Mawsons Concrete & Quarries

Groundwater Drilling and Well Construction Report

Blue Hills Quarry

November 2023

Report prepared by Water Resource Solutions

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1 Introduction

1.1 Background

Mawsons Concrete and Quarries (Mawsons) are undertaking specialist studies to support a work plan application for quarrying at Blue Hills (herein referred to as the Site), located around 9 km northwest of the township of Maldon in Victoria (Figure 1-1). Mawsons are seeking to extract hornfels at the Site to supply local and regional markets. Resource drilling has identified an extensive resource which extends around 1,000 m east-west and 400 m north-south, covering an area of approximately 36 hectares.

The Site is located within the North Central Catchment Management Authority area. The Site is not located within a Groundwater Management Area, Groundwater Restricted Quality Usage Zone, or a Water Supply Protection area.

To progress the quarry development plan, four groundwater observation wells were drilled and constructed at the site. The wells were constructed to enable the collection of site-specific groundwater level and salinity data to inform the development of a hydrogeological conceptual model for the site. This report documents the drilling and well construction methodology and groundwater level and quality data collected from the completed wells.

1.2 Scope

The project scope is detailed below:

- Oversee well construction and well development and collect relevant hydrogeological data to inform the hydrogeological conceptualisation of the Site.
- Collect groundwater quality samples for laboratory analysis.
- Collect groundwater levels from completed wells at the end of the drilling program.
- Record site activities during the drilling program and distribute daily reports to Mawsons.
- Where possible, collect groundwater levels in resource definition drillholes previously drilled at the site.
- Document the drilling and well construction methodology and findings.



2 Geological Setting

The proposed quarry Site is situated on rocks of the Ordovician Castlemaine Group, which are regionally characterised by marine sandstone, mudstone, siltstone, shale and chert. The late Devonian Baringhup Granodiorite exists to the east and south of the Site, characterised by fine to medium grained, slightly porphyritic granodiorite. The intrusion of the granodiorite during the late Devonian period created a zone of contact metamorphism to the east, resulting in the development of cordierite hornfels, biotite hornfels and calc-silicate hornfels which are the target quarry material.

Quaternary and Tertiary sediments cover the Castlemaine Group to the west of the Site. These sediments include Quaternary colluvium consisting of diamictite, gravel, sand, silt, clay and rubble and Tertiary Shepparton Formation sediments consisting of clay, sand and silt. The proposed quarry location is shown in Figure 2-1 overlain on the Bendigo 1:250,000 geological map sheet (GeoScience Victoria, 2014).



3 Drilling and Well Construction

3.1 Methodology

Four sites were selected for drilling and well construction (Figure 4-1). The wells were positioned around the edges of the proposed quarry footprint to enable access for monitoring during operations should the quarry proceed to this point. Murray's Water Boring were engaged to undertake the drilling and well construction. Drilling was completed between 31 October 2023 to 09 November 2023. Drilling and well construction activities were completed in accordance with the Minimum Construction Requirements for Water Bores in Australia (4th Edition, 2020). Well construction permits obtained from Goulburn Murray Water are provided in Appendix A. Drilling and well construction activities including well development were supervised by Water Resource Solutions.

The following summarises the drilling procedure and well construction methodology:

- Wells were drilled with a rock hammer bit and conventional air circulation. Sites 1, 3 and 4 were drilled with a 6 ¾ inch hammer bit (171 mm) while Site 2 was drilled with a 7 inch bit (178 mm).
- During drilling, water cuts, yield and salinity were monitored at the end of each 6 m drill rod. Drill cuttings were collected at 3 m intervals and were laid out on-site for geological logging.
- Drilling continued in each hole until a water bearing zone/fracture was intersected and/or the target elevation was reached, which was set as the proposed base elevation of the quarry pit (170 mAHD).
- Sites 1 and 2 were constructed with DN125 mm PN9 uPVC casing. Screens were hand slotted on-site using an electric saw. Sites 3 and 4 were constructed with DN80 PN12 uPVC casing with 0.8mm aperture machine slotted screens. Screens were set to align with the water bearing zones/fractures observed during drilling.
- Sites 1 and 2 were grouted from 6 m below ground level to surface. A cement shoe was used to ensure that cement was held at the desired depth. The annulus between the casing and borehole at Sites 1 and 2 was left open.
- Sites 3 and 4 were backfilled with 2-3 mm graded gravel pack from the base of the hole to 16 m below ground level. A one metre bentonite seal was installed above the gravel pack followed by a cement-bentonite mix (5%) from the top of the bentonite seal to surface.
- Sites 2, 3 and 4 were fitted with a lockable steel standpipe and concrete plinth. Site 1 was not completed with a steel standpipe as it is possible that this well with be equipped with pumping infrastructure in the future (subject to relevant approvals).
- Sites 1, 2 and 3 were developed via airlifting with 50 mm polypipe until discharge water was free of solids and water quality parameters had stabilised. Site 4 was not developed due to its low yield.
- Table 3-1 provides the construction details for each of the four completed wells.



Blue Hills

Table 3-1: Well Construction Summary

Well ID	Permit Number	Easting (GDA 2020 Z55)	Northing (GDA 2020 Z55)	Surface Elevation ¹ (mAHD)	Stick-up (m)	Drilled Depth (m)	Base Elevation (mAHD)	Screened Interval (m)	Aquifer
Site 1	WRK141056	234638	5909935	310.65	0.30	117	193.38	54 – 60	Fractured
								66 – 78	ROCK
								108 – 114	
Site 2	WRK141054	233560	5910430	255.43	0.58	85	170.43	41 - 53	Fractured
								75 – 85	Rock
Site 3	WRK141057	234087	59099758	283.36	0.65	111	172.46	27 – 33	Fractured
								45 – 51	Rock
								105 – 111	
Site 4	WRK141055	234153	5910341	278.35	0.80	111	167.47	27 – 33	Fractured
								51 – 63	Rock
								81 – 111	

Notes: 1. Surface elevations taken from 50cm resolution LiDAR data supplied by Groundwork Plus

3.2 Lithological Sampling

Lithological samples were collected and laid out in 3 m intervals at each site for geological logging. Appendix B contains the hydrogeological logs of the drillholes which include details on lithology, geological units, well construction and other drilling data considered relevant for hydrogeological interpretations. Assignment of geological units was guided by existing mapping and drillhole logging.

Representative lithological samples were collected and placed in chip trays at 3 m intervals. Photographic logs of the chip trays are provided in Appendix C.

3.3 Well Development

Well development was undertaken at Sites 1, 2 and 3 using compressed air with 50 mm polypipe inserted to the base of the well. Developed was considered complete when discharge water was free of sediment and field water quality parameters had stabilised. Field water quality parameters measured during development included:

- Electrical Conductivity (µS/cm)
- pH
- Temperate (°C)

Development durations, estimated yield and field water quality parameters for each of the constructed wells are provided in Table 3-2. Site 4 was not developed due to its slow recovery rate and low yield.

Well yields were found to be low, ranging from less than 0.1 L/s at Site 4 up to 1.5 L/s at Site 1. The yield data indicates that the fractured rock aquifer has low permeability. The available yield is interpreted to be sourced from secondary porosity features such as fractures and faults. The primary porosity of the rock mass is expected to be very low.

