Low flow, degraded/eroded by cattle, organic material
	25-Jun-10	599	7.62	-	-	-	389		Parameters taken from dam below the discharge point
	28-Mar-12	599	***	-	-	11.3	389		
	25-Jun-13	589	7.91	72.1	7.86	12.6	383		
	15-May-14	552	8.50	39.5	4.05	13.9	359		Low flow, cattle prints evident
	26-Feb-16	1022	6.37	84	7.34	17.6	664		Large pool spilling down slope, duckweed, cow hoof imprints, water brown-clear
	18-Jan-17	674	7.88	52	2.55	19.7	438		Large pool, no flow observed. Water pooled in cow hoof prints to half way down slope.
	9-Oct-17	655	6.97	101	7.30	14.5	426		Vegetation and spring both appear very healthy as per last time. Large pool and boggy in area. Cattle trough full so no flow observed.
	3-Jul-18	669	7.8	200	8.31	10.4	435		Large pool and boggy in area. Cattle trough full so no flow observed.
	8-Jan-19	784	7.39	-430	5.10	18.2	510		Black/clear, no odour, low-medium turbidity

Table A4
Historic Field Parameters Recorded at Spring Locations

Spring Number	Date	Electrical Conductivity µS/cm	pH	Redox Potential mV	Dissolved Oxygen mg/L	Temperature °C	TDS* mg/L	Flow rate (m3/day)	Observations
	18-Jul-19	775	7.14	-40.1	1.33	9.8	504		Cow in Springs. No odour, grey, low turbidity
	16-Dec-19	812	7.87	-17.1	2.36	14.5	528		Tall grass and floating vegetation. No flow.
	6-Nov-20	697	7.79	-24.1	-	13.4	453		Standing water. Seeping down slope. Sign reads Spring 4
	17-Jun-21	452	7.46	-25.3	6.20	9.5	294		Bin installed to manage overflow. Some flow into bin.
	20-Dec-21	694	7.98	32.2	8.05	13.5	451		~100mL/s flowing out of bin
	17-Jun-22	662	7.83	-79.4	5.93	12.8	430		Healthy vegetation. Sunken bin leading to only intermittent flow from spring. Unable to gauge during visit but trough filled from spring lower down slope full.
	21-Dec-22	673	7.66	-3.1	4.58	17.6	437	3.0	Flow rate 5L in 142 Secs, healthy veg, flow into bin with some seepage
	15-Jan-24	768	7.51	205.8	1.65	19.31	499	0.3	Water flowing around bin
	17-Dec-01	1206	7.11	196	2.05	17.1	784		
	22-Feb-02	928	7.08	185	3.75	21.8	603		
SP04	12-Jun-02	Could not find any signs of flow, ground wet in this area.							
	30-Jan-03	1359	7.58	145	6.08	18.1	883		
	27-Jun-03	1096	7.89	176	8.07	11.5	712		
	21-Jul-04	1031	8.84	296	**	11.6	670		
SP04(N)	12-Mar-09	1469	7.43	-	-	-	955		Northern discharge point, low to no flow
	12-Mar-09	1342	7.69	-	-	-	872		Southern discharge point, low flow
	25-Jun-10	1080	6.75	-	-	-	702		Low flow, parameters taken from groundwater discharge pooling in hoof impressions
	28-Mar-12	1099	***	-	-	19.5	714		
	25-Jun-13	1414	7.39	15.5	0.00	14.9	919		
	15-May-14	875	7.43	-43	4.05	12.7	569		No measurable flow, stagnant
	26-Feb-16	1078	6.80	97	1.24	17.8	701		Small puddle of water (<30cm^2, and <5cm deep), wet, marshy grass, water clear
	18-Jan-17	1004	7.92	65	4.33	20.3	653		Small puddle; clear, marshy, overgrown and boggy; around 30 cm2 x 5 cm deep.
SP04 (S)	9-Oct-17	1498	6.89	232	3.33	14.5	974		Shallow pool (~5cm) and very boggy in area. Vegetation healthy.
	3-Jul-18	Spring dry. Vegetation healthy.							Dry Spring, vegetation healthy
	8-Jan-19	Spring dry. Vegetation healthy.							Dry
	18-Jul-19	Spring dry. Vegetation healthy.							Dry Spring, vegetation healthy though overgrown
	16-Dec-19	Spring dry. Vegetation healthy.							Slightly damp seep observed.
	6-Nov-20	Spring dry. Vegetation healthy.							Thicker vegetation. Sign reads Spring 3
	17-Jun-21	Unable to be accessed.							
	20-Dec-21	Spring dry. Vegetation healthy.							
	17-Jun-22	Spring dry. Vegetation healthy.							
	21-Dec-22	1232	7	-102	4	18	801		Thick vegetation, clear water, algae, no flow from spring. Audible flow on bank above spring but not visible through vegetation.
	15-Jan-24	1041	6.81	227.4	6.81	19.7	677		Audible flow upslope
	21-Nov-01	434	6.93	107	5.04	16.6	282		
	17-Dec-01	2350	6.92	206	5.24	17.3	1528		
	22-Feb-02	487	6.76	207	1.77	22.0	317		
	12-Jun-02	Could not find any signs of flow, ground wet in this area.							
	30-Jan-03	No obvious water even with digging, but area green							
	27-Jun-03	612	7.85	212	6.01	10.2	398		
	21-Jul-04	280	7.34	280	**	9.9	182		
	12-Mar-09	Could not locate, no obvious flow							
	25-Jun-10	Could not locate, no obvious flow							No flow
	28-Mar-12	Could not find signs of flow							
	25-Jun-13	Could not be located							
	15-May-14	Spring dry							
	26-Feb-16	Spring dry							
SP05	18-Jan-17	No parameters could be taken.							Muddy and minor water pooling in cow hoof prints.
	9-Oct-17	Spring dry							Very boggy in area, no large pool observed. Large boggy area with the only pooling in cattle hoof depressions. Unable to get a large enough pool to take reliable parameters.
	3-Jul-18	Spring dry. Vegetation healthy.							Dry Spring, vegetation healthy
	8-Jan-19	Spring dry. Vegetation healthy.							Dry
	18-Jul-19	Spring dry. Vegetation healthy.							Dry Spring, vegetation healthy though overgrown
	16-Dec-19	Spring dry. Vegetation healthy.							Tall vegetation. No damp ground observed.
	6-Nov-20	Spring dry. Vegetation healthy.							Thicker vegetation. Sign reads Spring 1.
	17-Jun-21	Spring dry. Vegetation healthy.							Vegetation healthy. Sign reads Spring 1.
	20-Dec-21	Spring dry. Vegetation healthy.							Vegetation healthy. Sign reads Spring 1.
	17-Jun-22	Spring dry. Vegetation healthy.							Vegetation healthy. Sign reads Spring 1.
	21-Dec-22	Spring dry. Vegetation healthy.							Vegetation healthy. Confirmed with Holcim that all signs has been fixed
	15-Jan-24	Spring dry. Vegetation healthy.							Spring dry, wet ground, water present on upper bank
	4-Oct-01	574	7.65	174	**	16.5	373		
	21-Nov-01	477	7.19	135	6.39	20.9	310		
	17-Dec-01	638	7.04	195	3.22	21.5	415		
	22-Feb-02	701	7.41	170	2.17	24.3	456		
	30-Jan-03	720	8.01	103	5.75	17.0	468		
	27-Jun-03	785	6.54	234	5.86	10.5	510		
	21-Jul-04	463	8.01	315	**	11.7	301		
	12-Mar-09	No flow							Dry, some subsurface flow assumed
	25-Jun-10	660	7.07	-	-	-	429		
	28-Mar-12	No flow							
	25-Jun-13	388	7.12	51.9	5.30	16.6	252		
	15-May-14	527	7.58	-40.5	13.00	13.6	343		No measurable flow, stagnant
	26-Feb-16	846	6.98	143.0	3.86	22.2	550		Pool of water, 10x5m, duckweed, water clear to moderate turbidity
SP06	18-Jan-17	457	8.29	58	8.70	25.4	297		Pool of water, 10 x 5 m, with duckweed.
	9-Oct-17	Not able to be accessed							
	3-Jul-18	543	7.32	222	8.52	9.8	353		Stagnate water, very boggy and pool approx. 15-20m2 and 0.5 deepest point.
	8-Jan-19	592	8.1	38.7	10.62	22.3	385		Brown, no odour, low-medium turbidity
	18-Jul-19	417.9	7.68	36.1	9.01	9.4	272		Brown, no odour, low turbidity, boggy
	16-Dec-19	437.5	7.88	49.3	7.64	17.5	284		Standing water. Livestock pugging evident.
	6-Nov-20	386	7.67	18.3	-	15	251		Standing water. Livestock pugging evident.
	17-Jun-21	512	7.42	-34.4	4.88	9.5	333		Water light brown. Cows entering water.
	20-Dec-21	668	7.85	-25.3	1.51	16.3	434		Brown water, medium turbidity. No outflow.
	17-Jun-22	444	8.22	-16.6	11.53	12	288		Brown, medium turbidity. Cattle pugging evident. No outflow visible.
	21-Dec-22	474.8	7.52	-67.8	3.7	21.3	309		Light brown, medium turbidity, healthy veg. Standing water with audible slope flow beneath spring, not visible through vegetation.
	15-Jan-24	397	6.55	185.7	3.35	23.5	258.05		Heavily vegetated, ground below spring saturated
	4-Oct-01	758	7.74	166	**	15.4	493		
	21-Nov-01	406	7.05	110	7.03	21.1	264		
	12-Jun-02	627	7.04	218	3.45	13.2	408		
	12-Mar-09	No flow							Dry, some subsurface flow assumed
	25-Jun-10	493	6.14	-	-	-	320		Significant pooling in valley floor

