Appendix A

Bore Completion Report

Drilling and completion report

Stage 1 Groundwater Monitoring Network | Snowy 2.0

Prepared for Snowy Hydro Limited | 19 April 2018

Drilling and completion report

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Drilling and completion report

Final

Report J17188RP29 | Prepared for Snowy Hydro Limited | 19 April 2018

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1 Introduction

1.1 Project overview

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). This would be achieved by establishing a new underground hydro-electric power station that would increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and providing approximately 350 gigawatts hours (GWh) of storage available to the National Electricity Market (NEM) at any one time, which is critical to ensuring system security as Australia transitions to a decarbonised NEM. Snowy 2.0 would link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and hydro-electric power station.

Snowy 2.0 has been declared to be Critical State Significant Infrastructure (CSSI) by the NSW Minister for Planning under the provisions of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) and is defined in Clause 9 of Schedule 5 of the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). Separate applications and environmental impact statements (EIS) for different phases of Snowy 2.0 are being submitted under Part 5, Division 5.2 of the EP&A Act. The application for Exploratory Works is the first application for Snowy 2.0.

The purpose of the Exploratory Works for Snowy 2.0 is primarily to gain a greater understanding of the conditions at the proposed location of the power station, approximately 850 metres (m) below ground level. Understanding factors such as rock conditions, ground temperature and stress conditions is essential to confirm the suitability of the site for the underground power station.

1.2 Groundwater Assessment

The collection of field data is important for the accurate representation of hydrogeological conceptual and numerical groundwater flow models, which will inform the Groundwater Assessment in support of the EIS for the Exploratory Works. This assessment covers all issues relating to site water management, groundwater, and surface water and their related environmental and other uses.

A comprehensive groundwater monitoring network has been installed to provide hydrogeological field data which will be used to characterise the groundwater regime in and around the project area.

The report details the drilling and completion of the Stage 1 groundwater monitoring network, installed by EMM Consulting Pty Ltd (EMM) in consultation with NSW Department of Industry: Water (DoI Water) between January and April 2018.

2 Drilling program

2.1 Monitoring bore network

The Stage 1 groundwater monitoring network includes conventional groundwater monitoring bores, vibrating wire piezometers (VWPs), and shallow drive point piezometers located within and in the vicinity of the project area. Project monitoring bores and VWPs are positioned to provide spatial coverage, investigate the major hydrogeological environments, and monitor potentially sensitive features. Specifically, the groundwater monitoring network was designed to:

- identify and characterise water bearing units in the project area, with particular focus on characterising groundwater flow and quality;
- provide spatial representation and flux of pressure heads across the project area to investigate potential vertical hydraulic gradients and connectivity between water bearing units;
- investigate the potential for surface water–groundwater interaction; and
- monitor potential sensitive features, including alpine bogs, Yarrangobilly River, Murrumbidgee River, Tantangara Creek, Gooandra Creek and potential groundwater dependent ecosystems.

The network comprises 20 monitoring bores, including conventional standpipe piezometers and nested monitoring sites, at 11 locations. Nested monitoring bores are installed at selected monitoring locations allowing multiple hydrogeological systems to be monitored in close proximity. Each nested site comprises a minimum of two monitoring bores with screened sections targeting major water bearing zones in the basalt, alluvium and underlying competent fractured volcanic and metasedimentary rock.

These installations allow assessment of the groundwater characteristics and the complex relationship occurring between shallow and deep groundwater systems at the same location. A schematic of a nested groundwater monitoring site is shown on Figure 2.1.

A summary of the installed monitoring bores is provided in Table 2.1, with locations shown on Figure 2.2 and bore construction logs provided in Appendix A.