Monitoring Well	Development Duration (mins)	Airlift Yield (L/s)	EC Field (μS/cm)	pH Field	Temp Field (°C)
Site 1	20	1.5	1,625	8.29	17.3
Site 2	30	0.25	6,300	8.52	18.1
Site 3	40	0.5	1,375	8.25	18.1
Site 4	NA	< 0.1	4,010	7.46	17.3

Notes: 1. Site 4 was not actively yielding water and therefore was not developed. Its yield was estimated during *drilling.*

3.4 Groundwater Sampling

Groundwater samples were collected for laboratory analysis at the end of well development. For Site 4 a sample was collected from the water which had recharged the well during drilling. Samples were sent to Envirolab under chain of custody protocols for testing of the following water quality parameters:

- pH, Electrical conductivity (EC) and Total Dissolved Solids (TDS).
- Ionic balance (major anions-total alkalinity, OH, CO₃, HCO₃, sulphate, chloride, fluoride and cations – Ca, Mg, K, Na).
- Nutrients (total N, nitrate, nitrite, total P).
- Dissolved Metals (Al, As, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Hg, Mo, Ni, Se, U, V, Zn).

3.5 Well Completion

3.5.1 Site 1

Site 1 was drilled and constructed southeast of the proposed quarry pit (Figure 3-1). Site 1 intersected weathered Castlemaine Group sediments from 0 to 3 m followed by hornfels of the Castlemaine Group from 3 m to a total depth of 117 m. Groundwater was intersected at 52 m, 57 m and 67 m. A seep was also noted at 30 m below ground level. The cumulative yield of the well was estimated to be 1.5 litres per second (L/s). The well was screened from 54 - 60 m, 66 - 78 m and 108 - 114 m below ground level.

Site 1 was developed for 20 minutes until discharge water was free of sediment and field water quality parameters had stabilised. A field salinity of 1,625 μ S/cm and pH of 8.29 were recorded at the end of development.

Water level recovery following drilling indicated that it took up to 5 days for the well to approach its equilibrium level. The highest depth to groundwater recorded was 18.17 m below ground level (mBGL) recorded 5 days after drilling. The standing water level (SWL) is notably higher than the point at which groundwater was intersected in the well (water cut observed around 34 m), suggesting some confinement from lower permeability rocks above the observed water cut.

Although the yield of 1.5 L/s suggests low to moderate permeability, the water level recovery data suggests that fractures and/or faults are likely to be limited in extent and connectivity as evidenced by the slow recovery rate.

3.5.2 Site 2

Site 2 was drilled and constructed west of the proposed quarry pit (Figure 3-1). Site 2 intersected Quaternary sediments (0-12 m), Tertiary sediments (12-27 m) and hornfells of the Castlemaine Group (27-85 m). Groundwater was intersected at 44 m below ground level. The cumulative yield of the well was estimated to be 0.25 L/s, indicating a low permeability. The well was screened from 41 - 53 m and 75 - 85 m below ground level.

Site 2 was developed for 30 minutes until discharge water was free of sediment and field water quality parameters had stabilised. A field salinity of 6,300 μ S/cm and pH of 8.52 were recorded at the end of development.

Water level recovery following drilling indicated that it took several days for the well to approach its equilibrium level. A depth to groundwater of 38.2 mBGL was recorded one day after well development. The SWL is slightly higher than the point at which groundwater was intersected (water cut observed around 44 m).

3.5.3 Site 3

Site 3 was drilled and constructed south of the proposed quarry pit (Figure 3-1). Site 3 intersected weathered Castlemaine Group sediments from 0 to 3 m followed by hornfels of the Castlemaine Group from 3 m to a total depth of 111 m. Groundwater was intersected at 27 m and 69 m. The cumulative yield of the well was estimated to be 0.5 L/s. The well was screened from 27 - 33m, 45 - 51 m and 105 - 111 m below ground level.

Site 3 was developed for 40 minutes until discharge water was largely free of sediment and field water quality parameters had stabilised. It is noted that the water was still slightly turbid at the end of development. A field salinity of 1,375 μ S/cm and pH of 8.25 were recorded at the end of development. The highest depth to groundwater measured during the field program was 10.49 mBGL, recorded 2 days after well construction. The SWL is notably higher than the point at which groundwater was intersected in the well (water cut observed around 16 m), suggesting some confinement from lower permeability rocks above the observed water cut.

3.5.4 Site 4

Site 4 was drilled and constructed on the northern edge of the proposed quarry pit (Figure 3-1). It was unable to be located outside of the proposed pit footprint due to access constraints. Site 4 intersected weathered Castlemaine Group sediments from 0 to 3 m followed by hornfels of the Castlemaine Group from 3 m to a total depth of 111 m. There were no noted water cuts at Site 4, suggesting a very low permeability at this site. Water was observed to seep into the hole at 21 m following a break in drilling from 07 - 08/11/23. The well was not actively producing water, and the yield is best described as a seep (< 0.1 L/s). The well was screened from 27 - 33m, 61 - 63 m and 81 - 111 m below ground level.

Site 4 was not developed due to its low yield. A water sample was retrieved from the hole when the well was allowed to recover during a break in drilling from 08 - 09/11/23. A field salinity of 4,010 μ S/cm and pH of 7.46 were recorded. The highest depth to groundwater measured during the field program was 11.97 mBGL, recorded 1 day after well construction.

4 Hydrogeology

4.1 Hydrostratigraphic Units

The main hydrostratigraphic unit at the Site is a fractured rock aquifer comprised of hornfels of the Castlemaine Group geological unit. Groundwater within the fractured rock aquifer was found to occur in discrete intervals which are interpreted to coincide with secondary porosity features such as fractures and faults. At each well, the standing water level rose above the point at which water was intersected, suggesting some confinement from lower permeability rocks above the observed water cut. The primary porosity of the rock mass is expected to be very low. Quaternary and Tertiary sediments were intersected at Site 2, however, these sediments were found to be unsaturated at this location.

4.2 Groundwater Levels

Groundwater levels in the fractured rock aquifer were measured at the end of the field program in the four completed wells (Table 4-1). Measurements were taken from the top of the casing, which is commonly referred to as the wells reference point. Depth to groundwater measurements were corrected to reduced standing water levels (RSWL) relative to the Australian Height Datum (AHD) using 50 cm resolution LiDAR elevation data (supplied by Groundwork Plus). Depth to groundwater measurements ranged from 10.49 m to 38.20 m below ground level (Table 4-1 and Figure 4-1). Groundwater elevations from the four completed wells range from 292.48 at Site 1 to 217.23 mAHD at Site 2 (Figure 4-2).

Additional groundwater level data was obtained from existing exploration holes drilled within the proposed quarry footprint. In many cases the exploration holes were found to be blocked, backfilled or not visible at the listed coordinates. Of the 24 holes surveyed, groundwater level measurements were collected from 6 holes, with groundwater depths observed to range from 9.9 m to 27.38 m below ground level (Figure 4-1). The levels obtained from the exploration holes are consistent with the groundwater levels from the constructed wells. Groundwater elevations from the exploration holes ranged from 288.47 mAHD to 244.43 mAHD. The data obtained from the exploration holes have been added to Figure 4-2 to assist in the interpretation of flow directions at the Site. Appendix D contains the details of the exploration hole survey.