Table A4
Historic Field Parameters Recorded at Spring Locations

Spring Number	Date	Electrical Conductivity	pH	Redox Potential	Dissolved Oxygen	Temperature	TDS*	Flow rate (m3/day)	Observations
		µS/cm		mV	mg/L	°C	mg/L		
SP07	28-Mar-12	831	***	-	-	16.4	540		
	25-Jun-13	251	7.56	98.9	10.55	14.6	163		
	15-May-14	No flow							No flow, very shallow/small ponds, parameters not possible
	26-Feb-16	Dry							
	18-Jan-17	Dry							
	9-Oct-17	Not able to be accessed							
	3-Jul-18	Not able to be accessed							
	8-Jan-19	Not able to be accessed							-
	18-Jul-19	Dry							Dry and no sign of water in valley going towards dam. Large amounts of blackberry plants and some dumped rubbish in valley.
	16-Dec-19	Dry / Not identified							No damp ground observed.
	6-Nov-20	Dry / Not identified							Damp patches. No spring positively identified.
	17-Jun-21	Unable to be accessed.							
	20-Dec-21	Dry / Not identified							
	17-Jun-22	Dry / Not identified							
	21-Dec-22	Reclassified as seep							
SP08	21-Nov-01	1748	7.12	118	4.60	17.9	1136		
	17-Dec-01	642	7.11	194	2.95	19.2	417		
	22-Feb-02	611	7.81	131	7.83	25.2	397		
	12-Jun-02	731	7.36	201	3.61	12.6	475		
	30-Jan-03	880	7.60	122	4.76	18.4	572		
	27-Jun-03	1103	6.73	232	6.98	9.6	717		
	21-Jul-04	572	8.02	323	**	11.7	372		
	12-Mar-09	No flow							Dry, no indication of recent flow
	25-Jun-10	No flow							No flow
	28-Mar-12	706	***	-	-	16.4	459		
	25-Jun-13	457	7.57	100.3	10.42	14.6	297		
	15-May-14	606	7.88	32	13	13	394		No measurable flow, stagnant. Cattle prints evident
	26-Feb-16	1369	6.29	116	4.7	22.1	890		Hoof indentations, area marshy.
	18-Jan-17	675	7.82	64	6.16	25.4			Water pooling in dozens of small locations, with minor flow in parts.
	9-Oct-17	Not able to be accessed							
	3-Jul-18	504	6.62	222	5.76	8.6	328		Large wetland with alot of reeds, clear/orange tinge, water, no odour and suspended solids.
	8-Jan-19	1103	7.79	86.2	6.98	21.7	717		Overgrown, brown/clear, no odour, low-medium turbidity
	18-Jul-19	396.4	7.36	42.1	8.31	10.3	258		Reeds, no odour, low turbidity, clear
	16-Dec-19	631	7.94	46.9	9.61	16.9	410		Standing water in pond. Low flow down slope. Oxidised iron apparent in stream.
	6-Nov-20	655	7.51	-54.7	-	14	426	8.6	Flowing approx 0.1-0.2L/s. Standing water.
	17-Jun-21	692	7.64	-106.3	3.8	6.9	450		Water clear and flowing. Cattle entry to stream evident.
	20-Dec-21	612.5	8.02	60.8	7.75	14.2	398	26.0	Extensive cattle pugging in former channel. Parameters measured over fence in riding club grounds where flowing water (200-300 mL/s) was present
	17-Jun-22	612	8.14	16.4	9.45	12.3	398	9.0	Measured in riding club grounds. Water flowing diffusely, unable to gauge accurately. 100-200 mL/s estimated.
	21-Dec-22	640	8.21	41.5	8.22	14.7	416	9.0	1L/10sec, consistent flow. Healthy vegetation. Recommendation to install means of measuring flow such as v-notch or elevated pipe.
	15-Jan-24	431	6.92	177.5	8.22	14.7	280	13.0	Healthy vegetation, medium turbidity.
SP09	22-Feb-02	229	6.90	198	6.90	23.3	149		
	12-Jun-02	Could not find any signs of flow, ground wet in this area.							
	30-Jan-03	Could not find any signs of flow, area green.							
	27-Jun-03	759	6.40	142	8.23	10.6	493		
	21-Jul-04	909	7.04	254	4.52	8.9	591		
	12-Mar-09	No flow							Dry, subsurface flow assumed
	25-Jun-10	550	6.66	-	-		358		Low to moderate flow with ponding below at the break of slope, parameters from discharge zone
	28-Mar-12	676	***	-	-	20	439		
	25-Jun-13	899	8.56	133.7	10.06	15.9	584		
	15-May-14	1053	6.68	-40	1.7	15.4	684		Very low flow, doesn't now appear to be a spring
	26-Feb-16	1798	6.40	-22	0.26	22.2	1169		Measurement collected at large pond with reeds, clear. Unlikely that the pond is reflective of seepage only. Will be collecting rainfall and run off also.
	18-Jan-17	860	8.36	65	12.23	22.2	559		Large pond. Spring area cannot be observed.
	9-Oct-17	1185	7.33	85	4.44	16.4	770		Former spring 9 is now a small wetland. Wetland full with water. Highest water level observed in the area. Vegetation very healthy and wildlife.
	3-Jul-18	1169	5.16	199	6.47	10.8	760		Small wetland full of water. Vegetation very healthy due to large amount of water
	8-Jan-19	1163	7.63	86.7	6.58	21.5	756		Black/clear, no odour, low-medium turbidity
	18-Jul-19	780	7.53	-8.8	10.24	9.4	507		Large pond, cloudy/grey no-odour, low turbidity
	16-Dec-19	1231	7.59	-2	6.81	18.4	800		Wetland. Reeds and other vegetation healthy.
	6-Nov-20	556	6.96	-2	8.26	14.2	361		Vegetated wetland. Standing water. Sign reads Spring 10
	17-Jun-21	675	7.53	59.7	13.74	8.1	439		Wetland.
	20-Dec-21	957	7.8	55.9	6.32	18.2	622		Wetland.
	17-Jun-22	770	7.72	-119.3	2.33	11.2	501	26.0	Wetland. Reeds and other vegetation healthy. Outflow at pipe measured at 0.311 L/s. Signed has been replaced to read Spring 9
	21-Dec-22	776	8.03	-18	2.67	17.3	504	1.2	2.5L/3min. Thick veg, clear water
	15-Jan-24	457	7.06	205.3	1.28	20.46	297	21.6	Healthy vegetation, many frogs
SP10	19-Apr-02	2819	6.15	260	9.52	17.4	1832		
	12-Jun-02	2640	6.80	230	7.20	10.6	1716		
	30-Jan-03	2292	7.43	43	6.15	24.6	1490		
	27-Jun-03	1167	6.52	137	8.63	10.6	759		
	21-Jul-04	374	7.71	282	9.13	9.2	243		
	12-Mar-09	No flow							Spring dry, sample taken from dam fed by spring
	25-Jun-10	790	7.03	-	-	-	514		Low flow, parameters from discharge pooling in cattle hoof impression
	28-Mar-12	1207	***	-	-	19.8	785		
	25-Jun-13	578	7.37	29.8	6.99	11.3	376		
	15-May-14	Spring dry							
	26-Feb-16	1616	6.34	73	8.48	19.7	1050		Hoof indentations with water pooling in them- about 5cm deep, water clear.
	18-Jan-17	Spring dry							Dry- spring area cannot be observed.
	9-Oct-17	Water as per SP09							Boggy area that feeds the wetland at the location of former Spring 9. Vegetation healthy and very wet and boggy. No parameters taken and water only pooled in small amounts and the same water feeds spring 9 wetland.
	3-Jul-18	No parameters could be taken.							Boggy area that feeds the wetland at the location of former Spring 9. Vegetation healthy and very wet and boggy. No parameters taken and water only pooled in small amounts and the same water feeds spring 9 wetland
	8-Jan-19	Spring dry							Dry
	18-Jul-19	Spring dry							Dry. Vegetation healthy
	16-Dec-19	Spring dry							Damp seep in embankment.

Table A4
Historic Field Parameters Recorded at Spring Locations

Spring Number	Date	Electrical Conductivity	pH	Redox Potential	Dissolved Oxygen	Temperature	TDS*	Flow rate (m3/day)	Observations
		µS/cm		mV	mg/L	°C	mg/L		
	6-Nov-20	Spring dry							Damp seep in embankment.
	17-Jun-21	Spring dry							Damp seep in embankment.
	20-Dec-21	Spring dry							Damp seep in embankment.
	17-Jun-22	Spring dry							Damp seep in embankment.
	21-Dec-22	Spring dry							Damp seep in embankment. Reclassified as seep.
SP11	15-Jan-24	-	-	-	-	-	-		Insufficient water to allow parameters to be taken
Max		4320	5789879	323	14	25	2808		
Min		229	5	-430	0	7	149		

* TDS estimated by electrical conductivity x 0.65
**Dissolved Oxygen not recorded as probe malfunctioning
***pH readings not reported due to probe error

Table A5 - Historical groundwater bore development data (ground

BORE ID	DATE	EC (µS/cm)	TDS* (mg/L)
MB04C	18/01/2017	3461	2318.87
MB02C	18/01/2017	2964	1985.88
MB02B	21/10/2014	2017	1351.39
MB04B	23/10/2014	2161	1447.87
MB03B	28/10/2014	1702	1140.34
MB05B	28/10/2014	1806	1210.02

* TDS calculation = EC (uS/cm) X 0.67

Table A6
Water Levels Northern and Southern Dams

Date	Northern Dam	Southern Dam	Difference
October 2020	173	165	8
February 2021	174	165	9
April 2021	173	165	8
June 2021	173	165	8
Sept 2021	173	165	8
Dec 2021	173	165	8
Apr 2022	172	165	7
July 2022	173	165	8
September 2022	173	165	8
December 2022	173	166	6
April 2023	173	166	5789879
June 2023	173	166	7
September 2023	173	166	7
October 2023	173	165	8
November 2023	173	165	8
December 2023	173	165	7
Max	**174**	**166**	**5789879**
Min	**172**	**165**	**6**
Average	173	165	361875

Data provided from Holcim Jan 2024

Attachment 3 Charts

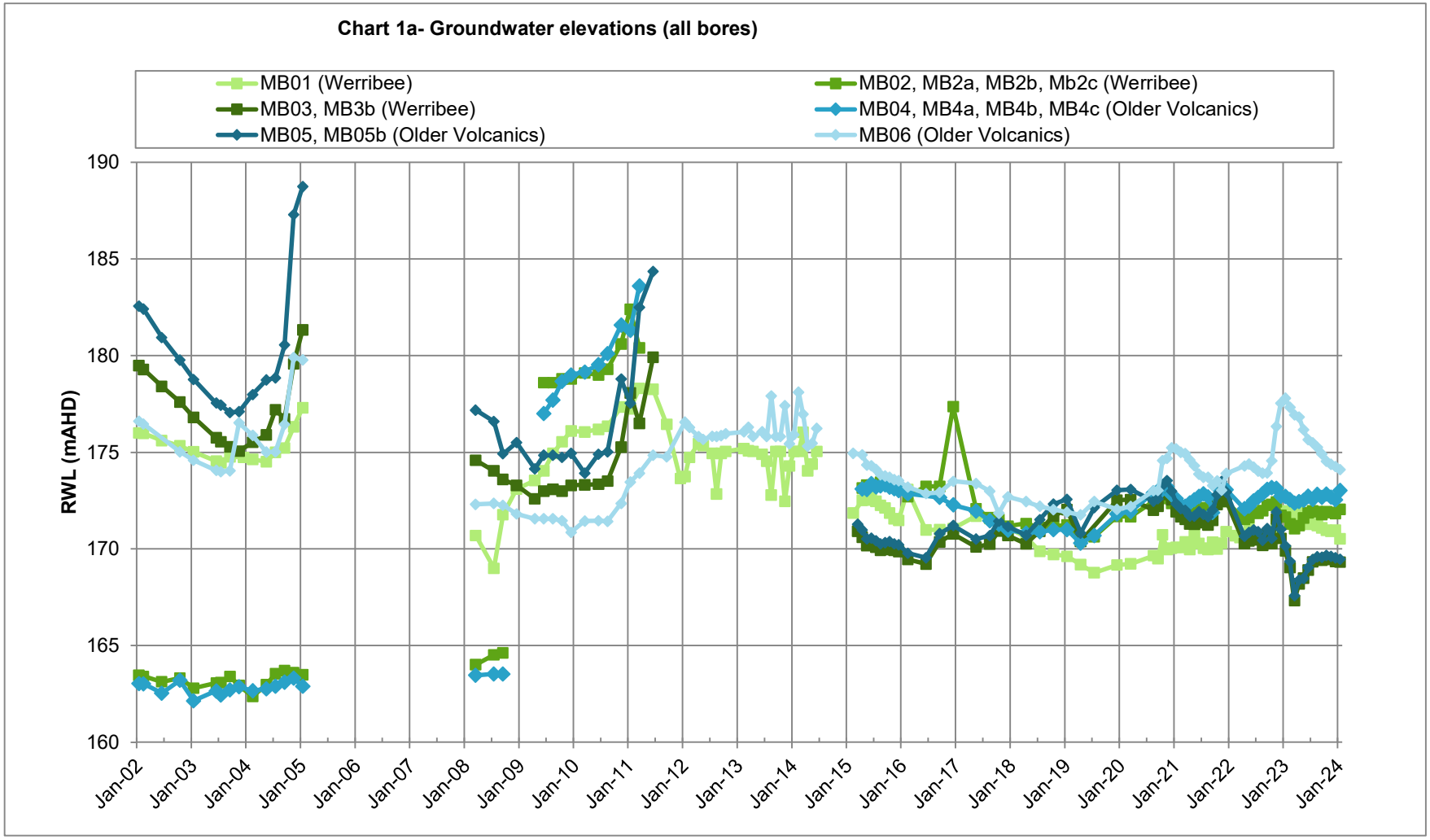


Chart 1b- Groundwater elevations (all bores, 2015 to 2024)