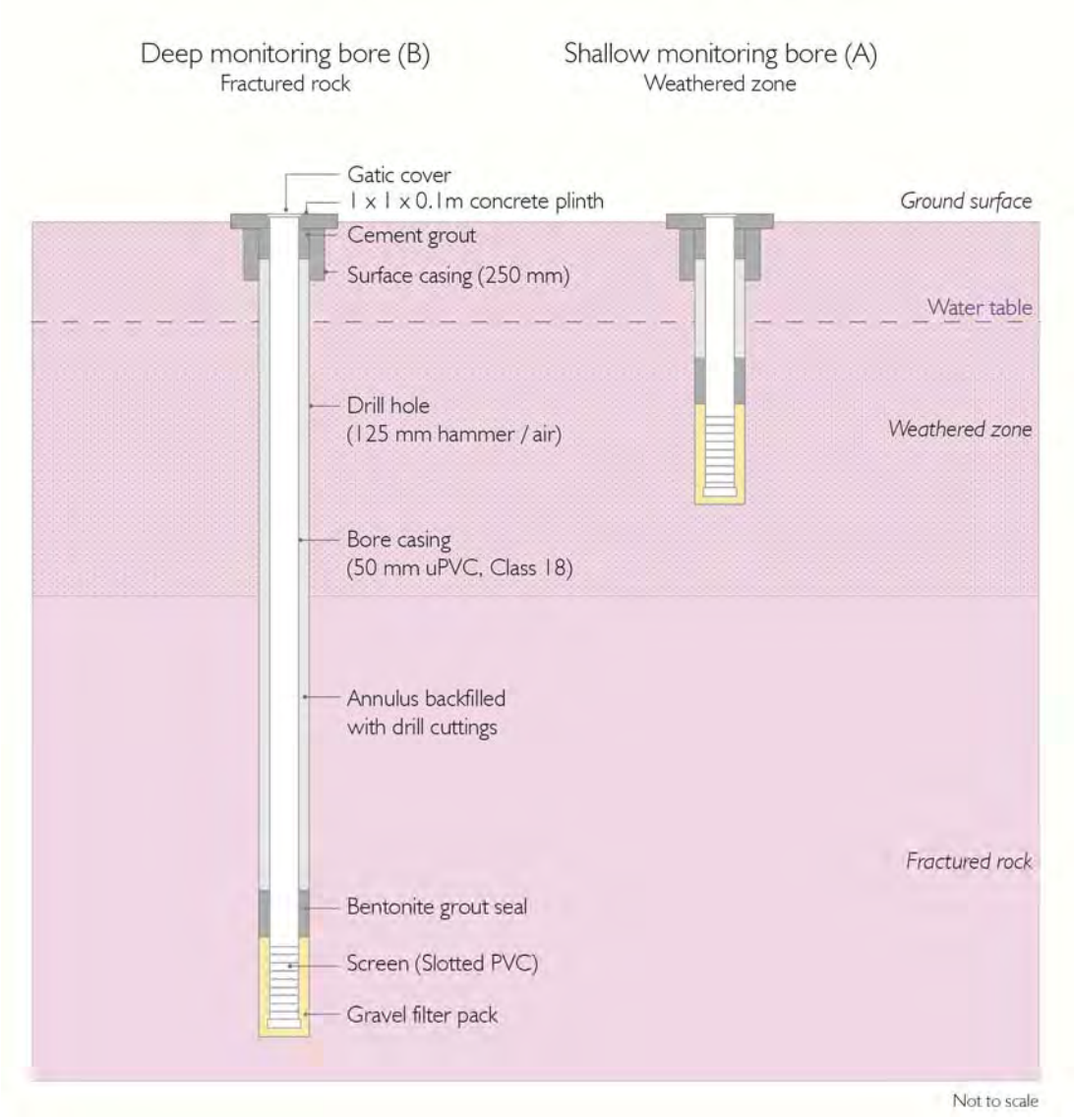


Figure 2.1 Typical nested groundwater monitoring site

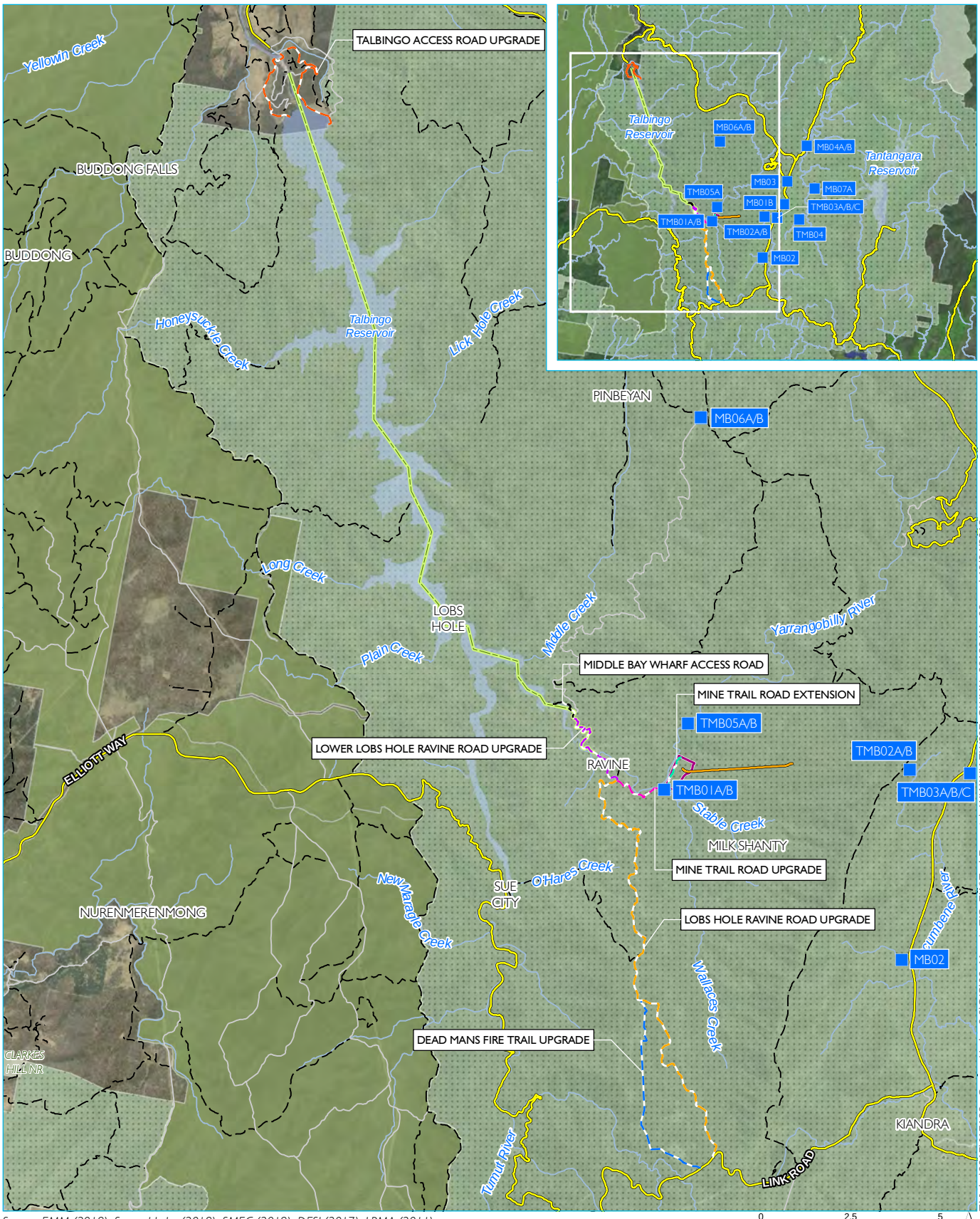
Table 2.1 Stage 1 groundwater monitoring bores

Bore ID	Easting[1]	Northing[1]	Ground level (mAHD)[2]	Total depth (mgbl)[3]	Screen (mbgl)	Monitored formation	Lithology
TMB01A	627670.5	6038074.1	581.2	15	11-14	Boraig Group	Ignimbrite
TMB01B	627677.7	6038070.0	581.8	72	63-69	Ravine Formation	Siltstone
TMB02A	634554.0	6038586.4	1469.6	15	11-14	Gooandra Volcanics	Basalt
TMB02B	634548.5	6038606.6	1472.3	200	191-197	Gooandra Volcanics	Chloritic schist
TMB03A	636224.2	6038504.3	1477.7	34	29.5-32.5	Gooandra Volcanics	Basalt
TMB03B	636215.2	6038505.1	1477.6	150	141-147	Gooandra Volcanics	Chloritic schist
TMB03C	636220.7	6038495.1	1478	250	237-249	Gooandra Volcanics	Chloritic schist
TMB04	639018.2	6038261.2	1345.8	200	191-197	Gooandra Volcanics	Chloritic schist
TMB05A	628370.7	6039896.0	601.7	19	12-18	Ravine Formation	Weathered siltstone
TMB05B	628370.9	6039896.0	601.7	77	68-74	Ravine Formation	Siltstone
MB01B	637059.5	6040238.0	1464.4	7.5	5.3-6.8	Tertiary Basalt	Basalt
MB01C	637065.7	6040245.3	1464.0	53	45-51	Gooandra Volcanics	Chloritic schist
MB02	634310.5	6033304.1	1386.7	150	141-147	Gooandra Volcanics	Chloritic schist
MB03	637491.0	6043212.7	1373.0	100	92-98	Gooandra Volcanics	Chloritic schist
MB04A	640023.4	6047809.3	1330.0	30	23-29	Gooandra Volcanics	Basalt
MB04B	640023.7	6047817.4	1330.0	102.5	93.5-99.5	Gooandra Volcanics	Chloritic schist
MB06A	628723.4	6048391.5	1145.4	14	9-12	Boraig Group	Ignimbrite
MB06B	628719.8	6048397.0	1145.5	72	64-70	Boraig Group	Ignimbrite
MB07A	641051.0	6042294.1	1265.0	15	10-13	Tantangara Formation	Weathered siltstone
MB07B	641042.9	6042294.0	1265.0	60	51-57	Tantangara Formation	Sandstone

Notes: *1. Coordinates in MGA 94 (Zone 55);*

2. mAHD = metres Australian Height Datum; and

3. mbgl = metres below ground level.



Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); DFSI (2017); LPMA (2011)

KEY

- Groundwater monitoring bore
- Talbingo access road upgrade
- Middle Bay Wharf access road
- Lower Lobs Hole Ravine Road upgrade
- Lobs Hole Ravine Road upgrade
- Mine Trail Road upgrade
- Mine Trail Road extension
- Dead Mans Fire Trail upgrade
- Indicative communications cable location
- Exploration tunnel and portal
- Exploratory tunnel portal and construction pad envelope
- Main road
- Local road
- Vehicular track
- Perennial watercourse
- Scheme storage
- Kosciuszko National Park
- Other NPWS reserve
- State forest

Groundwater monitoring locations

Snowy 2.0
Drilling and completion report
Stage 1 Groundwater Monitoring Network
Figure 2.2

2.2 Monitoring bore licence

A test (monitoring bore) licence (40BL192701) under the Water Act 1912 was obtained by Snowy Hydro from DoI Water prior to the commencement of the drilling program (Appendix B). Form A: Particulars of Completed Works forms (drilling completion forms) were submitted to DoI Water following monitoring bore installation and are included in Appendix C.