The combined well and exploration hole data indicates a westerly groundwater flow direction with a hydraulic gradient of around 0.063 m/m. The groundwater flow direction is consistent with the Site topography, which is common in fractured rock aquifer settings. Groundwater depths are deepest through the middle of the proposed pit where surface elevation is highest. Shallower groundwater depths are observed near drainage lines south and north of the proposed pit.

Monitoring Well	Aquifer ¹	Ground Elevation ² (mAHD)	Stick-up ³ (m)	SWL (m)	RSWL (mAHD)
Site 1	FRA	310.38	0.30	18.17	292.48
Site 2	FRA	255.43	0.58	38.20	217.23
Site 3	FRA	283.46	0.65	10.49	272.87
Site 4	FRA	278.47	0.80	11.97	266.38

Table 4-1: Groundwater Levels

Notes: 1. FRA = fractured rock aquifer

1. Surface elevations taken from 50cm resolution LiDAR data supplied by Groundwork Plus

2. Stick-up refers to the distance from the top of the PVC casing to the ground surface



Figure 4-1: Depth to Groundwater November 2023



Figure 4-2: Groundwater Elevation November 2023

4.3 **Groundwater Quality**

Groundwater quality samples were taken and analysed for Electrical Conductivity (EC), Total Dissolved Solids (TDS), pH, major cations and anions, nutrients and dissolved metals. Laboratory reports are provided in Appendix E with compiled water chemistry data provided in Appendix F.

Review of the water chemistry data indicates:

- Groundwater salinity at the site is fresh to brackish, ranging from 710 mg/L at Site 3 up to 3,000 mg/L at Site 2 (Table 4 3 and Figure 4-4).
- Groundwater salinity at Sites 1 and 3 meets the salinity guideline for each of the Environment Reference Standard (ERS, 2022) environmental values except potable water supply (desirable) which has a salinity limit of 0-600 mg/L.
- Groundwater salinity at Sites 2 and 4 meets the salinity guidelines for each of the ERS (2022) environmental values except potable water supply (desirable and acceptable) which have a salinity limit of 1,200 mg/L.
- Ph is neutral to slightly alkaline ranging from 7.46 to 8.82.
- Dissolved metals are generally below the recommended drinking water, stock, and irrigation water quality guidelines with the exception of:
 - Molybdenum at Sites 3 and 4 which is above the recommended long-term (100year) irrigation trigger value (ANZECC, 2000).
 - Manganese at Sites 3 and 4 which is above the recommended long-term (100year) irrigation trigger value (ANZECC, 2000).
 - Selenium at Site 3 which is above the recommended drinking water guideline value (ANZG, 2022) and the long-term irrigation trigger and stock drinking water guidelines values (ANZECC, 2000).
 - Uranium at Site 3 which is equal to the recommended drinking water guideline value (ANZG, 2022) and above the long-term irrigation trigger guideline value (ANZECC, 2000).
- Nutrients are generally below the recommended guideline values with the exception of:
 - Phosphorus at Sites 1 and 3 which is above the recommended long-term (100year) irrigation trigger value (ANZECC, 2000).
- The four sites exhibit slightly different ionic compositions suggesting the aquifer may be compartmentalised (Figure 4-3). The following water types are interpreted from the piper diagram (Figure 4-3):
 - \circ Na-K-HCO₃ at Site 1.
 - \circ $\,$ Na-Cl at Site 2 and 4.
 - No dominant type (i.e. mixed) at Site 3.



Figure 4-3: Piper Diagram

Table 4-2: Major Ion Chemistry

Monitoring Well	Calcium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Magnesium (mg/L)	Chloride (mg/L)	Sulpahte (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Total Alkalinity (mg/L)	TDS mg/L	pH (Lab)
Site 1	16	6.7	210	64	170	13	530	17	550	920	8.4
Site 2	74	19	670	270	1700	180	540	19	560	3000	8.4
Site 3	16	6.5	130	61	190	38	330	5	340	710	8.4
Site 4	58	11	500	170	850	42	680	0	680	2000	8



5 Summary

Mawsons Concrete and Quarries are seeking to develop a hard rock quarry 9 km northwest of the township of Maldon in Victoria. Four groundwater monitoring wells were constructed at the proposed quarry site between 31 October to 09 November 2023. The four wells were completed in the fractured rock aquifer, which at the Site consists entirely of hornfels of the Castlemaine Group geological unit. The wells were drilled to depths of 85 m to 117 m below ground level.

Groundwater yields were found to be low ranging from less than 0.1 L/s up to 1.5 L/s. Groundwater level monitoring following drilling indicates that groundwater levels took several days to recover to an equilibrium level, indicating a low permeability aquifer unit. At each well, the standing water level rose above the point at which water was intersected, suggesting some confinement from lower permeability rocks above the observed water cut.

Groundwater depths were found to be variable ranging from 9.9 m up to 38.2 m below ground level based on the data collected from the four constructed wells and six exploration holes. The depth to groundwater is deepest in the elevated areas through the centre of the proposed quarry footprint and shallowest to the north and south of the proposed quarry. Groundwater flow is from east to west, consistent with the topographic gradient at the Site. Groundwater flow is interpreted to occur via fractures and faults, though these appear to be limited in extend and connectivity based on the observations made during drilling. The primary porosity of the rock mass is expected to be very low.

Groundwater quality is fresh to brackish with salinity observed to range from 710 mg/L at Site 3 up to 3,000 mg/L at Site 2. Ph is neutral to slightly alkaline ranging from 7.46 to 8.82. Dissolved molybdenum, manganese, selenium, uranium and phosphorus where above relevant guideline values in some wells.

Drilling and groundwater level data indicates that dewatering of the quarry will be required if the quarry is excavated to the proposed depth of 170 mAHD. An assessment of the likely inflow rates and associated impacts will be required to support detailed quarry planning and approvals.

It is recommended that groundwater levels are monitored monthly and groundwater quality samples collected and tested every three months in each of the four observation wells. A review of the data should be undertaken after 12 months to ascertain if there are any seasonal trends occurring at the site.

References

Edwards, J. & Slater, K.R. (2001) Bendigo 1:250,000 geological map. Geological survey of Victoria.

Minimum Construction Requirements for Water Bores in Australia (4th Edition, 2020).

Appendix A: Well Construction Permits

Works Licence ID:

WLE086433

Printed on: 06 Nov 2023 9:43:33 am

COPY OF RECORD IN THE VICTORIAN WATER REGISTER LICENCE TO CONSTRUCT WORKS

under Section 67 of the Water Act 1989

The information in this copy of record is as recorded at the time of printing. Current information should be obtained by a search of the register. The State of Victoria does not warrant the accuracy or completeness of this information and accepts no responsibility for any subsequent release, publication or reproduction of this information.

This licence does not remove the need to apply for any authorisation or permission necessary under any other Act of Parliament with respect to anything authorised by the works licence.

Water used under this licence is not fit for any use that may involve human consumption, directly or indirectly, without first being properly treated.