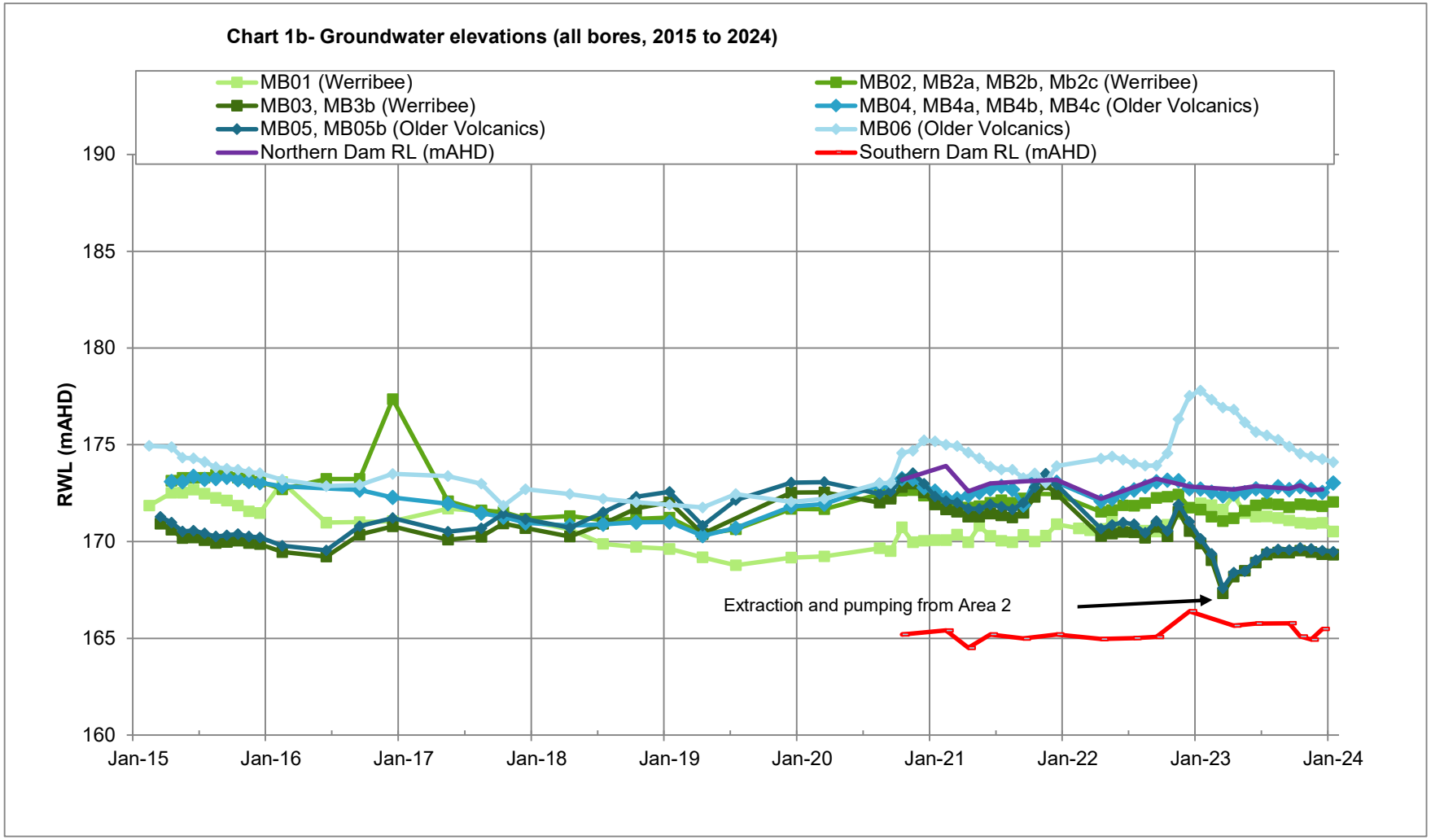


Chart 1c- Groundwater elevations (MB01 and MB06)

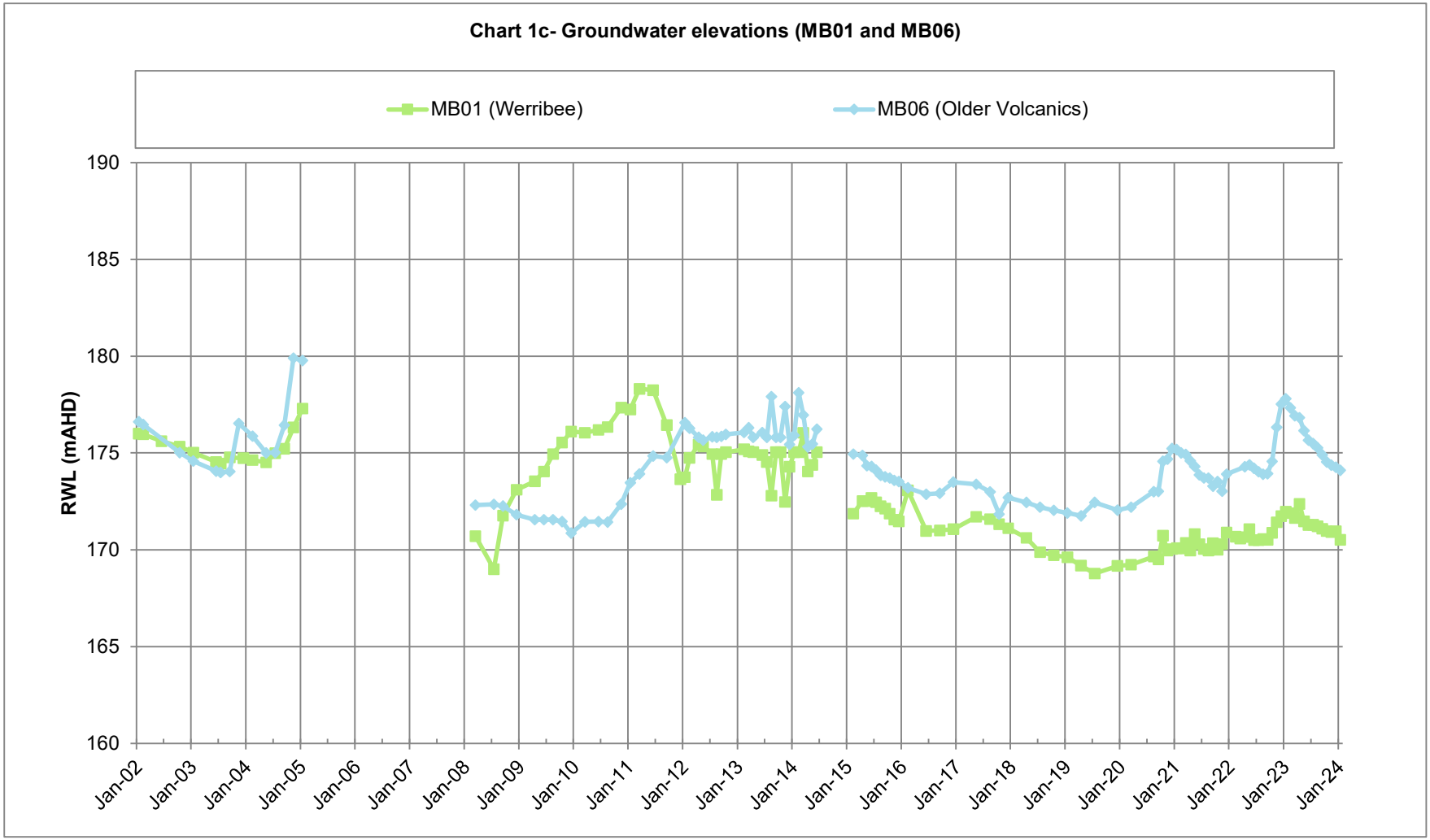


Chart 1d- Groundwater elevations (MB01 and MB06, 2015-2024)

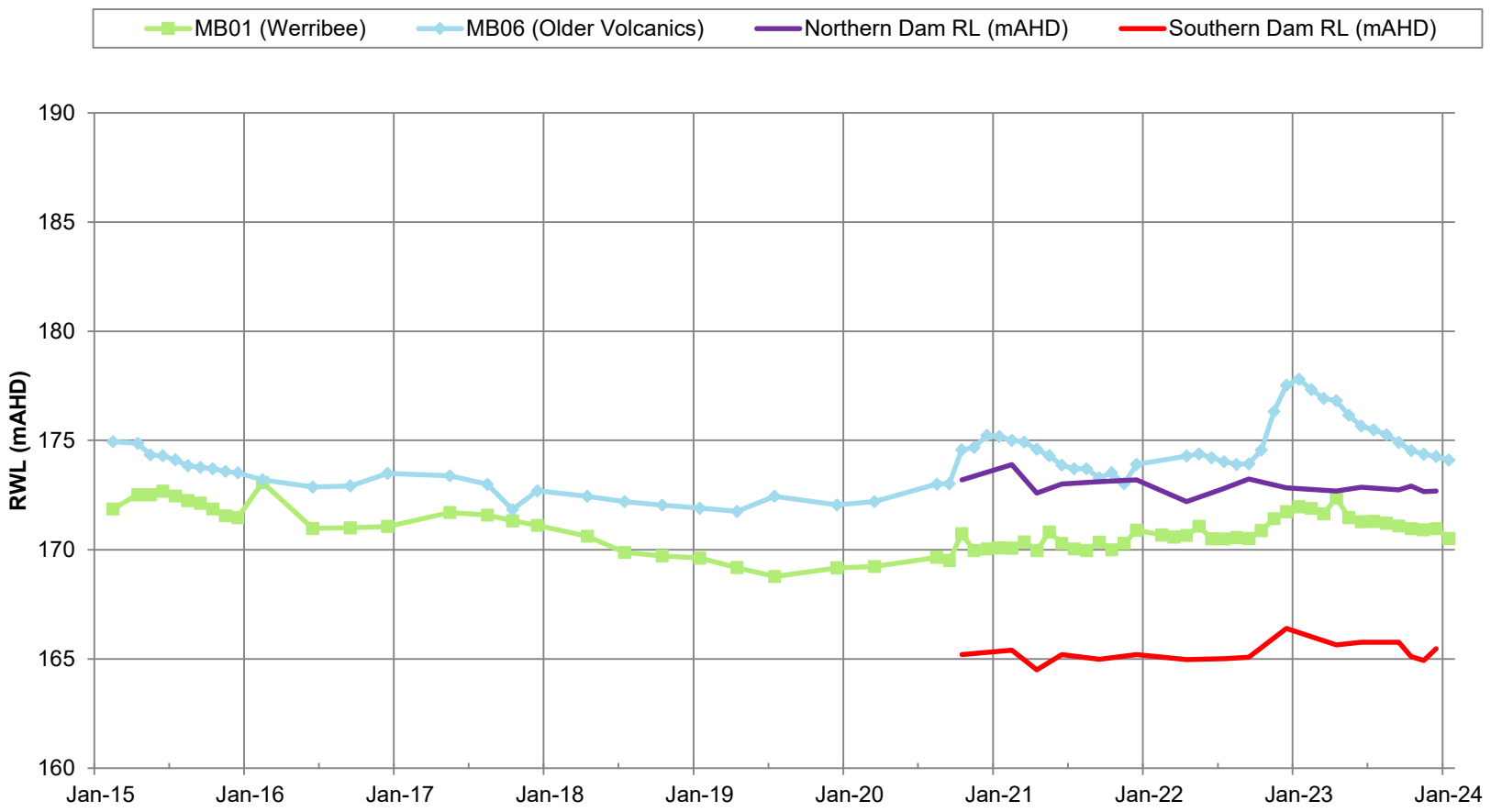


Chart 2a- Groundwater elevations vs. rainfall (all bores)