2.3 Drilling and construction specifications

2.3.1 Overview

Highland Drilling was engaged by EMM to undertake borehole drilling and monitoring bore construction and installation. EMM provided the design and specification, and undertook project management and hydrogeological supervision during the drilling program.

All monitoring bores were drilled and constructed in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2012). Drilling and construction was a minimal impact temporary activity with the final constructed bore presenting at the surface as a 100 millimetre (mm) high, 1 x 1 m concrete slab and flush galvanised steel gatic plate (see Figure 2.1).

2.3.2 Drilling

Boreholes were drilled using an open hole (rotary percussion) technique using air (under pressure) to evacuate cuttings from the borehole during drilling. This drilling method ensured water quality and indicative yields could be recorded throughout the drilling process without contamination or interference.

All water produced from the bores during drilling was controlled in a series of above ground tanks and disposed of in accordance with the Snowy 2.0 Review of Environmental Factors (REF) (SHL 2018). Water for drilling was sourced from licensed supply in the Snowy Hydro village of Cabramurra. There were no instances of uncontrolled release of water; water was discharged only when it met the water quality limits specified in the REF. All drilling fluids and water that did not comply with REF limits was contained in above-ground tanks and disposed of at a licensed waste facility.

Geology was logged at 1 m intervals and instantaneous water flow recorded at the end of each drill rod (every 6 m) once drilling had penetrated the water table. Water quality physico-chemical parameters were measured using a calibrated YSI^{TM} water quality meter and included temperature, Electrical Conductivity (EC), pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS) and Oxidation Reduction Potential (ORP). The parameters concentrations are shown on the geological bore logs in Appendix A.

Airlift development was continuous during drilling and the boreholes were further developed once the target depth was reached until the discharge water was free of sediment and the water quality physico-chemical parameters stabilised.

The bores were designed such that the screened section of the monitoring bores was aligned with the target water bearing zone. A washed and graded (3 to 5 mm) gravel filter pack was installed in the annulus around the screen and extended a minimum of 3 m above the screened section.

Coated bentonite pellets were installed 3 to 5 m above the gravel pack. Blue metal gravel backfill was placed above the bentonite seal and finally a cement grout mix was then injected in a controlled manner to seal the annulus to the ground surface. The bentonite seal and cement grout ensure hydraulic isolation of the screened section preventing any flow of groundwater through the annulus of the bore.

3 Field testing

3.1 Hydraulic conductivity testing

Falling and rising head ('slug') tests were conducted at most monitoring bores to estimate the horizontal hydraulic conductivity of the screened water bearing zone.

A falling head test is achieved by introducing a 'slug' device to displace the water column within the monitoring bore causing the water level to instantaneously rise and water to flow from the bore into the aquifer via the well screen (Butler 1998). The water level decay is recorded until the water level has returned to static level.

A rising head test is then conducted where the slug is removed causing a reduction in the bore water level with respect to the screened formation. Water then moves from the formation into the bore via the well screen. The water level recovery is recorded until the water level has returned to static level.

Hydraulic testing results (K values) from the installed Stage 1 bores are shown in Table 3.1.

Table 3.1 Hydraulic conductivity results for Stage 1 monitoring bores

Monitoring Bore	Formation	Average Hydraulic conductivity (K) (m/day)[1]
TMB01A	Boraig Group	3.27
TMB01B	Ravine Formation	0.00034
TMB02A	Gooandra Volcanics	0.11
TMB02B	Gooandra Volcanics	0.59
TMB05A	Ravine Formation	0.13
TMB05B	Ravine Formation	0.006
MB01B	Tertiary Basalt	11.4
MB01C	Gooandra Volcanics	41.9
MB02	Gooandra Volcanics	0.037
MB03	Gooandra Volcanics	4.2
MB04A	Gooandra Volcanics	0.013
MB04B	Gooandra Volcanics	0.017
MB07A	Tantangara Formation	55.1
MB07B	Tantangara Formation	0.013

Note: 1. Average values calculated from analysis of falling and rising head tests.

3.2 Groundwater levels

Groundwater level monitoring began in January 2018 at MB01B/C and has expanded to include all 20 monitoring bores as the bores have been progressively drilled and constructed.

SolinstTM pressure transducers and data loggers are installed in all the project groundwater monitoring bores and record groundwater level fluctuations every six hours. When the loggers were downloaded, manual groundwater level measurements were also recorded to calibrate the logger data. A barometric data logger installed above the water table at TMB02A records changes in atmospheric pressure. Data

from this logger is used to correct for the effects of changing barometric pressure and barometric efficiency on groundwater levels.

3.3 Groundwater quality monitoring

3.3.1 Sampling methodology

An initial round of groundwater quality monitoring was completed following each monitoring bore installation. Groundwater quality monitoring is then scheduled to continue at a monthly frequency.

The groundwater sampling method used across the monitoring network has been selected based on the hydraulic conductivity of the screened formations. Dedicated low-flow double valve pumps have been installed in each the screen section of each monitoring bores. During sampling, water quality parameters (including pH, temperature and electrical conductivity (EC)) are measured during purging and pumping to monitor water quality changes, and to indicate representative groundwater suitable for sampling and analysis.

Water quality samples were collected in laboratory provided sample bottles, with appropriate preservation. Samples undergoing dissolved metal analysis were filtered through a 0.45 µm filter in the field before collection in nitric acid preserved plastic sample bottles. Samples were stored on ice and sent to the laboratory under appropriate chain-of-custody protocols.

Groundwater samples are analysed by ALS for either the standard or comprehensive suite of analytes shown in Table 3.2.

Table 3.2 Analytical suite

Suite	Analytes
Physico-chemical properties	Field parameters (pH, EC, redox potential, DO, temperature) EC, TDS, TSS
Major ions	calcium, magnesium, sodium, potassium, sulphate, chloride, alkalinity
Dissolved metals	arsenic, cadmium, chromium, copper, fluoride, lead, magnesium, nickel, zinc
Nutrients	ammonia as N, nitrite as N, nitrate as N, reactive phosphorous, phosphorous, total phosphorus

Field and laboratory QA/QC procedures are used to establish accurate, reliable and precise results. Some QA/QC procedures included: analysis of unstable parameters in the field, calibration of equipment, submitting laboratory samples within holding times, collection of blind duplicate samples, keeping samples chilled and wearing gloves during sampling.

3.3.2 Results

Groundwater quality results collected between February 2018 and April 2018 are presented as an average for each monitoring site in Table 3.3. Laboratory certificates are presented in Appendix D.