This licence is not to be interpreted as an endorsement of the design and/or construction of any works (including dams). The Authority does not accept any responsibility or liability for any suits or actions arising from injury, loss, damage or death to person or property which may arise from the maintenance, existence or use of the works.

Each person named as a licence holder is responsible for ensuring all the conditions of this licence are complied with.

This licence authorises its holders to construct the described works, subject to the conditions.

Licence Holder(s)

CHERYL WARD of UNIT 7 53 MCMILLAN ROAD ECHUCA VIC 3564

Licence Contact Details

C WARD

UNIT 7 53 MCMILLAN ROAD ECHUCA VIC 3564

Licence Details

Expiry date	03 Nov 2024
Status	Active
Authority	Goulburn-Murray Water
Name of waterway or aquifer	NA for construct/decommission
Water system	Unincorporated (GMU)

Summary of Licensed Works

The details in this section are a summary only. They are subject to the conditions specified in this licence.

Works ID	Works type	Use of water
WRK141054	Bore	Observation
WRK141055	Bore	Observation
WRK141056	Bore	Observation
WRK141057	Bore	Observation

Description of Licensed Works

WORKS ID WRK141054

Works type	Bore
Works subtype	Drilled bore
Proposed maximum depth	Unrestricted

Works location

Easting	Northing	Zone MGA
233579.152	5910296.032	Zone 55
Land description		

Volume 10690 Folio 916 CA 9 Section 11 Parish of Bradford

Property address

BRADFORD ROAD, BRADFORD, VIC 3463

Description of Licensed Works

WORKS ID WRK141055

Works type	Bore
Works subtype	Drilled bore
Proposed maximum depth	Unrestricted

Works location

Easting	Northing	Zone MGA
234575.911	5910443.037	Zone 55

Land description

Volume 8909 Folio 935 CA 10 Section 11 Parish of Bradford

Property address

BRADFORD ROAD, SHELBOURNE 3515

Description of Licensed Works

WORKS ID WRK141056					
Works type	Bore				
Works subtype	Drilled bore				
Proposed maximum depth	Unrestricted				

Works location

Easting	Northing	Zone MGA
234719.060	5909916.595	Zone 55

Land description

Volume 10690 Folio 916 CA 9 Section 11 Parish of Bradford

Property address

BRADFORD ROAD, BRADFORD, VIC 3463

Description of Licensed Works

WORKS ID WRK141057

Works type	Bore
Works subtype	Drilled bore
Proposed maximum depth	Unrestricted

Works location

Easting	Northing	Zone MGA
234018.471	5909868.876	Zone 55

Land description

Volume 10690 Folio 916 CA 9 Section 11 Parish of Bradford

Property address

BRADFORD ROAD, BRADFORD, VIC 3463

Related Instruments

Related	entitlements	Nil
Related	entitlements	N

Related water-use entities Nil

Application History

Reference	Туре	Status	Lodged date	Approved date	Recorded date
WLV909634	Modify	Approved	06 Nov 2023	06 Nov 2023	
WLV718256	Modify	Approved	03 Nov 2023	03 Nov 2023	
WLI618879	Issue	Approved	03 Oct 2023	03 Oct 2023	

Conditions

Licence WLE086433 is subject to the following conditions:

Siting and construction

- 1 The bore(s) must be drilled at the location specified in the application approved by the Authority.
- 2 If after drilling the bore is considered unsatisfactory a replacement bore may be drilled on the land specified in the licence.

Preventing pollution

- 3 All earthworks must be carried out, and all drilling fluids and waters produced during construction and development must be disposed of, in ways that avoid contaminating native vegetation, waterways, aquifers, the riparian environment, the riverine environment or other people's property.
- 4 Construction must stop immediately if the Authority reasonably believes that fuel, lubricant, drilling fluid, soil or water produced during construction and development is at risk of being spilled into native vegetation, waterways, aquifers, the riparian environment, the riverine environment or other people's property.
- 5 The licence holder must construct and maintain bund walls, in accordance with the timeframe, specifications, guidelines or standards prescribed by the Authority, to prevent fuel, lubricant, drilling fluid, soil or water produced during construction and development from being spilled into native vegetation, waterways, aquifers, the riparian environment, the riverine environment or other people's property.

Construction standards

6 The bore(s) must be constructed, and where relevant decommissioned, in accordance with the Minimum Construction Requirements for Water Bores in Australia, Edition 4 or its successor.

Drilling licence and supervision requirements

- 7 The bore(s) must be constructed by, or under the supervision of, a driller licenced under the Water Act 1989 as follows;
- 8 If artesian pressure is expected or encountered, then a driller licensed under the Water Act 1989, and endorsed as a class 3 driller, must install casing in the bore(s) to a suitable depth, and in a suitable manner, to prevent its outbreak. A suitable valve must also be fitted to the bore.

Bore completion report

9 A Bore Completion Report must be submitted to the Authority within 28 working days of the bore(s) being completed.

Protecting water resources

- 10 No more than 4 bore(s) may be brought to final development under this licence.
- 11 At the completion of drilling and before the drilling rig leaves the site, all but 4 bore(s) must be decommissioned so as to eliminate physical hazards, conserve aquifer yield, prevent groundwater contamination and prevent the intermingling of desirable and undesirable waters.
- 12 The bores(s) must be located at least 100 metres from any waterway unless otherwise authorised by the Authority.
- 13 The bores(s) must be located at least 50 metres from any bore(s) not operated by the licence holder unless authorised by the Authority.
- 14 The bore(s) must be located at least 30 metres from any authority's channel, reserve or easement unless authorised by the Authority.

Protecting water quality

- 15 The bore(s) must be constructed so as to prevent aquifer contamination caused by vertical flow outside the casing.
- 16 If two or more aquifers are encountered, the bore(s) must be constructed to ensure that an impervious seal is made and maintained between each aquifer to prevent aquifer connection

through vertical flow outside the casing; under no circumstances are two or more aquifers to be screened within the one bore or in any other manner to allow connection between them.

17 Boreheads must be constructed, to ensure that no flood water, surface runoff or potential subsurface contaminated soakage can enter the bore or bore annulus.

Protecting other water users

- 18 The diameter of the drill casing must not exceed 130 millimetres.
- 19 The bore(s) must be constructed so that water levels in the bore(s) can be measured by an airline, a piezometer or a method approved in writing by the Authority.

Fees and charges

20 The licence holder must, when requested by the Authority, pay all fees, costs and other charges under the Water Act 1989 in respect of this licence.