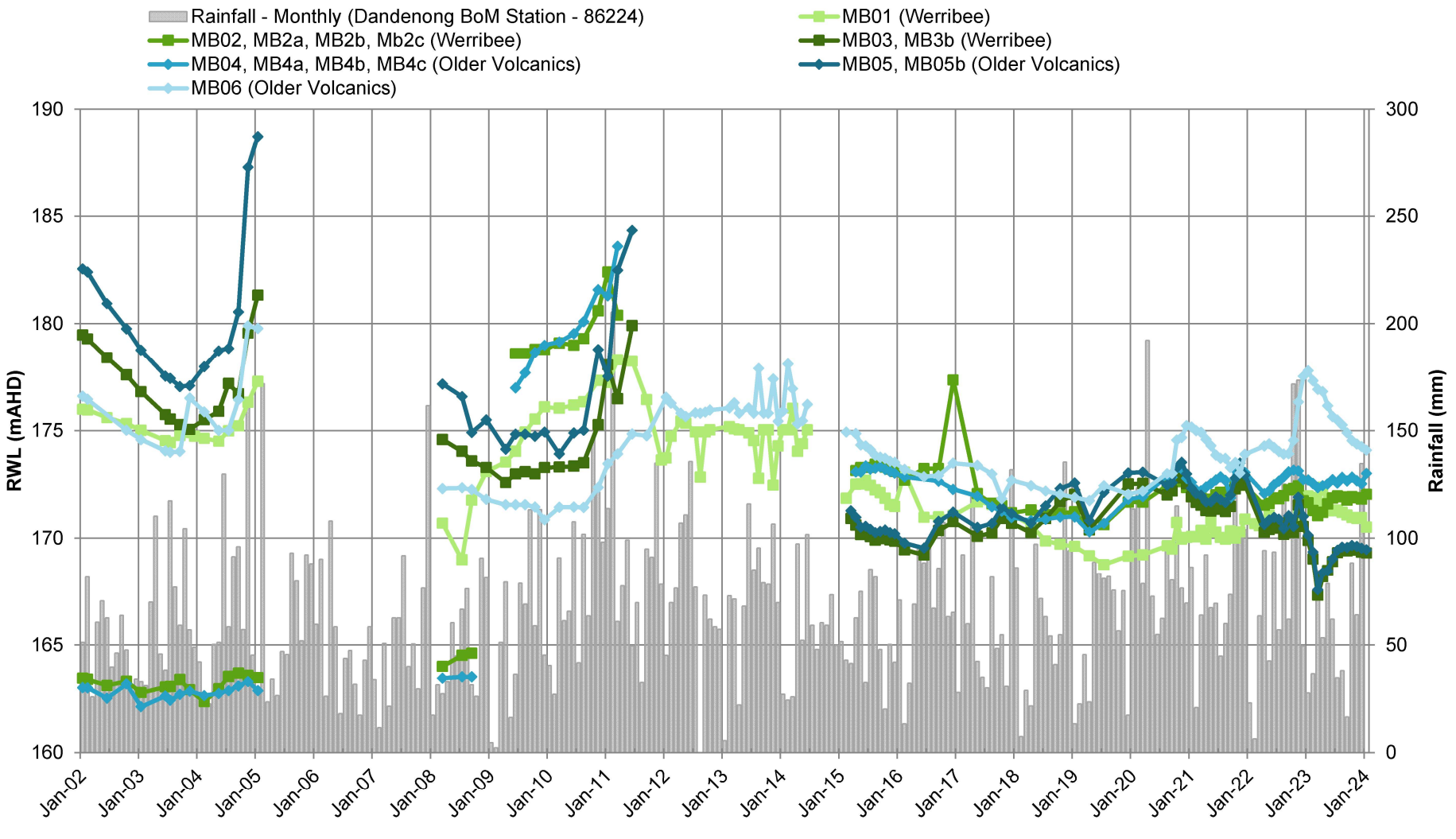


Chart 2b Groundwater elevations vs. rainfall (all bores 2015-2024)

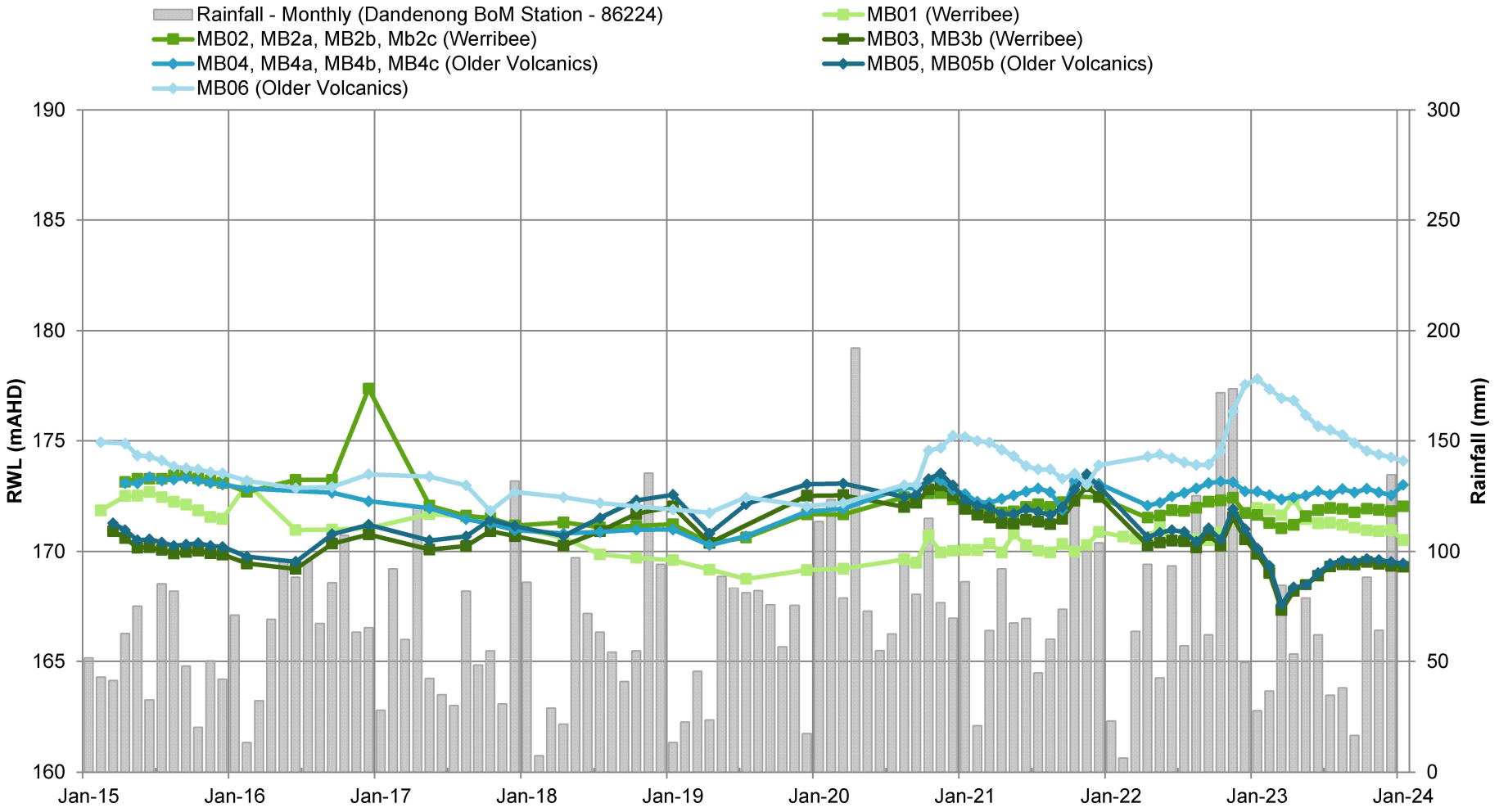


Chart 2c- Groundwater elevation vs. rainfall (MB01 and MB06)

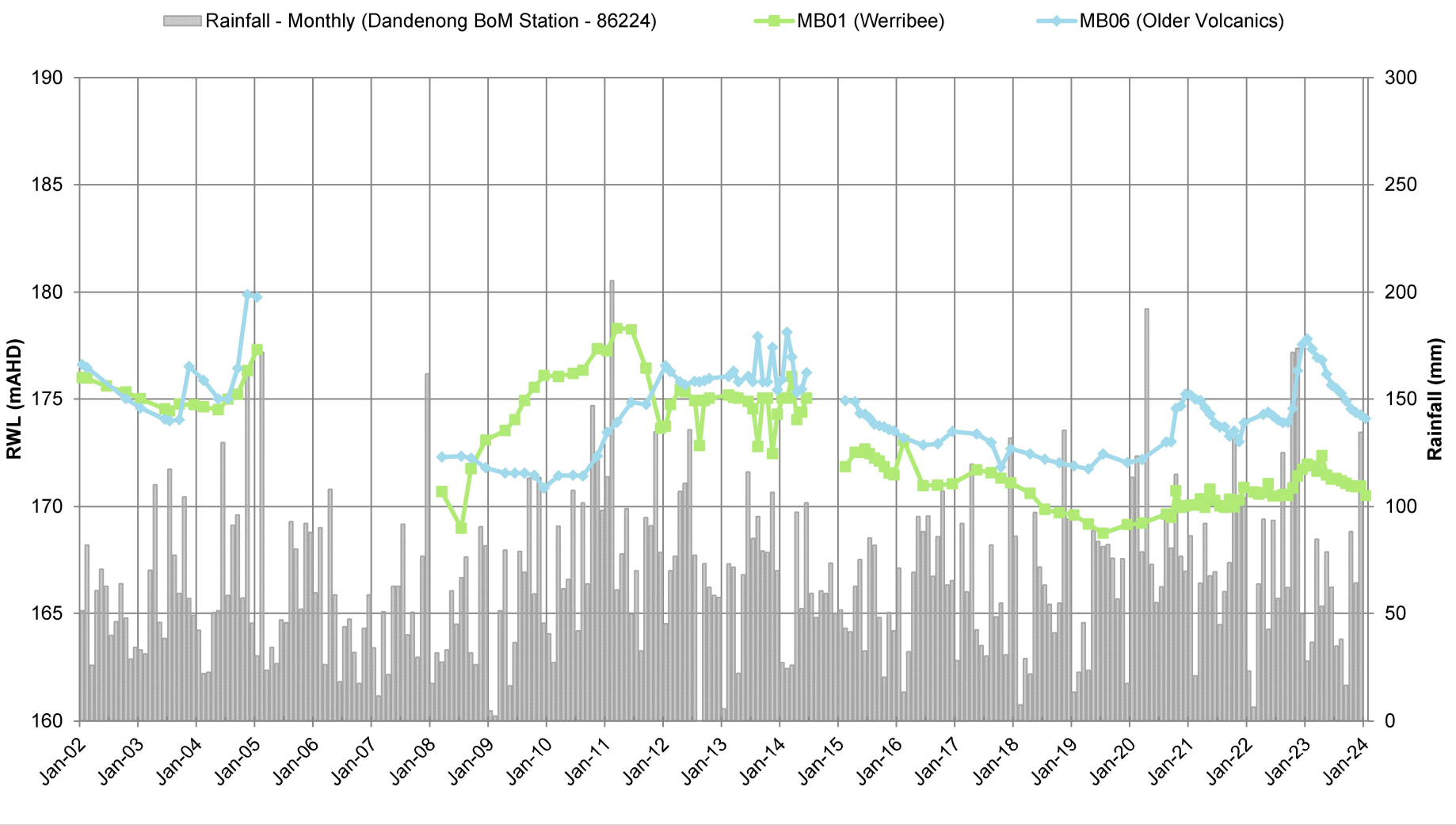


Chart 2d Groundwater elevations vs. rainfall (MB01 and MB06, 2015-2024)