Table 3.3 Mean groundwater quality results (February 2018 – April 2018)

Analyte	Units	ANZECC/ ARMCANZ 99% protection	MB01B	MB01C	MB02	MB03	MB04A	MB04B	TMB02A	TMB02B	TMB03A	TMB03B	TMB04	TMB05A	TMB05B	MB07A	MB07B
Formation			**Tertiary basalt**	**Gooandra Volcanics**	**Gooandra Volcanics**	**Gooandra Volcanics**	**Gooandra Volcanics (w)**	**Gooandra Volcanics**	**Gooandra Volcanics (w)**	**Gooandra Volcanics**	**Gooandra Volcanics (w)**	**Gooandra Volcanics**	**Gooandra Volcanics**	**Ravine Beds (w)**	**Ravine Beds**	**Tantangara Formation (w)**	**Tantangara Formation**
Field analytes																	
pH	-	6.5-7.5	6	7.94	7.01	6.6	7.715	8.97	5.8	8.24	6.3	7.64	8.57	8.18	9.18	7.32	9.34
EC[1]	µS/cm	30-350	95.85	183	138	144	261	553	35.3	132	99.8	206	80.2	948	613	59	437
Temperature	°C	-	13.2	9.7	10.5	13.3	12.7	10	10.9	11	10.9	9.7	9.2	18.2	18.8	10.3	13.1
Dissolved oxygen	mg/L	-	4.48	-	-	4.44	4.5	-	-	-	-	-	-	-	-	-	-
Laboratory analytes																	
TDS[2]	mg/L	-	269	127	79	121.5	193	1015	98	80	110	138	56	627	484	94	312
Major ions																	
Calcium	mg/L	-	8.5	14	16	13	29.5	8.5	4	13	6.5	18	9	35	6	4	55
Chloride	mg/L	-	1	1	3	4	5.5	45	0.5	0.5	5.5	4	0.5	9	10	1	5
Magnesium	mg/L	-	4.5	6	2	4.5	2.5	1	0.5	2	3	2.5	0.5	8	4	2	4
Sodium	mg/L	-	5.5	9	3	5.5	14.5	108.5	1	7	6	11	3	148	142	3	13
Potassium	mg/L	-	0.05	1	0.05	9	1.5	2	0.5	0.5	1	3	0.5	11	8	0.5	3
Sulfate	mg/L	-	5	13	14	7.5	60.5	86	6	8	6	18.5	5	348	22	9	158
Fluoride	mg/L	-	0.005	0.05	0.1	0.005	0.4	0.55	0.05	0.2	0.1	0.45	0.05	1.1	1.5	0.05	0.5
Alkalinity																	
Bicarbonate as CaCO3	mg/L	-	53	81	45.5	67	59	128	12	56	38.5	74	33	117	198	18	22
Carbonate as CaCO3	mg/L	-	0.5	0.5	0.05	0.5	0.5	5	0.5	0.5	0.5	0.5	0.5	0.5	128	0.5	0.5
Hydroxide as CaCO3	µg/L	-	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Total as CaCO3	mg/L	-	53	81	45.5	67	59	130.5	12	56	38.5	74	33	117	326	18	22
Total metals																	
Arsenic	mg/L	-	0.0005	0.009	0.0005	0.0005	0.001	0.002	0.0005	0.004	0.001	0.0145	0.0005	0.01	0.011	0.0005	0.002
Cadmium	mg/L	0.00006	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.0001	0.00005	0.00005	0.00005	0.0005	0.00005	0.00005
Chromium (III+VI)	mg/L	-	0.0005	0.0005	0.0005	0.002	0.002	0.0005	0.001	0.0005	0.0005	0.0005	0.002	0.003	0.013	0.0005	0.002
Copper	mg/L	0.001	0.066	0.0005	0.0045	0.054	0.0475	0.006	0.009	0.007	0.007	0.048	0.101	0.004	0.003	0.007	0.098
Mercury	mg/L	0.00006	0.00005	0.00005	0.00005	0.0011	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005
Nickel	mg/L	0.008	0.007	0.0005	0.002	0.003	0.003	0.002	0.002	0.001	0.0025	0.003	0.002	0.001	0.003	0.002	0.002
Zinc	mg/L	0.0024	0.148	0.00025	0.039	0.0705	0.116	0.018	0.037	0.015	0.0405	0.0655	0.119	0.007	0.012	0.027	0.105
Lead	mg/L	0.001	0.007	0.005	0.001	0.005	0.004	0.002	0.002	0.001	0.001	0.005	0.006	0.0005	0.0005	0.001	0.005
Nutrients																	
Ammonia as N	mg/L	-	1.95	0.6	1.6	1.4	0.75	0.9	0.5	0.6	0.35	0.3	0.5	0.3	0.08	0.6	0.6
Kjeldahl Nitrogen Total	mg/L	-	0.6	0.4	0.2	0.25	0.35	0.55	0.7	0.2	0.2	0.45	0.2	0.6	0.3	0.2	1
Nitrate (as N)	mg/L	-	0.035	0.005	0.08	0.25	0.52	0.66	0.005	0.01	0.01	0.03	0.04	0.03	0.2	0.17	0.005
Nitrite (as N)	mg/L	-	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.06
Nitrogen (Total)	mg/L	2.5	6	4	2.5	5.5	9	9	7	2	2	4.5	2	6	5	4	11
Phosphorus	mg/L	-	16.915	0.11	0.05	0.54	0.185	0.665	0.09	0.07	0.1	0.075	0.13	0.66	0.03	0.18	1.66

Notes: 1.EC = electrical conductivity; and

2. TDS = total dissolved solids.

The groundwater quality results are reasonably comparable between the different target formations across the larger Snowy 2.0 project area. The pH is slightly alkaline, averaging 7.5. Salinity varies across the Snowy 2.0 project area, fresher (201 µS/cm) to the east of Long Plain Fault across the plateau area and marginal (780 µS/cm) west of the fault, within the Ravine Beds and the Exploratory Works project area. There is a range of total suspended solids values; this is likely associated with bore construction rather than groundwater quality.

The dominant water type for each monitored formation is shown in Table 3.4. The dominant hydrochemical water type in the Ravine Beds (within the Exploratory Works project area) was Ca-Na-SO_4-$CaCO_3$. The strong sodium component in the Ravine Beds (siltstone) is likely the result of the original marine deposition within the incised ravine area.

The predominant hydrochemical water type in the Gooandra Volcanics, the dominant monitored lithology east of the Long Plain Fault is Ca-SO_4-$CaCO_3$. Natural sources of sulfate include rock weathering, specifically dissolution of pyrite, input from volcanoes and biochemical processes (Herojeet et al 2013). This corresponds with the mineralogy of the volcanic rocks across the plateau area.

Table 3.4 Dominant major ion chemistry for each groundwater system

Groundwater system	Water type
Tertiary basalt	Mg-Ca-Na-SO_4
Gooandra Volcanics	Ca- SO_4-$CaCO_3$
Gooandra Volcanics (weathered)	Ca- SO_4-$CaCO_3$
Tantangara Formation	Ca- SO_4-$CaCO_3$
Ravine Beds	Ca-Na-SO_4-$CaCO_3$

Concentrations of most dissolved metals are typically low for most samples collected from each groundwater system, with many measurements below detection limits. This is typical of groundwater with reasonably neutral pH.

4 Conclusions

A Stage 1 network of 20 groundwater monitoring bores was installed at 11 sites between January and April 2018. The network includes conventional standpipe piezometers and nested monitoring sites. Nested monitoring bores are installed at selected monitoring locations allowing multiple hydrogeological systems to be monitored in close proximity. Each nested site comprises a minimum of two monitoring bores with screened sections targeting major water bearing zones in the basalt, alluvium and underlying competent fractured volcanic and metasedimentary rock.

On completion each bore was subject to a program of field testing including permeability testing (raising and falling head tests) and a water sampling program. Data loggers are installed in each bore set to record groundwater level fluctuations every six hours.

References

Butler, J.J., Jr. 1988, *Pumping tests in nonuniform aquifers—the radially symmetric case*, Journal of Hydrology, vol. 101, pp. 15-30.