END OF COPY OF RECORD

Appendix B: Hydrostratigraphic Logs

	VRS			BLUE HILLS				LOG:	Site 1
CLIE EAS ⁻ NOR	NT: TING: ITHING:	Maw 2346 5909	/sons 638 9935	PERMIT NUMBER: DRILLING CO.: DRILLING METHOD	WRK14105 Murrays W D: Air - Hamn	56 /ater Boring ner	STICK-L SCREEI SWL (m	JP (m): NED INTERVAL (BGL):	0.3 m): 54-114 18.17
DAT	UM: FACE RL (mAHD)	GDA 310	A2020 Z55	LOGGED BY: DRILLED DEPTH (m	Rohan Bai	rd	YIELD (L	L/s): `Y (ma/L):	1.5 920
		510.			<i></i>				
(m)	STRATIGRAPHY			LITHOLOGY		COMME	VIS	CONSTR	CTON
0			silty Clay: R angular rock <u>Hornfels:</u> Lig metamorphi and weather <u>Hornfels:</u> Gr	ed brown, silty clayey sa fragment up to 200mm ght grey to grey, fine gra c rock, micaceous, sligh red rey, fine grained metase	and, large nined htly broken diment, lar chins				_ 128mm ID PN9 Casing [_] Cement Basket
15 -			slow hard d	rilling	lai chips,				
25 -									
30 -						Seep			
35 -			<u>Hornfels:</u> Da slightly mica	ark grey, fine grained me aceous, hard angular fra	etasediment, gments, slow				
40 -			nard drilling						
45 -									
50 -			Weathering	light grey clay on faces	of chips from	Water cut a and 57m_0	t 52m 1 L/s		Sereen E4 60m
60 -	Castlemaine Group		46-57m. Co	incides with water cut.					⁻ 128mm ID Hand Slotted Casing
65 –									Borenole (127mm)
70 –						Water cut a 0.7 L/s	t 67m		Screen 66-78m - ⁻ 128mm ID Hand
75 –			78m-84m H fine grained	ornfells with white to ver rock, possible quartz ve	ry pale grey eins				Slotted Casing
80 -						Water cut a 81m 1 25 I	round /s		
90 -									
95 -						Water cut a	round		
100 -						9511 1.5 L/S			
105 -									
110 -									Screen 108-114m - 128mm ID Hand Slotted Casing
115 -									Siottod Oddiny
DRI		. (01-03/11/2023		:: 17 SION: P	7/11/23			Page 1 of 1
					SION. RE	5V M			

V	VRS		BLUE HILLS				LOG:	Site 2
CLIE EAS ⁻ NOR	NT: TING: THING:	Mawsons 233560 5910430	PERMIT NUMBER: DRILLING CO.: DRILLING METHOD:	WRK14105 Murrays Wa Air - Hamm	4 ater Boring er	STICK-U SCREEN SWL (mE	P (m): IED INTERVAL (n 3GL):	0.58 n): 41-85 38.20
DAT SUR	UM: FACE RL (mAHD):	GDA2020 Z55 255.43	LOGGED BY: DRILLED DEPTH (m) [:]	Rohan Bair 85	ď	YIELD (L SALINIT)	/s): Y (mg/L):	0.25 3.000
(m)	STRATIGRAPHY		LITHOLOGY		COMME	NTS	CONSTR	
DAT SUR (m) 0 	JM: FACE RL (mAHD): STRATIGRAPHY Castlemaine Group Castlemaine Group	GDA2020 Z55 255.43	LITHOLOGY LITHOLOGY LITHOLOGY t brown, red grey, mottled, tig ry white, very fine grained silty m grain size red, very fine grained silt sa rain size t grey to white red to brown, very fine grained for faces of chips Grey to dark grey, fine grained nent, 69-75m minor quartz ch and greenish grey colour	Rohan Bair 85 httly sand, and, red silty eediment, d ips up to	d COMME	t 44m j L/s		Cement Basket Borehole (127mm) Screen 41-53m - 128mm ID Hand Slotted Casing Screen 75-85m - 128mm ID Hand Slotted Casing
DRI DE\	LLED DATE: /ELOPMENT DATE	31/10/23 : 9/10/2023	LOG DATE: LOG REVISION	17/ N: Re	v A		F	Page 1 of 1

V	VRS			BLUE	HILLS				LOG:	Site 3
CLIE EAS NOR DAT	:NT: TING: ITHING: UM:	Maw 2340 5909 GDA	MawsonsPERMIT NUMBER:WRK14'234087DRILLING CO.:Murrays5909958DRILLING METHOD:Air - HaGDA2020 Z55LOGGED BY:Rohan I				57 /ater Boring ner ird	STICK SCREI SWL (I YIELD	-UP (m): ENED INTERVAL (r mBGL): (L/s):	0.65 n): 27-111 10.49 0.5
SUR	FACE RL (mAHD):	283.	36	DRILLEI	D DEPTH (m):	111		SALIN	ITY (mg/L):	710
(m)	STRATIGRAPHY			LITHOLOG	GY		COMME	NTS	CONSTR	UCTION
0 5 10 15 20 25 30 35 40 45 55 60 55 60 65 70 65 70 75 80 75 80 90 95 100 105 100	Castlemaine Group		silty Clay: angular ro <u>Hornfels:</u> with mino <u>Hornfels:</u> predomint silty clay <u>Hornfels:</u> slightly m uniform a 87m-90m fine graine	Red brown, silt ock fragment up Light brown gre r silt and clay Light brown, we ly hard angular Dark grey, fine icaceous, hard ind consistent	ty clayey sand to 50mm ey, weathered eathered hornf ships with mi grained metas angular fragm	d, large hornfels fels, inor brown sediment, hents, very	Water cut a ~0.4 L/s	t 27m		 128mm ID PN9 Casing Cement Basket Screen 27-33m - 80mm ID Hand Slotted Casing Screen 45-51m - 80mm ID Hand Slotted Casing Borehole (127mm) Screen 105-111m - 80mm ID Hand Slotted Casing
DRI		(03-07/11/202	3	LOG DATE:	17	7/11/23		F	Page 1 of 1
	ELOPMENT DATE:		9/10/2023		LUG REVISIO	אוי. Ke	ev A			

	VRS			BLUE H	HILLS				LOG:	Site 4
CLIE EAS NOF DAT SUR	:NT: TING: :THING: UM: FACE RL (mAHD):	Maw 2341 5910 GDA 278.3	sons 53 1341 2020 Z55 35	PERMIT DRILLING DRILLING LOGGED DRILLED	NUMBER: G CO.: G METHOD:) BY:) DEPTH (m):	WRK1410 Murrays V Air - Ham Rohan Ba 111	55 Nater Boring mer nird	STICK SCREI SWL (1 YIELD SALIN	-UP (m): ENED INTERVAL (n mBGL): (L/s): ITY (mg/L):	0.8 n): 27-111 11.97 Seep 2,000
(m)	STRATIGRAPHY			LITHOLOG	iΥ		COMME	NTS	CONSTR	UCTION
0- 5- 10 - 15 - 20 -			silty Clay: angular ro hornfels <u>Hornfels:</u> metamorp and weath <u>Hornfels:</u> slightly mi slow hard	Red brown, silty ck fragment up t Light grey to gre hic rock, micace ered Dark Grey, fine g caceous, very hi drilling, very cor	y clayey sand to 200mm, w ey, fine graine eous, slightly grained metas ard, angular o nsistent litholo	, large eathered d broken sediment, chips, ogy	Seep (wate	rin		128mm ID PN9 Casing Cement Basket
25 - 30 - 35 - 40 - 45 - 50 -							hole overni	ght)		Screen 27-33m - 80mm ID Hand Slotted Casing
55 - 60 - 65 - 70 -	Castlemaine Group		Minor qua	rtz veing at 78 -	81		Dust dropp slightly at 5 Moisture at	ed 4m 63m		Borehole (127mm) Screen 51-63m - 80mm ID Hand Slotted Casing
75 - 80 - 85 - 90 - 95 - 100 -			Minor qua	rtz veing at 99 -	102		Adding wat lift cuttings Broken ground/slig quicker drill no water	er to htly ing,		Screen 81-87m - 80mm ID Hand Slotted Casing Screen 93-99m - 80mm ID Hand Slotted Casing
105 – 110 –)7-09/11/20?	3		1	7/11/23			Screen 105-111m - 80mm ID Hand Slotted Casing
DE	/ELOPMENT DATE	: 9	9/10/2023		LOG REVISIO	N: R	ev A		F	rage 1 of 1