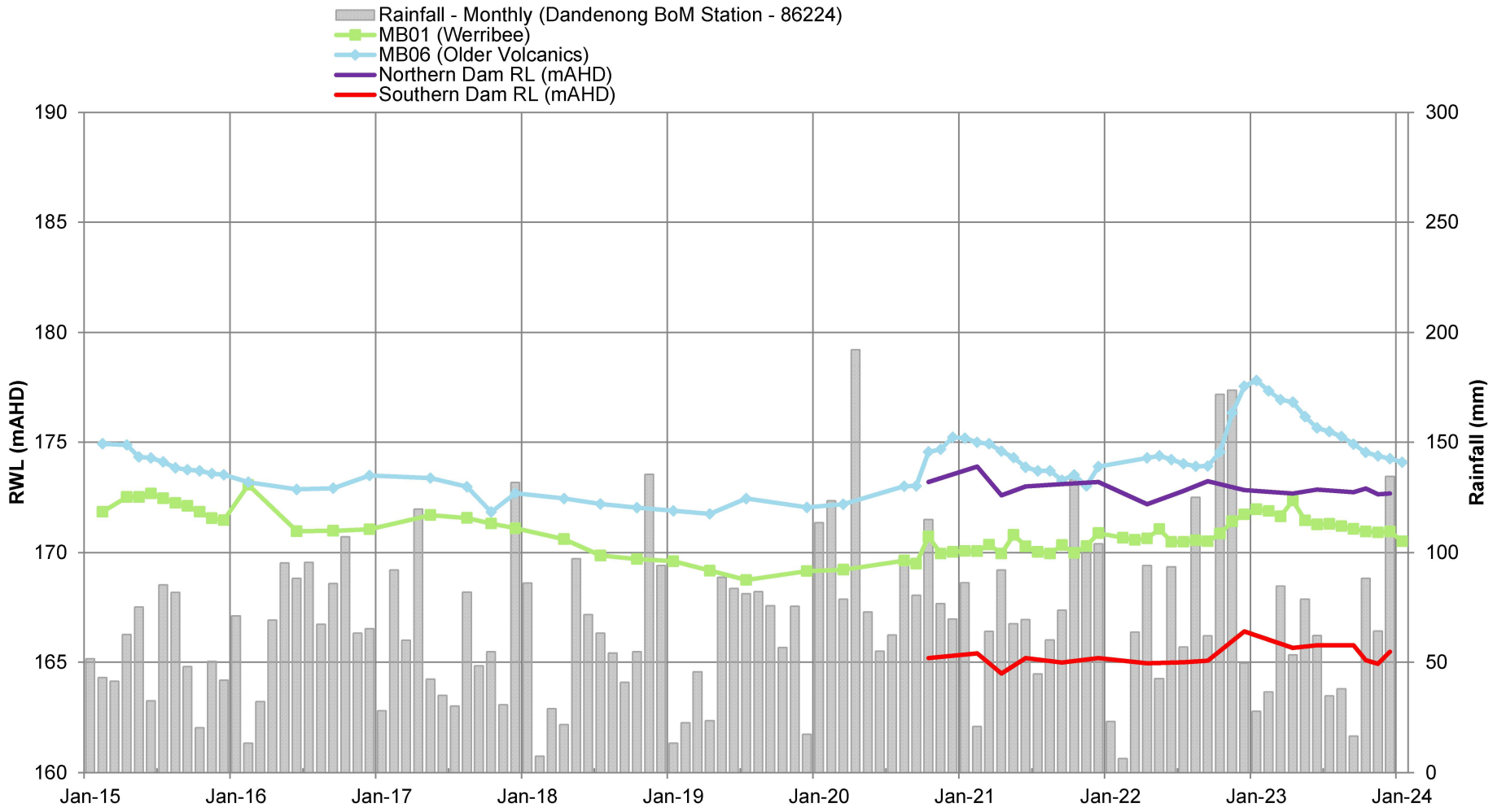


Chart 3a - Groundwater elevations vs. AMRR (all bores)

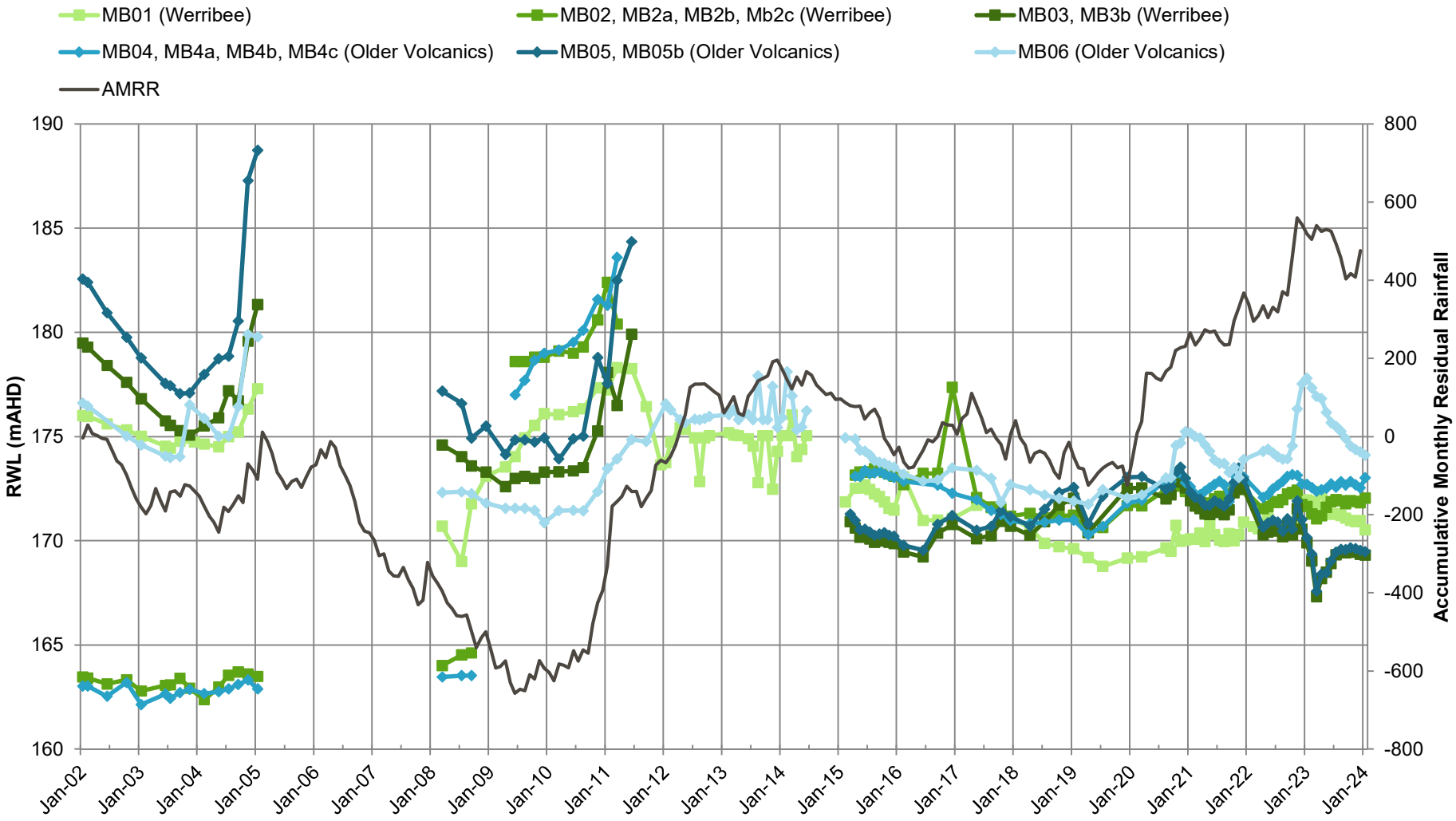


Chart 3b - Groundwater elevations vs. AMRR (MB01 and MB06)

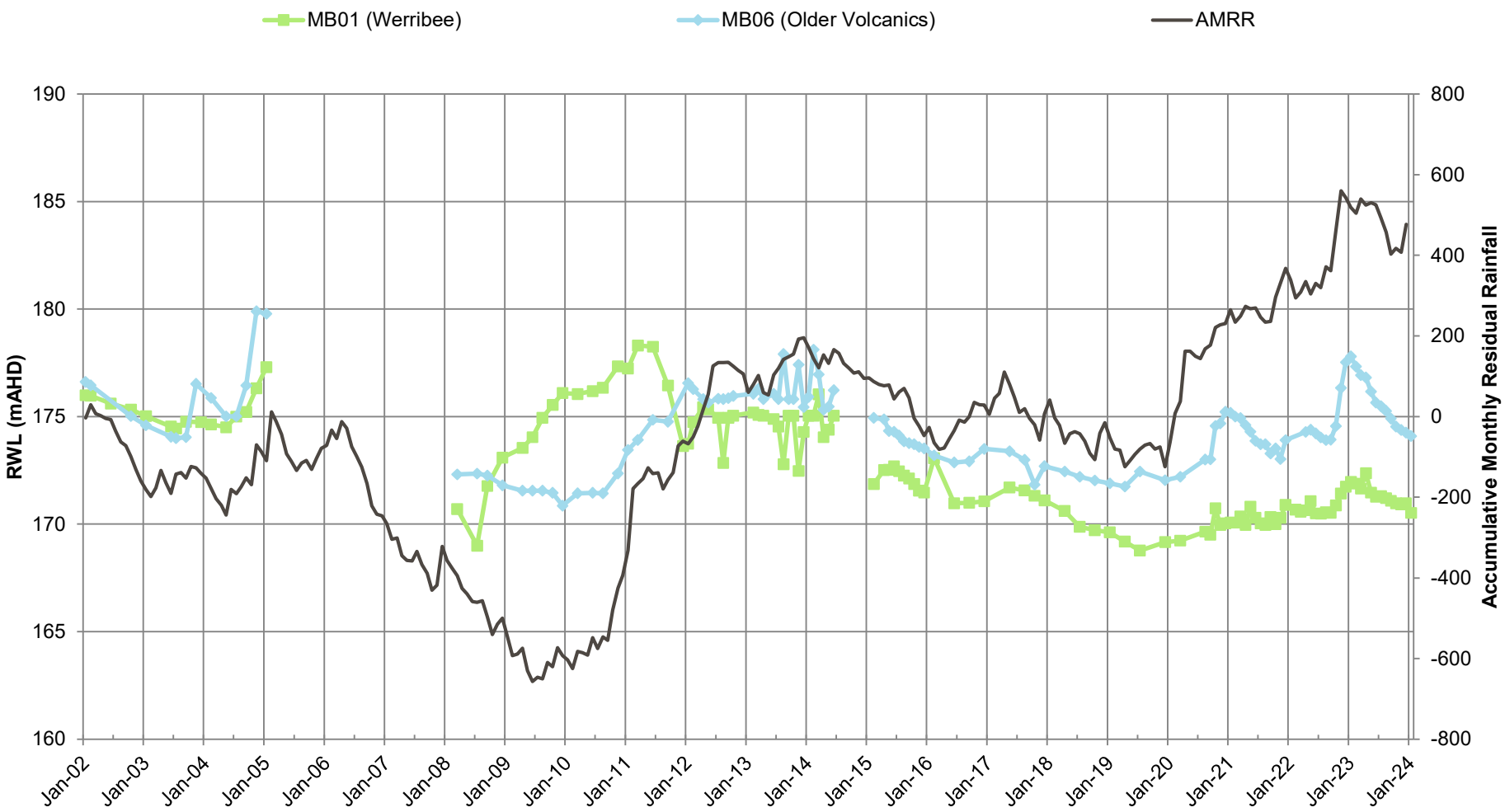


Chart 3c Groundwater elevations vs. AMRR (all bores, 2015 to 2024)