NUDLC 2012, *Minimum Construction Requirements for Water Bores in Australia National Third edition*, Australian Government National Water Commission, Uniform Drillers Licensing Committee.

Appendix A

Geological and bore construction logs

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WATER MONITORING BORE LOG

Bore ID: MB01B

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed:	18/01/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1464.4 mAHD
Drilling method:	Air rotary	**Easting:**	637059.5
Hydrogeologist:	S Cassidy	**Northing:**	6040238.0

Static Water Level: 3.5 mbgl **Screened Formation:** Tertiary Basalt **Date:** 18/01/18

Total depth: 12 mbgl **Screened depth:** 5.3 - 6.8 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		CLAY medium to dark orangey brown, extremely weathered, METABASALT 10% fine grained, black	Water Cut: 0.8 L/s, EC: 122.1 µS/cm, pH: 7.45	Cement grout Blue metal gravel backfill (5-8mm wash) 50mm blank PN18 U-PVC casing (threaded) Bentonite seal Gravel pack (5mm wash) 5 1/2 inch diameter borehole 50mm slotted PN18 U-PVC casing (0.5mm aperture) 50mm blank PN18 U-PVC sump (threaded) Hole collapsed to 7.1m	
2					
4					
6	Tertiary Basalt	BASALT fine to medium grained, brown, slightly oxidised, clay 0.1 medium orangey brown			
8		BASALT fine to medium grained, black, slightly oxidised, oxidation on broken surfaces. Weathered material from above			
10					
12					

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WATER MONITORING BORE LOG

Bore ID: MB01C

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed: 16/01/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: S Cassidy

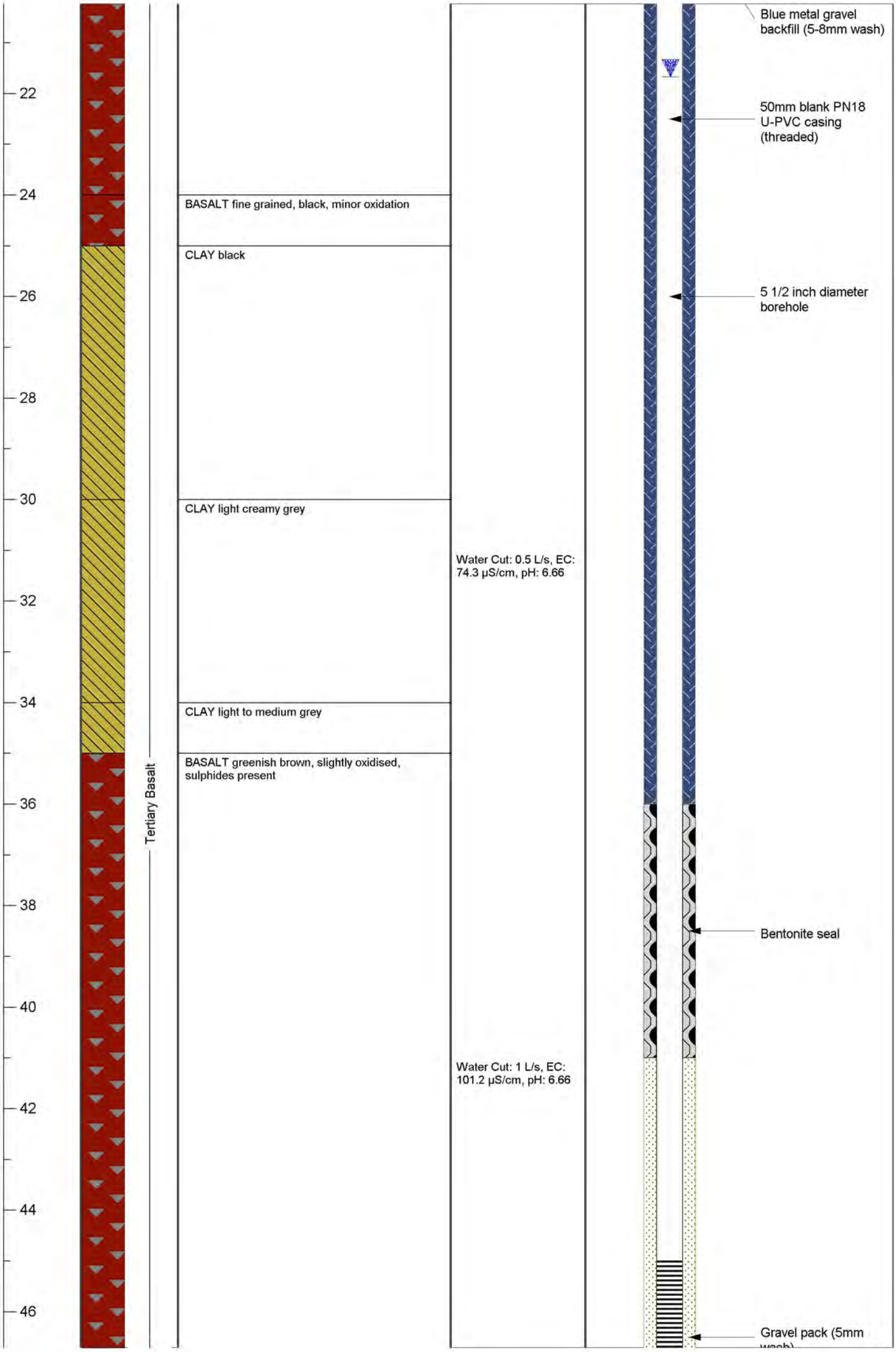
Project number: J17188
Elevation: 1464.0 mAHD
Easting: 637065.7
Northing: 6040245.3

Static Water Level: 21.5 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 16/01/18

Total depth: 52 mbgl **Screened depth:** 45 - 51 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		BASALT dark bluish black, fill from laydown area		Cement grout	
2		BASALT medium orangey brown, extremely weathered, BASALT 10% fine to medium grained, black, fresh			
4				6 inch steel surface casing	
6		NO SAMPLE no returns			
8					
10					
12		BASALT dark reddish black, slightly oxidised, BASALT 10% medium orangey brown, highly oxidised, oxidation of mineral crystals present	Water Cut: 0.5 L/s, EC: 160.7 µS/cm, pH: 6.6		
14					
16					
18				Blue metal gravel backfill (5-8mm wash)	
20		BASALT fine grained, black			