Appendix C: Photographic Logs









Appendix D: Exploration Hole Survey Data

ID	Easting	Northing	WL (mBGL)	Elevation (mAHD)	RSWL (mAHD)	Comments	Date Surveyed
1	234383	5910060	24.85	313.32	288.47	WL 24.85	8/11/2023
2	234355	5910132	27.10	311.56	284.46	WL 27.1	8/11/2023
3	233829	5910130	22.45	279.79	257.34	WL 22.45 mBGL	8/11/2023
4	234302	5910325	9.90	287.11	277.21	WL 9.9 mBGL, just above base of hole	8/11/2023
5	233879	5910312	27.38	271.81	244.43	WL 37.38 mBGL	9/11/2023
6	233766	5910391	NA	NA		Dry at 18m, collapsed	9/11/2023
7	233879	5910180	NA	NA		Blocked at 3.5m	9/11/2023
8	233997	5910115	NA	NA		Blocked at 1m	9/11/2023
9	234036	5910191	NA	NA		Blocked at 1m	9/11/2023
10	234063	5910039	NA	NA		Blocked at 1m	9/11/2023
11	234203	5910248	NA	NA		Blocked at 0.5m	9/11/2023
12	234178	5910088	24.55	303.79	279.24	WL 24.55 mBGL	9/11/2023
13	234254	5910136	NA	NA		Dry at 30m	9/11/2023
14	234155	5909943	NA	NA		Blocked at 3m	10/11/2023
15	234638	5910106	NA	NA		Blocked at 1m	10/11/2023

ID	Easting	Northing	WL (mBGL)	Elevation (mAHD)	RSWL (mAHD)	Comments	Date Surveyed
16	234279	5910015	NA	NA		Collapsed 0.5m	10/11/2023
17	234272	5910065	NA	NA		Cuttings at surface, can't locate hole	10/11/2023
18	233980	5910201	NA	NA		Blocked 0.5m	10/11/2023
19	233692	5910192	NA	NA		No evidence of hole at coordinates	10/11/2023
20	233724	5910281	NA	NA		Backfilled	10/11/2023
21	235267	5910366	NA	NA		No evidence of hole at coordinates	10/11/2023
22	234501	5909839	NA	NA		No evidence of hole at coordinates	10/11/2023
23	234726	5909967	NA	NA		No evidence of hole at coordinates	10/11/2023
25	234748	5910182	NA	NA		No evidence of hole at coordinates	10/11/2023

Notes: 1. Surface elevations taken from 50cm resolution LiDAR data supplied by Groundwork Plus

Appendix E: Groundwater Laboratory Report



Envirolab Services Pty Ltd ABN 37 112 535 645 - 002 25 Research Drive Croydon South VIC 3136 ph 03 9763 2500 fax 03 9763 2633 melbourne@envirolab.com.au www.envirolab.com.au

CERTIFICATE OF ANALYSIS 40611

Client Details	
Client	Water Resource Solutions
Attention	Rohan Baird
Address	1131 Greenhill Rd, Uraidla 5142

Sample Details						
Your Reference	Mawsons - Blue Hills					
Number of Samples	5 Water					
Date samples received	10/11/2023					
Date completed instructions received	10/11/2023					

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on an as received basis for waters.

Please refer to the last page of this report for any comments relating to the results.

Report Details							
Date results requested by	17/11/2023						
Date of Issue	17/11/2023						
NATA Accreditation Number 2901. This document shall not be reproduced except in full.							
Accredited for compliance with ISO/IEC 17	7025 - Testing. Tests not covered by NATA are denoted with *						

Results Approved By Chris De Luca, Assistant Lab Manager Tara White, Metals Team Leader <u>Authorised By</u> Pamela Adams, Laboratory Manager



All metals in water-dissolved								
Our Reference				40611-1	40611-2	40611-3	40611-4	40611-5
Your Reference	UNITS	PQL	Rec. Max.	Site 1	Site 2	Site 3	Site 4	Duplicate
Date Sampled				09/11/2023	09/11/2023	09/11/2023	09/11/2023	09/11/2023
Type of sample				Water	Water	Water	Water	Water
Date prepared	-			13/11/2023	13/11/2023	13/11/2023	13/11/2023	13/11/2023
Date analysed	-			13/11/2023	13/11/2023	13/11/2023	13/11/2023	13/11/2023
Aluminium-Dissolved	µg/L	10	200	32	<10	29	<10	46
Arsenic-Dissolved	µg/L	1	10	5	<1	2	<1	5
Beryllium-Dissolved	µg/L	0.5	60	<0.5	<0.5	<0.5	<0.5	<0.5
Boron-Dissolved	µg/L	20	4000	50	40	40	40	50
Cadmium-Dissolved	µg/L	0.1	2	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	1	50	<1	<1	<1	<1	<1
Cobalt-Dissolved	µg/L	1		<1	<1	4	1	<1
Copper-Dissolved	µg/L	1	1000	<1	<1	<1	<1	<1
Iron-Dissolved	µg/L	10	300	18	<10	<10	<10	23
Mercury-Dissolved	µg/L	0.05	1	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium-Dissolved	µg/L	1		130	270	79	120	130
Lead-Dissolved	µg/L	1	10	<1	<1	<1	<1	<1
Molybdenum-Dissolved	µg/L	1	50	3	8	16	28	3
Manganese-Dissolved	µg/L	5	100	82	49	420	340	84
Nickel-Dissolved	µg/L	1	20	4	2	9	12	4
Selenium-Dissolved	µg/L	1	10	<1	<1	33	<1	<1
Uranium-Dissolved	µg/L	0.5	17	3.3	6.2	17	1.5	3.3
Vanadium-Dissolved	µg/L	1		<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	1	3000	8	1	2	2	8

Metals in Waters - Acid extractable								
Our Reference				40611-1	40611-2	40611-3	40611-4	40611-5
Your Reference	UNITS	PQL	Rec. Max.	Site 1	Site 2	Site 3	Site 4	Duplicate
Date Sampled				09/11/2023	09/11/2023	09/11/2023	09/11/2023	09/11/2023
Type of sample				Water	Water	Water	Water	Water
Date prepared	-			13/11/2023	13/11/2023	13/11/2023	13/11/2023	13/11/2023
Date analysed	-			13/11/2023	13/11/2023	13/11/2023	13/11/2023	13/11/2023
Phosphorus - Total	mg/L	0.05		0.07	0.05	0.1	0.05	0.08