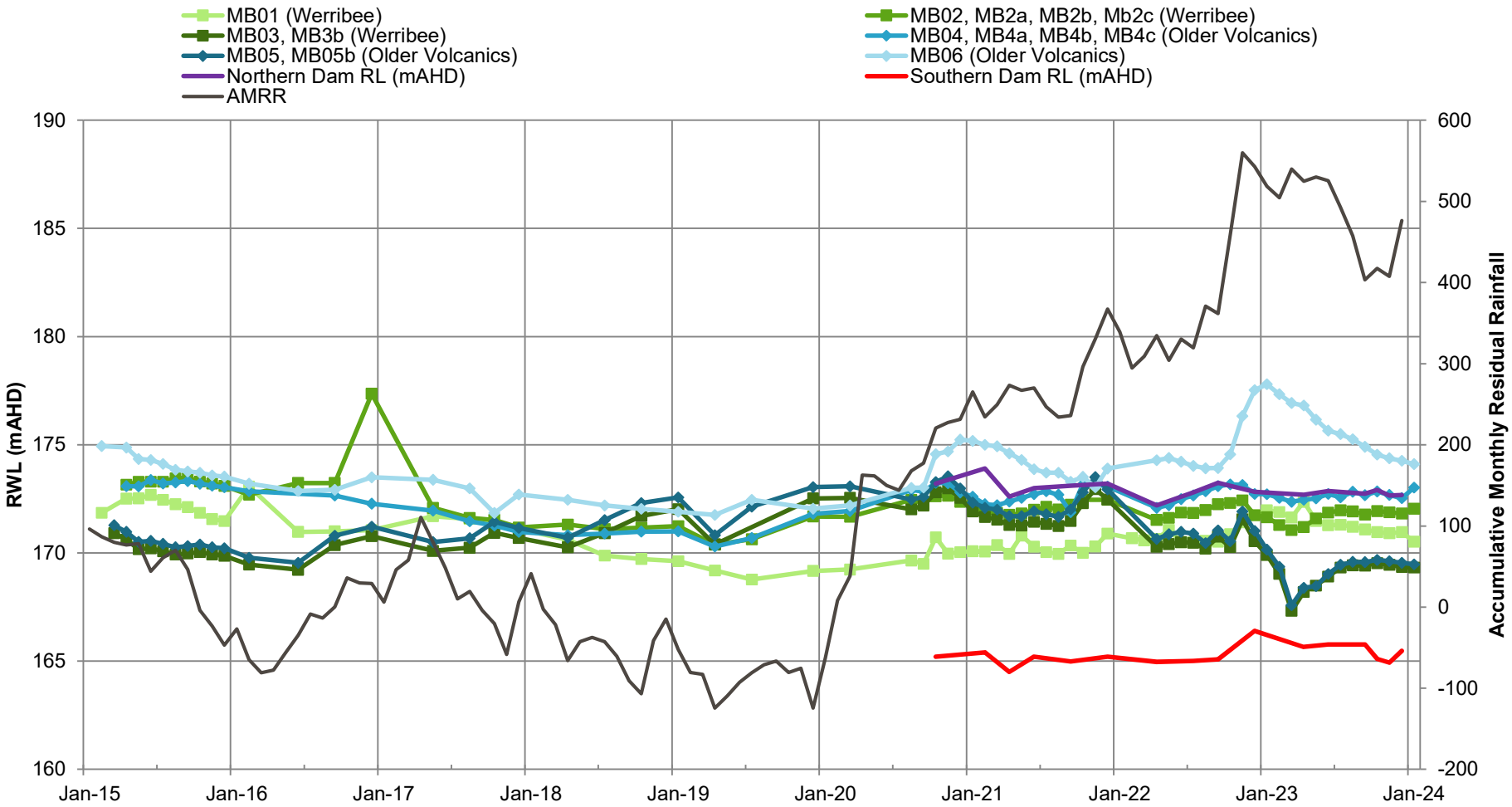


Chart 3d Groundwater elevations vs. AMRR (MB01 and MB06, 2020 to 2024)

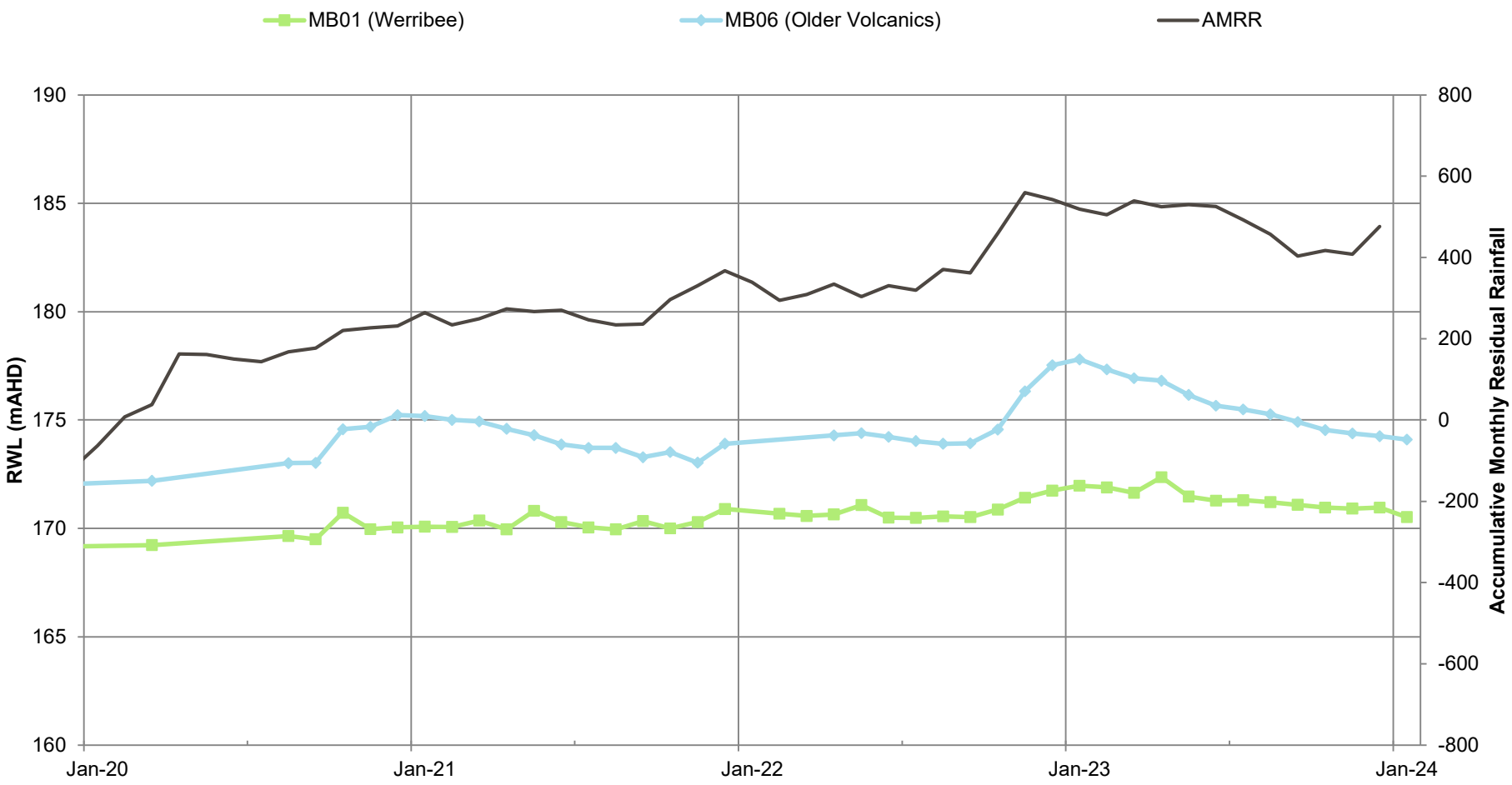
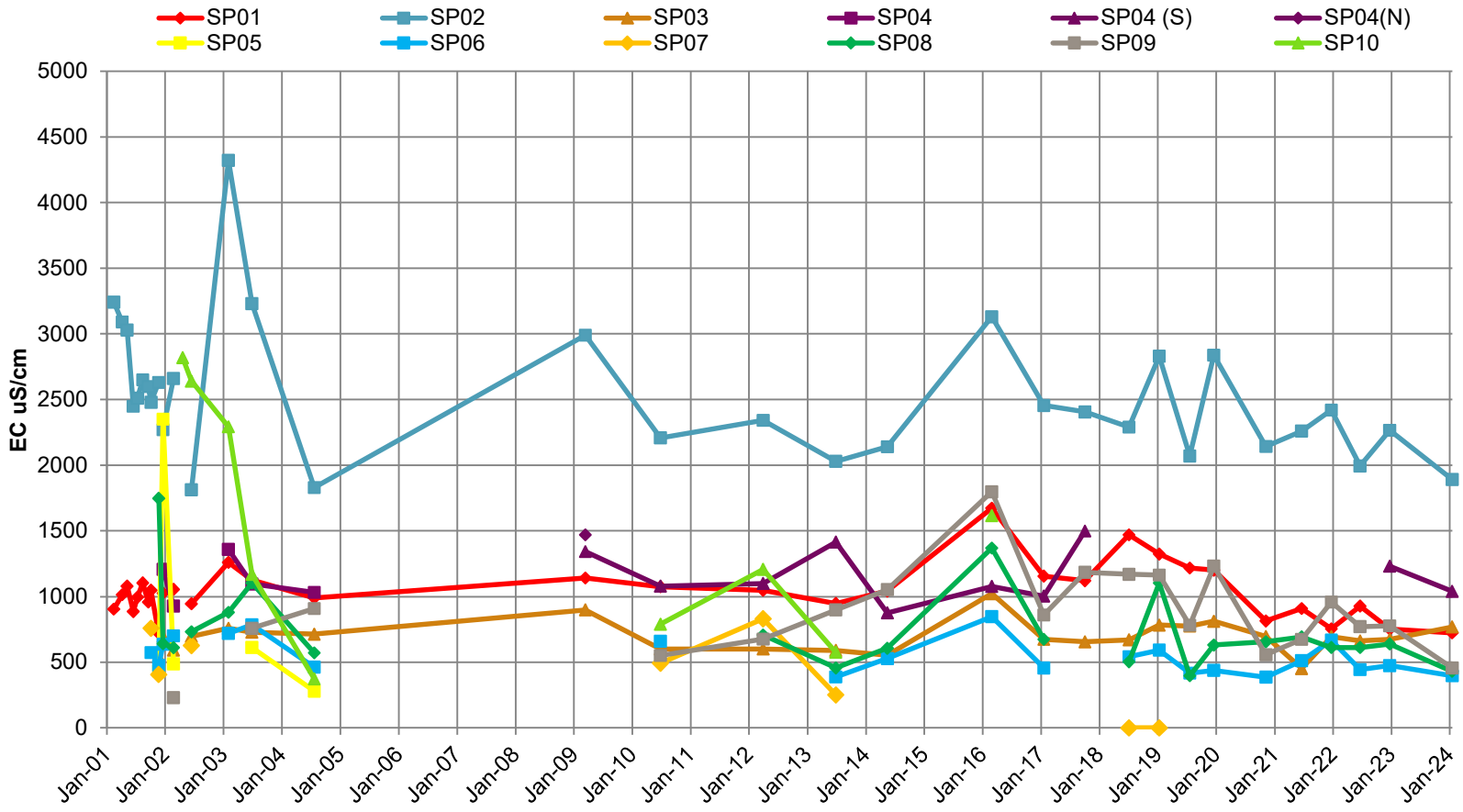