Tertiary Basalt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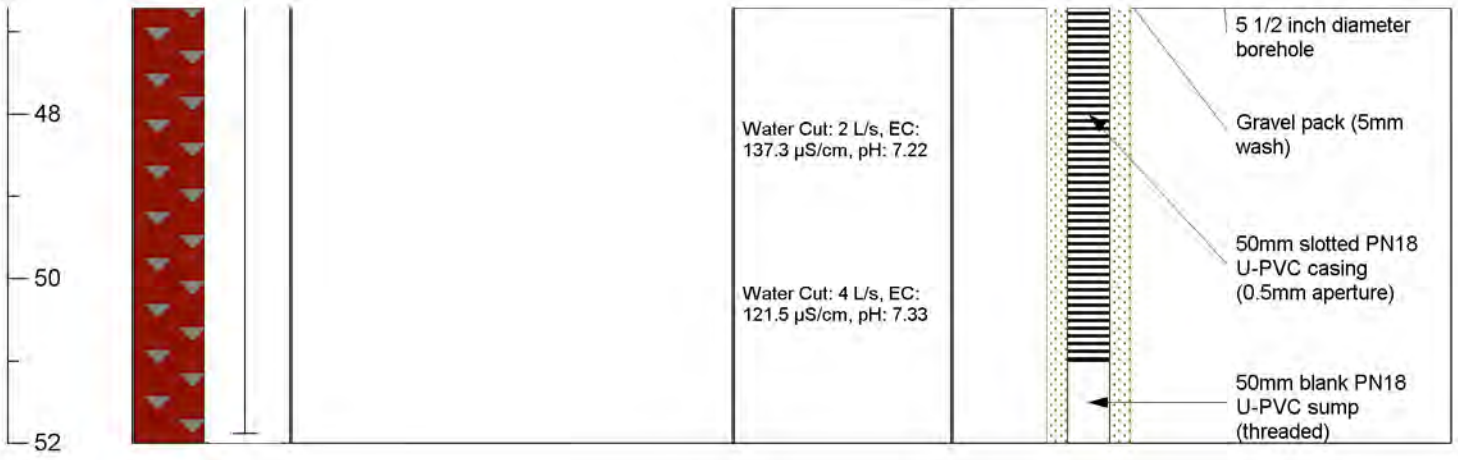
Tertiary Basalt
BASALT fine grained, black, minor oxidation
CLAY black
CLAY light creamy grey
CLAY light to medium grey
BASALT greenish brown, slightly oxidised, sulphides present
Water Cut: 0.5 L/s, EC: 74.3 µS/cm, pH: 6.66
Water Cut: 1 L/s, EC: 101.2 µS/cm, pH: 6.66
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm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52
Water Cut: 2 L/s, EC: 137.3 µS/cm, pH: 7.22
Water Cut: 4 L/s, EC: 121.5 µS/cm, pH: 7.33
5 1/2 inch diameter borehole
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: MB02

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

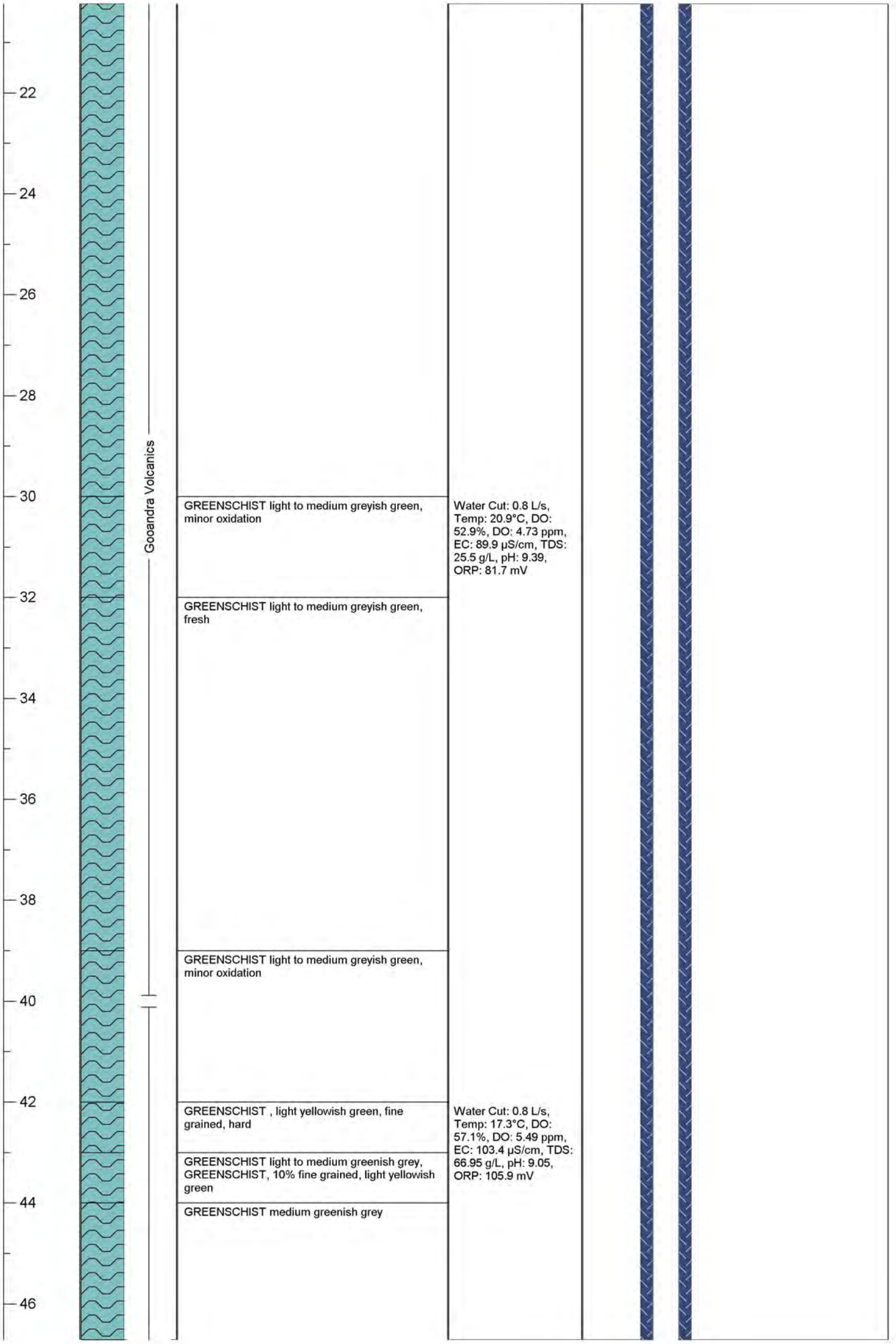
Date completed: 12/02/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: K Maher

Project number: J17188
Elevation: 1386.7 mAHD
Easting: 634310.5
Northing: 6033304.1

Static Water Level: 6.05 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 26/02/18