Miscellaneous Inorganics								
Our Reference				40611-1	40611-2	40611-3	40611-4	40611-5
Your Reference	UNITS	PQL	Rec. Max.	Site 1	Site 2	Site 3	Site 4	Duplicate
Date Sampled				09/11/2023	09/11/2023	09/11/2023	09/11/2023	09/11/2023
Type of sample				Water	Water	Water	Water	Water
Date prepared	-			10/11/2023	10/11/2023	10/11/2023	10/11/2023	10/11/2023
Date analysed	-			10/11/2023	10/11/2023	10/11/2023	10/11/2023	10/11/2023
рН	pH Units		6.5-8.5	8.4	8.4	8.4	8.0	8.5
Electrical Conductivity	µS/cm	1		1,500	6,000	1,300	3,800	1,500
Total Dissolved Solids (grav)	mg/L	5	600	920	3,000	710	2,000	1,000
Fluoride, F	mg/L	0.1	1.5	0.4	0.3	0.4	0.2	0.4
Total Nitrogen in water	mg/L	0.1		0.2	0.4	0.4	0.1	0.2
NOx as N in water	mg/L	0.005		0.020	0.060	0.10	0.01	0.020
TKN in water	mg/L	0.1		0.2	0.3	0.3	0.1	0.2
Nitrate as N in water	mg/L	0.005	50	0.020	0.030	0.090	0.01	0.020
Nitrite as N in water	mg/L	0.005	3	<0.005	0.030	0.006	<0.005	<0.005

Ion Balance								
Our Reference				40611-1	40611-2	40611-3	40611-4	40611-5
Your Reference	UNITS	PQL	Rec. Max.	Site 1	Site 2	Site 3	Site 4	Duplicate
Date Sampled				09/11/2023	09/11/2023	09/11/2023	09/11/2023	09/11/2023
Type of sample				Water	Water	Water	Water	Water
Date prepared	-			10/11/2023	10/11/2023	10/11/2023	10/11/2023	10/11/2023
Date analysed	-			11/11/2023	11/11/2023	11/11/2023	11/11/2023	11/11/2023
Calcium - Dissolved	mg/L	0.5	NS	16	74	16	58	15
Potassium - Dissolved	mg/L	0.5	NS	6.7	19	6.5	11	6.0
Sodium - Dissolved	mg/L	0.5	180	210	670	130	500	200
Magnesium - Dissolved	mg/L	0.5	NS	64	270	61	170	60
Hydroxide Alkalinity (OH ⁻) as CaCO ₃	mg/L	5	NS	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as CaCO ₃	mg/L	5	NA	530	540	330	680	520
Carbonate Alkalinity as CaCO ₃	mg/L	5	NS	17	19	5	<5	20
Total Alkalinity as CaCO ₃	mg/L	5	NS	550	560	340	680	540
Sulphate, SO4	mg/L	1	250	13	180	38	42	13
Chloride, Cl	mg/L	1	250	170	1,700	190	850	170
Hardness	mgCaCO 3 /L	3	200	300	1,300	290	840	290
Ionic Balance	%		15	-2.9	-6.9	-4.9	0.46	-4.8

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at $180\pm10^{\circ}$ C. NOTE: Where the EC of the sample is < 100μ S/cm, the TDS will typically be below 70mg/L (as the sample is very likely to be at least drinking water quality). Therefore to ensure data quality for TDS, the TDS is typically calculated as per the equation below:- TDS = EC * 0.6
Inorg-026	Fluoride determined by ion selective electrode (ISE) in accordance with APHA latest edition, 4500-F-C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-055	Nitrate/Nitrite/NOx - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055	Nitrate/Nitrite/NOx - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055/062	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Inorg-062	TKN - determined colourimetrically. Alternatively, TKN can be derived from calculation (Total N - NOx).
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110-B. Water samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Metals-022 ICP-MS	Determination of various metals by ICP-MS.
	Please note for Bromine and lodine, any forms of these elements that are present are included together in the one result reported for each of these two elements.

QUALITY CON	TROL: All m	etals in w	ater-dissolved			Du	plicate	Spike Recovery %				
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	40611-2		
Date prepared	-			13/11/2023	1	13/11/2023	13/11/2023		13/11/2023	13/11/2023		
Date analysed	-			13/11/2023	1	13/11/2023	13/11/2023		13/11/2023	13/11/2023		
Aluminium-Dissolved	µg/L	10	Metals-022 ICP-MS	<10	1	32	31	31 3		122		
Arsenic-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	5	5	0	107	109		
Beryllium-Dissolved	µg/L	0.5	Metals-022 ICP-MS	<0.5	1	<0.5	<0.5	0	106	105		
Boron-Dissolved	µg/L	20	Metals-022 ICP-MS	<20	1	50	50	0	112	116		
Cadmium-Dissolved	µg/L	0.1	Metals-022 ICP-MS	<0.1	1	<0.1	<0.1	0	109	108		
Chromium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	<1	<1	0	108	107		
Cobalt-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	<1	<1	0	101	97		
Copper-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	<1	<1 0		106	100		
Iron-Dissolved	µg/L	10	Metals-022 ICP-MS	<10	1	18	19	5	112	112		
Mercury-Dissolved	µg/L	0.05	Metals-021 CV-AAS	<0.05	1	<0.05	<0.05 0		111	102		
Lithium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	130	130	0	111	118		
Lead-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	<1	<1	0	102	101		
Molybdenum-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	3	3	0	108	116		
Manganese-Dissolved	µg/L	5	Metals-022 ICP-MS	<5	1	82	84	2	108	110		
Nickel-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	4	4	0	107	102		
Selenium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	<1	<1	0	107	104		
Uranium-Dissolved	µg/L	0.5	Metals-022 ICP-MS	<0.5	1	3.3	3.3	0	102	105		
Vanadium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	<1	<1	0	108	112		
Zinc-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	1	8	9	12	107	105		

QUALITY CONTRO	OL: Metals ir	Waters	- Acid extractable			Du		Spike Recovery %			
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]	
Date prepared	-			13/11/2023	1	13/11/2023	13/11/2023		13/11/2023	[NT]	
Date analysed	-			13/11/2023	1	13/11/2023	13/11/2023		13/11/2023	[NT]	
Phosphorus - Total	mg/L	0.05	Metals-020 ICP- AES	<0.05	1	0.07	0.08	13	101	[NT]	

QUALITY COI	NTROL: Mise	cellaneou	s Inorganics			Du	plicate	Spike Recovery %			
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]	
Date prepared	-			10/11/2023	1	10/11/2023	10/11/2023		10/11/2023	[NT]	
Date analysed	-			10/11/2023	1	10/11/2023	10/11/2023		10/11/2023		
рН	pH Units		Inorg-001	[NT]	1	8.4	8.4	0	100	[NT]	
Electrical Conductivity	μS/cm	1	Inorg-002	<1	1	1500	1500	0	95	[NT]	
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	1	920	910	1	89	[NT]	
Fluoride, F	mg/L	0.1	Inorg-026	<0.1	1	0.4	[NT]		101	[NT]	
Total Nitrogen in water	mg/L	0.1	Inorg-055/062	<0.1	1	0.2	0.2	0	[NT]	[NT]	
NOx as N in water	mg/L	0.005	Inorg-055	<0.005	1	0.020	0.020	0	92	[NT]	
TKN in water	mg/L	0.1	Inorg-062	<0.1	1	0.2	0.1	67	77	[NT]	
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	1	0.020	0.020	0	[NT]	[NT]	
Nitrite as N in water	mg/L	0.005	Inorg-055	<0.005	1	<0.005	<0.005	0	101	[NT]	