Chart 4- Spring EC Measurements



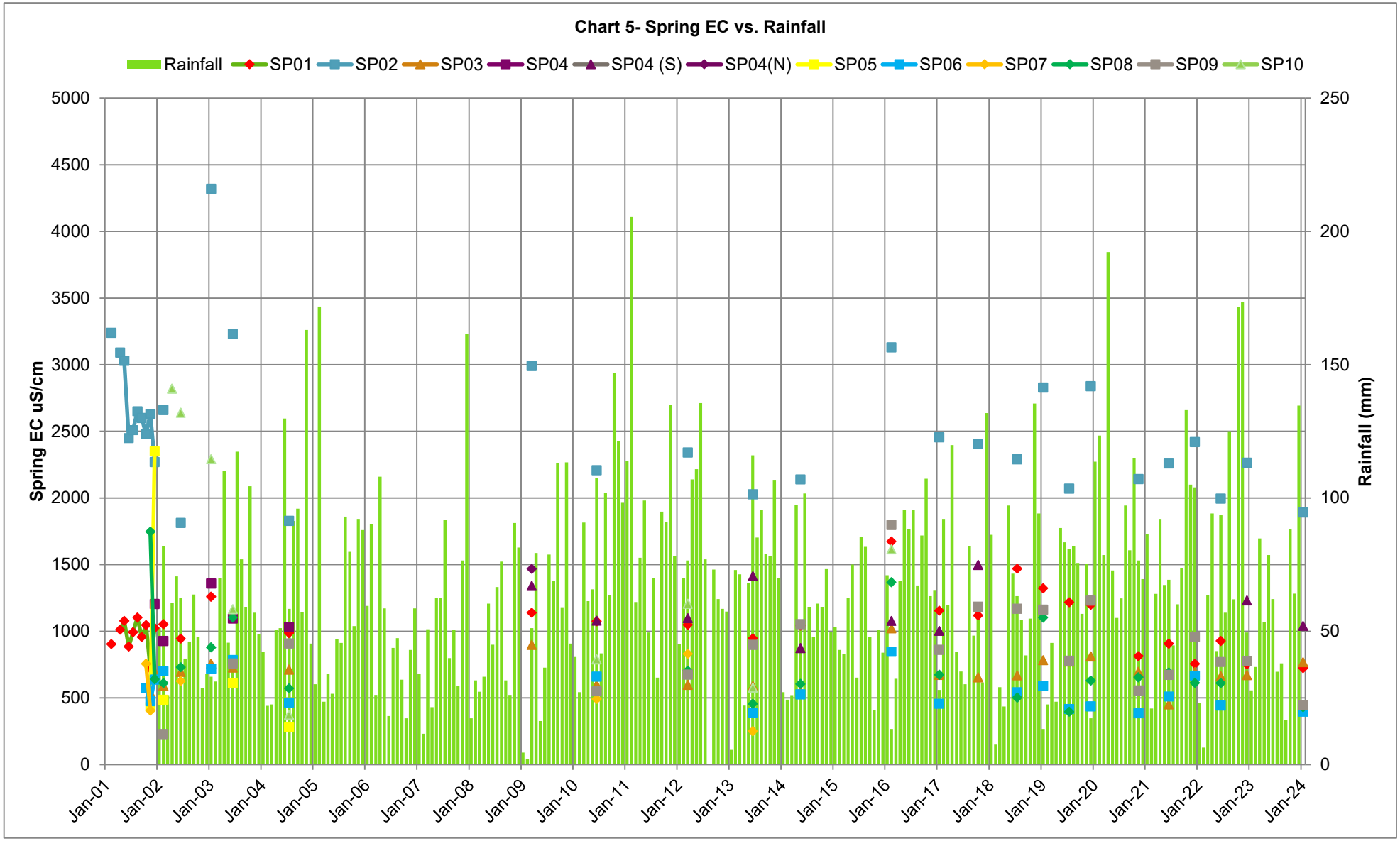


Chart 5- Spring EC vs. Rainfall
Rainfall
SP01
SP02
SP03
SP04
SP04 (S)
SP04(N)
SP05
SP06
SP07
SP08
SP09
SP10
Spring EC uS/cm
Rainfall (mm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
250
200
150
100
50
0
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24

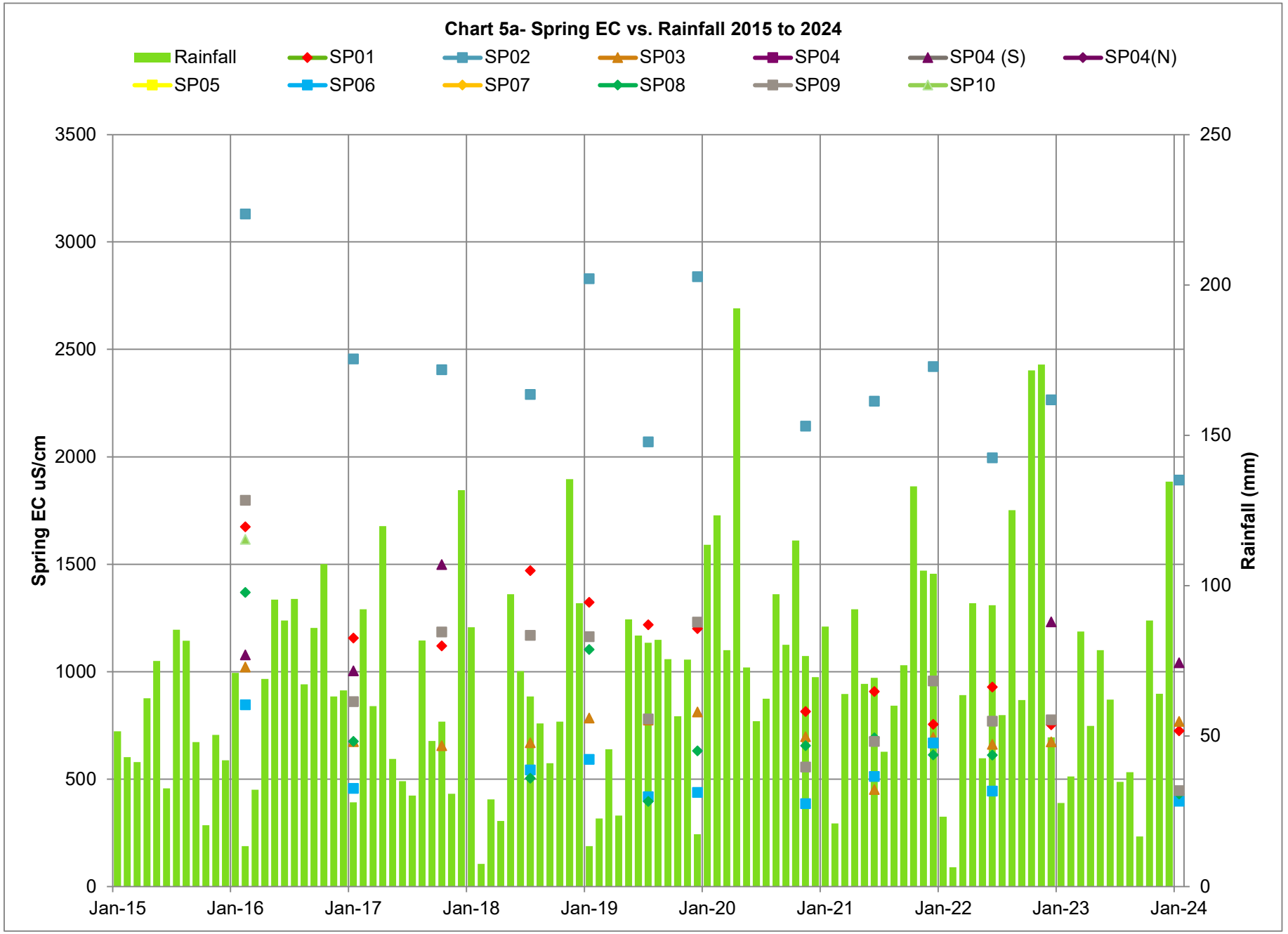


Chart 5a- Spring EC vs. Rainfall 2015 to 2024
Rainfall
SP01
SP02
SP03
SP04
SP04 (S)
SP04(N)
SP05
SP06
SP07
SP08
SP09
SP10
Spring EC uS/cm
Rainfall (mm)
3500
3000
2500
2000
1500
1000
500
0
250
200
150
100
50
0
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24