Total depth: 150 mbgl **Screened depth:** 141 - 147 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes
0		SOIL brown		Cement grout	
		CLAY reddish brown, extremely weathered			
2		CLAY reddish brown, extremely weathered, CLAY, 5% orange			
		CLAY orange, extremely weathered			
4					
6		SCHIST red orange, extremely weathered, oxidation on broken surfaces, breakable		6 inch PVC surface casing	
8					
10		SCHIST orange, extremely weathered, GREENSCHIST, 20% light creamy green			
		SCHIST orange, extremely weathered			
12		GREENSCHIST light to medium greyish green, fresh	Water Cut: 0.3 L/s, Temp: 19.3°C, DO: 51.1%, DO: 4.74 ppm, EC: 175.6 µS/cm, TDS: 114.4 g/L, pH: 6.56, ORP: 168.4 mV		
14			possible fracture, increase in flow		
16			possible fracture, increase in flow		
18			Water Cut: 0.8 L/s, Temp: 17.6°C, DO: 54.3%, DO: 5.18 ppm, EC: 132.1 µS/cm, TDS: 85.8 g/L, pH: 8.95, ORP: 101.9 mV		
20		Gooandra Volcanics			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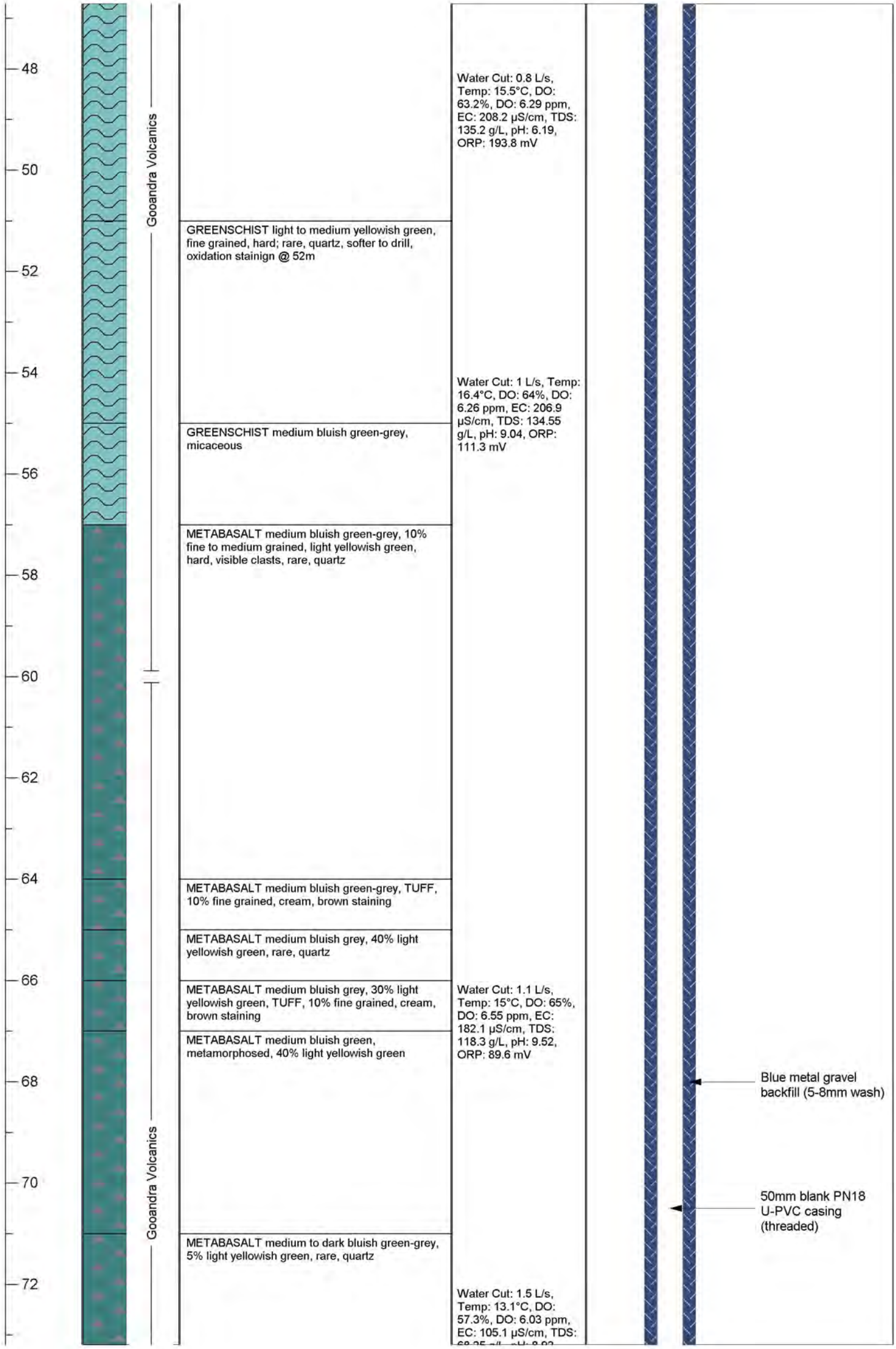
Gooandra Volcanics
GREENSCHIST light to medium greyish green, minor oxidation
GREENSCHIST light to medium greyish green, fresh
GREENSCHIST light to medium greyish green, minor oxidation
GREENSCHIST , light yellowish green, fine grained, hard
GREENSCHIST light to medium greenish grey, GREENSCHIST, 10% fine grained, light yellowish green
GREENSCHIST medium greenish grey
Water Cut: 0.8 L/s, Temp: 20.9°C, DO: 52.9%, DO: 4.73 ppm, EC: 89.9 µS/cm, TDS: 25.5 g/L, pH: 9.39, ORP: 81.7 mV
Water Cut: 0.8 L/s, Temp: 17.3°C, DO: 57.1%, DO: 5.49 ppm, EC: 103.4 µS/cm, TDS: 66.95 g/L, pH: 9.05, ORP: 105.9 mV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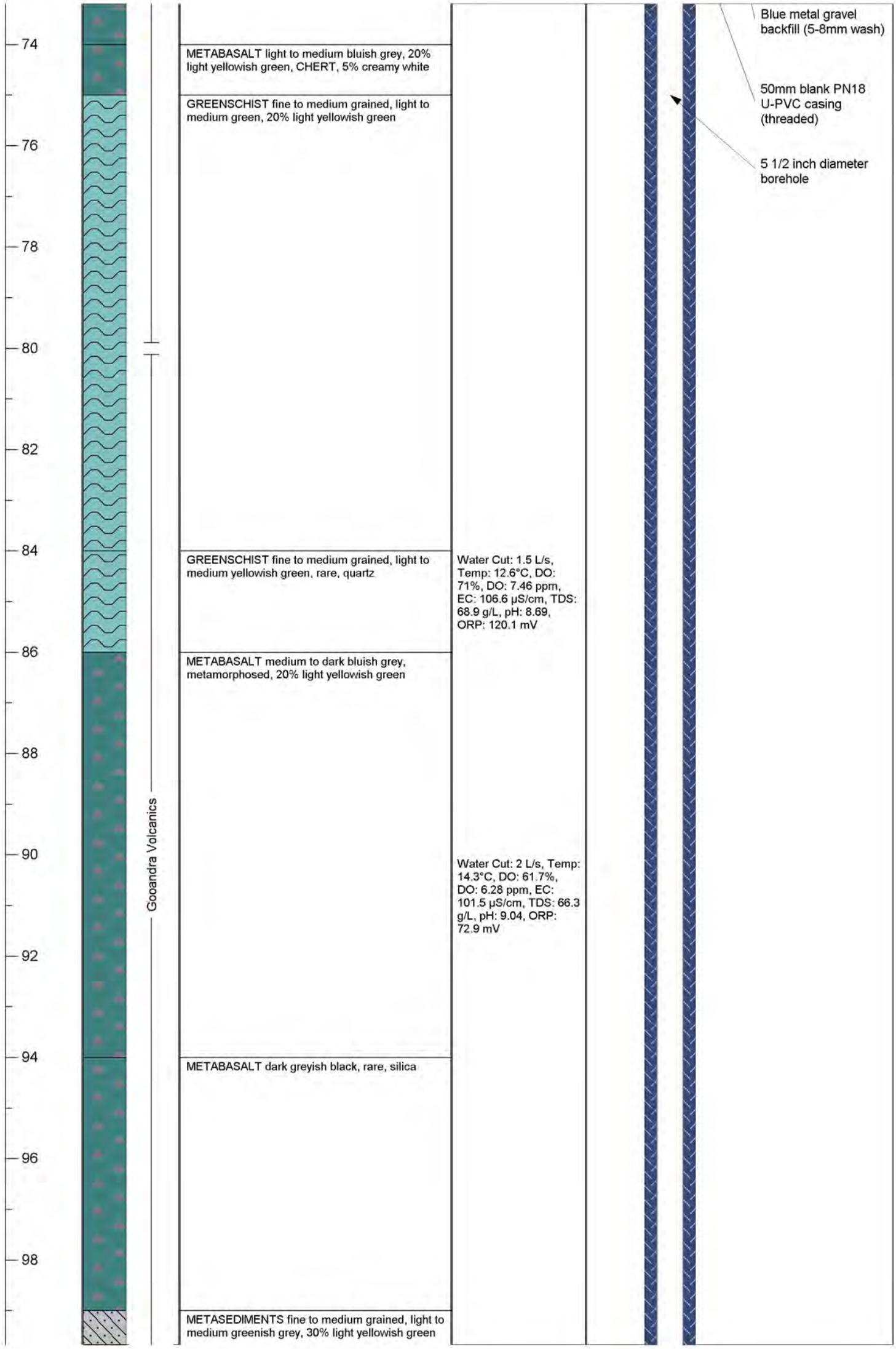
Gooandra Volcanics
Gooandra Volcanics
GREENSCHIST light to medium yellowish green, fine grained, hard; rare, quartz, softer to drill, oxidation stainign @ 52m
GREENSCHIST medium bluish green-grey, micaceous