QUALI	TY CONTRC	L: Ion Ba		Du	plicate		Spike Recovery %			
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			10/11/2023	1	10/11/2023	10/11/2023		10/11/2023	
Date analysed	-			11/11/2023	1	11/11/2023	11/11/2023		11/11/2023	
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP- AES	<0.5	1	16	16	0	115	
Potassium - Dissolved	mg/L	0.5	Metals-020 ICP- AES	<0.5	1	6.7	6.4	5	108	
Sodium - Dissolved	mg/L	0.5	Metals-020 ICP- AES	<0.5	1	210	190	10	95	
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP- AES	<0.5	1	64	60	6	111	
Hydroxide Alkalinity (OH $^{-}$) as CaCO $_{3}$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	
Bicarbonate Alkalinity as CaCO ₃	mg/L	5	Inorg-006	<5	1	530	530	0	97	
Carbonate Alkalinity as CaCO ₃	mg/L	5	Inorg-006	<5	1	17	19	11	[NT]	
Total Alkalinity as CaCO ₃	mg/L	5	Inorg-006	<5	1	550	550	0	97	
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	13	13	0	97	
Chloride, Cl	mg/L	1	Inorg-081	<1	1	170	200	16	92	
Hardness	mgCaCO 3 /L	3		[NT]	1	300	280	7	[NT]	
Ionic Balance	%		Inorg-040	[NT]	1	-2.9	-8.3	-96	[NT]	[NT]

Result Definiti	ons
NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control	I Definitions
Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

ION BALANCE: The mass inbalance may be caused by other ions that have not been measured or not been included in the mass balance calculation.

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Envirolab Sampie ID (Lab use only)	Client Sample ID or Information	Depth	Date Sampled	Type of Sample	pH, EC, TDS	ionic batance (major antons-to atkatinity, OH, CO3, HCO3, sulphate, chloride, ffuoride an cations Ca, Mg, K, Na)	nurrients (total N, nitrate, nitrit total P)	Dissolved and Total Metals (A As, Be, B, Cd, Cr, Co, Cu, Fe, Hg, Li, Pb, Mo, Mn, Ni, Se, U, Zn)	Pectheldese (Clears, Christ, acid Tarbicides)								Provide as much Information about tha sample as you can
1	Site 1	-	09/11/25	Grandwood	V								_				
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Appendix F: Groundwater Chemistry Data

			Aluminium (filtered)	Arsenic (filtered)	Beryllium (filtered)	Boron (filtered)	Cadmium (filtered)	Chromium (III+VI)	Cobalt (filtered)	Copper (filtered)	Iron (filtered)	Marri Inv (filterad)	(fithornal)	1	Molinh domina (filtered)	Manganese (filtered)	Nickel (filtered)	Selenium (filtered)	Uranium (filtered)	Vanadium (filtered)	Zinc (filtered)
	Uni	its mg/L	m	g/L n	ng/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2011	(Updated 2022) Health		-	0.01	0.06	4	0.002	-	-	2	-	0.00	1	- 0.0	1 0.0	5 0.	5 0.02	0.01	0.017	-	
ANZECC 20	000, HM IRR LTV <100y		5	0.1	0.1	0.5	0.01	0.1	0.05	0.2	0.2	0.00	2 2	5	2 0.0	1 0.	2 0.2	0.02	0.01	0.1	2
ANZECC 2	2000, HM IRR STV <20y		20	2	0.5	-	0.05	1	0.1	5	10	0.00	2 2	5	5 0.0	5 1	0 2	0.05	0.1	0.5	5
ANZECC 200	00, Stock Drinking Water		5	0.5	-	5	0.01	1	1	-	-	0.00	2	- 0	1 0.1	5	- 1	0.02	0.2	-	20
Site 1 40611	09/11/20	23 0	0.032	0.005	< 0.0005	0.05	0.0005	< 0.001	< 0.001	< 0.01	0.018	< 0.0000	5 0.1	3 < 0.00	1 0.00	3 0.08	2 0.004	< 0.002	0.0033	< 0.001	0.008
Site 2 40611	09/11/20	23 <	0.01	< 0.001	< 0.0005	0.04	0.0005	< 0.001	< 0.001	< 0.01	< 0.01	< 0.0000	5 0.2	7 <0.00	0.00	8 0.04	9 0.002	< 0.003	0.0062	< 0.001	0.001
Site 3 40611	09/11/20	23 0	0.029	0.002	< 0.0005	0.04	0.0005	< 0.001	0.004	< 0.01	< 0.01	< 0.0000	5 0.07	9 <0.00	1 0.01	6 0.4	2 0.009	0.033	0.017	< 0.001	0.002
Site 4 40611	09/11/20	23 <	0.01	< 0.001	< 0.0005	0.04	0.0005	< 0.001	0.001	< 0.01	< 0.01	< 0.0000	5 0.1	2 <0.00	1 0.02	8 0.3	4 0.012	< 0.003	0.0015	< 0.001	0.002
				1	-	-	1										-	1			
		s Phosphorus	Ha		Electrical Conduct ivity	 Iotal Dissolved Solids(grav) 	s Truchuce FTotal Nitrogen in water	s NOx as N in water	s TKN in water	s Nitrate as N in water	s Nitrite as N in water	 Calcium - Dissolved 	s Potassium - Dissolved	sodium - Dissolved	- Magnesium - Dissolved	 Hydroxide Alkalinity (OH-)as CaCO3 	 bicarbonate Aikalinity ascacu3 Carbonate Aikalinity ascac03 	Total Alkalinity as CaCO3		s Sulpriate, 504	Hardness
10110 2014 /	Units	mg/L	pH Units	s μS/o	cm mg	/L mg/	'L mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ng/L n	g/L mg	/L mg/	_ mg/L	mg	/L mg/	L mgCaCO3/L
ADWG 2011 (-				1.	1 5000														
ANZECC 200		0.05					2 125000														
ANZECC 200	Stock Drinking Water	12					2 125000														
7.112200 2000,	Jocos Dinking Water																				
Site 1 40611	09/11/2023	0.07	8.4	4 15	i00 9:	20 0.	4 0.2	0.02	0.2	0.02	<0.005	16	6.7	210	64	<5 5	30 1	7 550		13 17	0 300
Site 2 40611	09/11/2023	0.05	8.4	4 60	00 30	00 0.	3 0.4	0.06	0.3	0.03	0.03	74	19	670	270	<5 5	40 19	560	1	30 170	0 1300
Site 3 40611	09/11/2023	0.1	8.4	4 13	00 7	10 0.	4 0.4	0.1	0.3	0.09	0.006	16	6.5	130	61	<5 3	30	5 340		38 19	0 290
Site 4 40611	09/11/2023	0.05	5	8 38	300 20	00 0.	2 0.1	0.01	0.1	0.01	< 0.005	58	11	500	170	<5 6	80 <	680		42 85	0 840