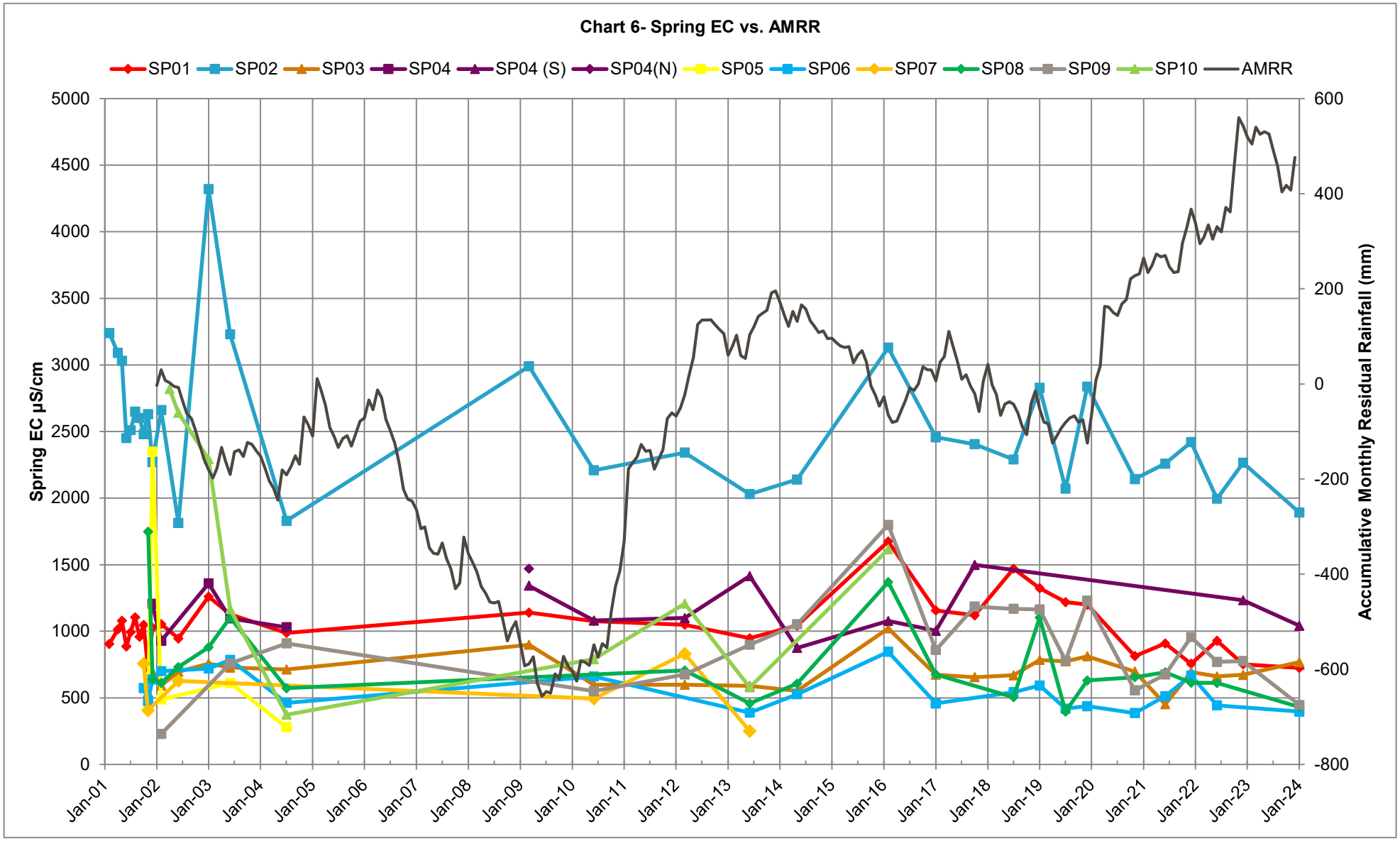


Chart 6- Spring EC vs. AMRR
SP01
SP02
SP03
SP04
SP04 (S)
SP04(N)
SP05
SP06
SP07
SP08
SP09
SP10
AMRR
Spring EC µS/cm
Accumulative Monthly Residual Rainfall (mm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
600
400
200
0
-200
-400
-600
-800
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24

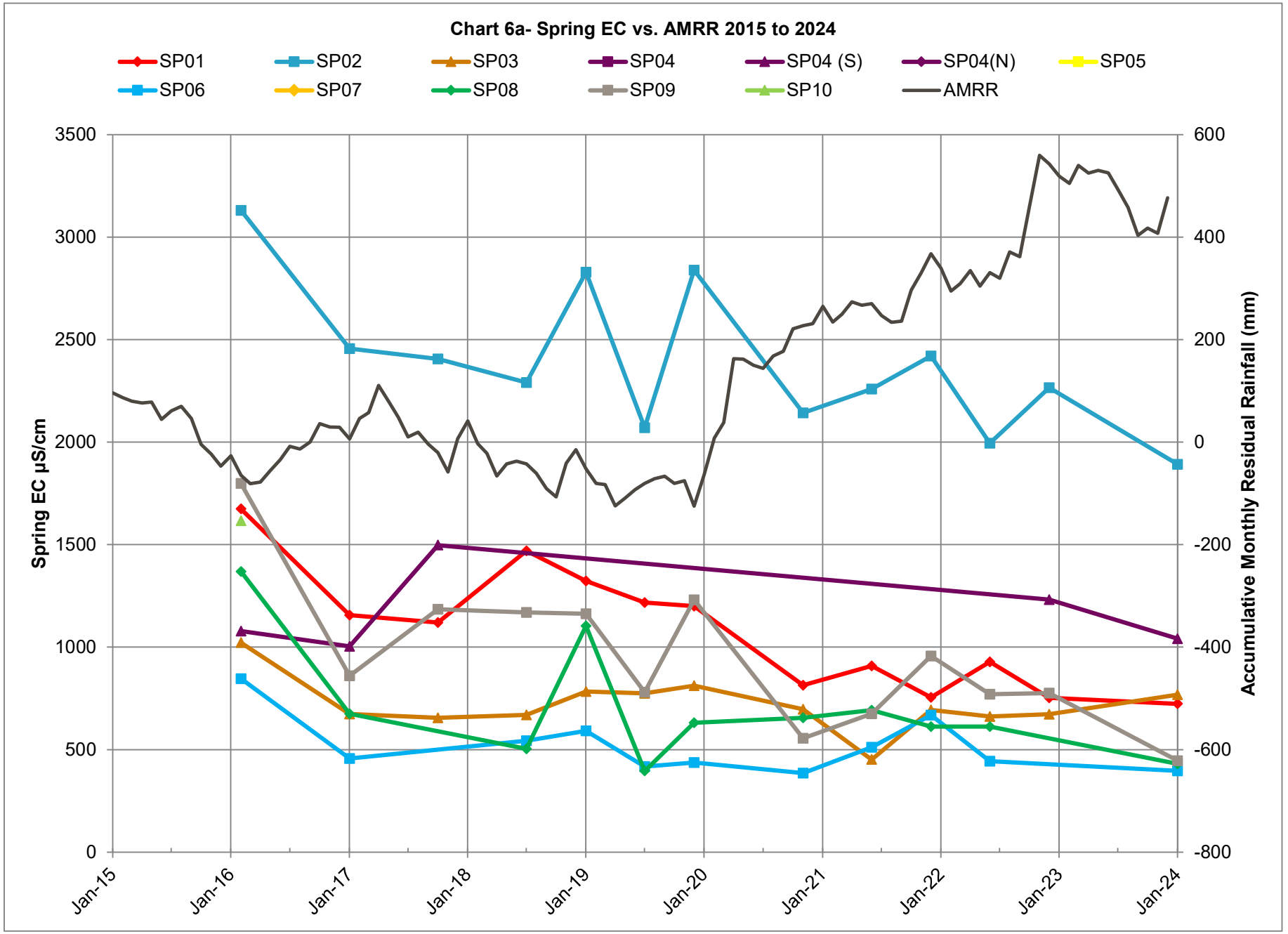


Chart 6a- Spring EC vs. AMRR 2015 to 2024
SP01
SP02
SP03
SP04
SP04 (S)
SP04(N)
SP05
SP06
SP07
SP08
SP09
SP10
AMRR
Spring EC µS/cm
Accumulative Monthly Residual Rainfall (mm)
3500
3000
2500
2000
1500
1000
500
0
600
400
200
0
-200
-400
-600
-800
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24

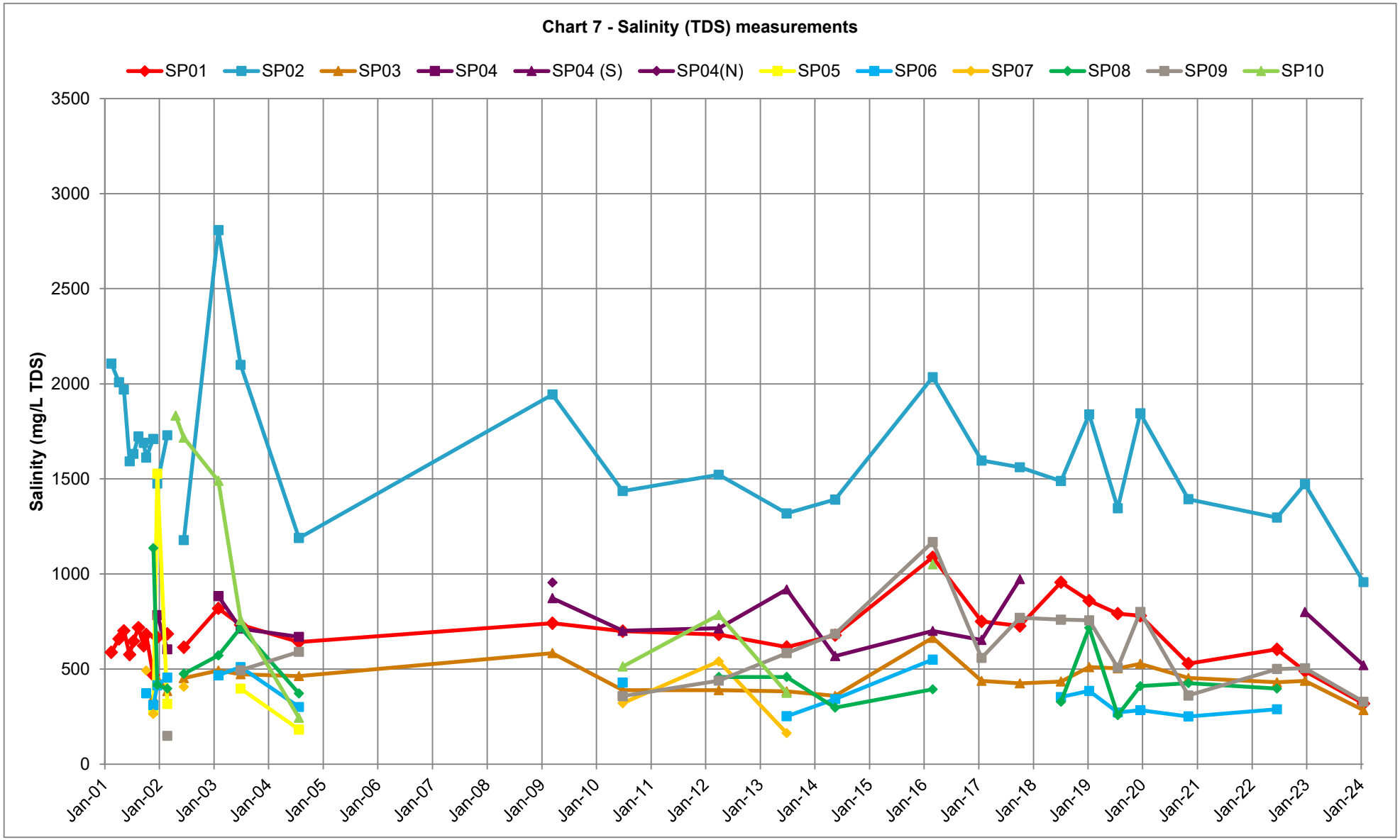


Chart 7 - Salinity (TDS) measurements
SP01
SP02
SP03
SP04
SP04 (S)
SP04(N)
SP05
SP06
SP07
SP08
SP09
SP10
Salinity (mg/L TDS)
3500
3000
2500
2000
1500
1000
500
0
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24

Attachment 4 Site Photographs

Plate 1 Spring 1
January 2024

Plate 2 Spring 2
January 2024

AECOM

Plate 3 Spring 3
January 2024

AECOM

Plate 4 Spring 4
January 2024

AECOM

Plate 5 Spring 5
January 2024 (is now correctly labelled)

Plate 6 Spring 6 **January 2024**

Plate 7 Seep 7 **January 2024**
No longer part of monitoring as has been reclassified as a seep and is generally dry/inaccessible

AECOM

Plate 8 Spring 8
January 2024

Plate 9 Spring 9
January 2024 (now correctly labelled as SP09)

AECOM

Plate 10 Spring (Reclassified as a seep)
January 2024

AECOM

Plate 11 Spring 11
January 2024