METABASALT medium bluish green-grey, 10% fine to medium grained, light yellowish green, hard, visible clasts, rare, quartz
METABASALT medium bluish green-grey, TUFF, 10% fine grained, cream, brown staining
METABASALT medium bluish grey, 40% light yellowish green, rare, quartz
METABASALT medium bluish grey, 30% light yellowish green, TUFF, 10% fine grained, cream, brown staining
METABASALT medium bluish green, metamorphosed, 40% light yellowish green
METABASALT medium to dark bluish green-grey, 5% light yellowish green, rare, quartz
Water Cut: 0.8 L/s, Temp: 15.5°C, DO: 63.2%, DO: 6.29 ppm, EC: 208.2 µS/cm, TDS: 135.2 g/L, pH: 6.19, ORP: 193.8 mV
Water Cut: 1 L/s, Temp: 16.4°C, DO: 64%, DO: 6.26 ppm, EC: 206.9 µS/cm, TDS: 134.55 g/L, pH: 9.04, ORP: 111.3 mV
Water Cut: 1.1 L/s, Temp: 15°C, DO: 65%, DO: 6.55 ppm, EC: 182.1 µS/cm, TDS: 118.3 g/L, pH: 9.52, ORP: 89.6 mV
Water Cut: 1.5 L/s, Temp: 13.1°C, DO: 57.3%, DO: 6.03 ppm, EC: 105.1 µS/cm, TDS:
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)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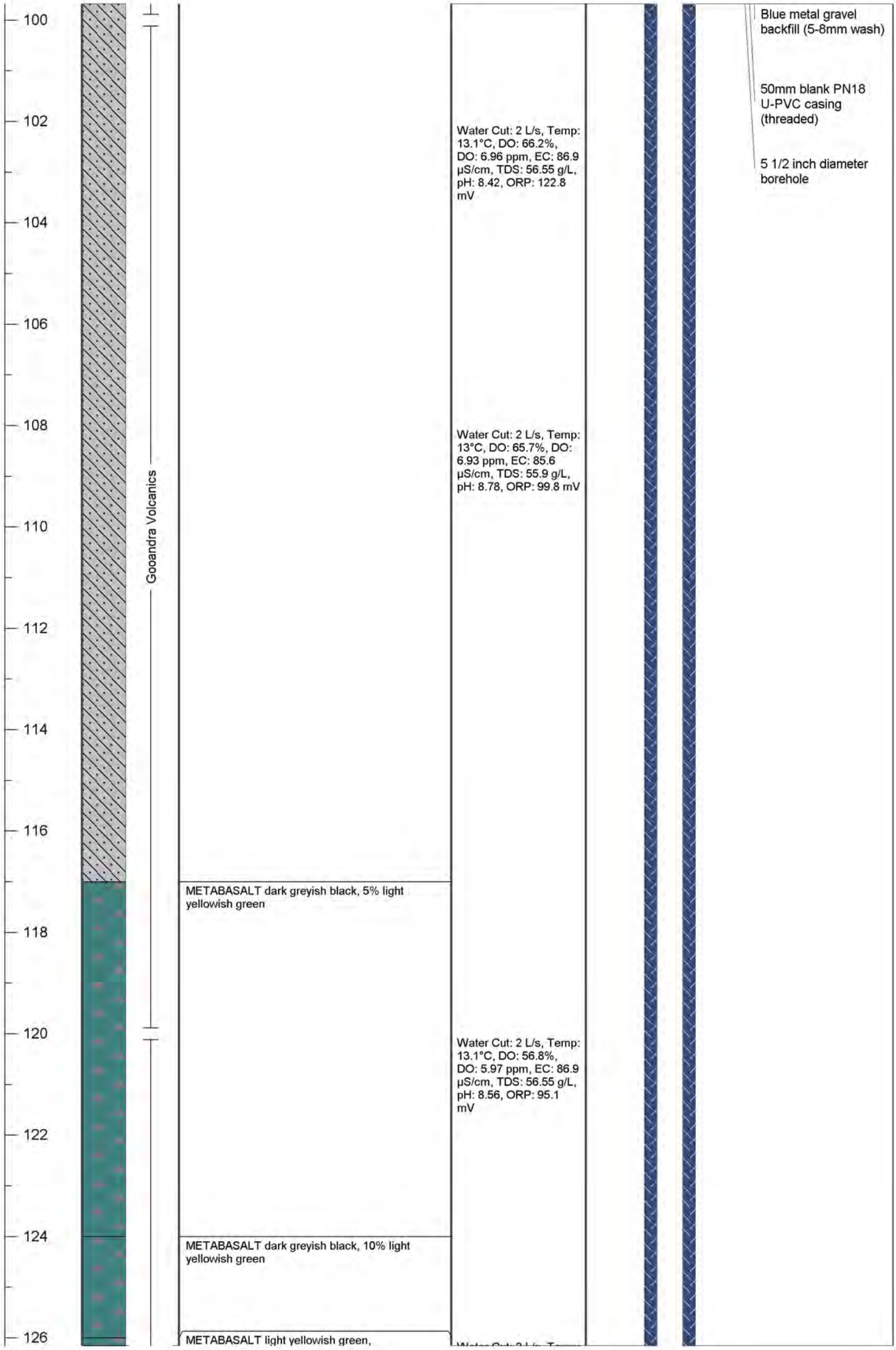
Gooandra Volcanics
METABASALT light to medium bluish grey, 20% light yellowish green, CHERT, 5% creamy white
GREENSCHIST fine to medium grained, light to medium green, 20% light yellowish green
GREENSCHIST fine to medium grained, light to medium yellowish green, rare, quartz
Water Cut: 1.5 L/s, Temp: 12.6°C, DO: 71%, DO: 7.46 ppm, EC: 106.6 µS/cm, TDS: 68.9 g/L, pH: 8.69, ORP: 120.1 mV
METABASALT medium to dark bluish grey, metamorphosed, 20% light yellowish green
Water Cut: 2 L/s, Temp: 14.3°C, DO: 61.7%, DO: 6.28 ppm, EC: 101.5 µS/cm, TDS: 66.3 g/L, pH: 9.04, ORP: 72.9 mV
METABASALT dark greyish black, rare, silica
METASEDIMENTS fine to medium grained, light to medium greenish grey, 30% light yellowish green
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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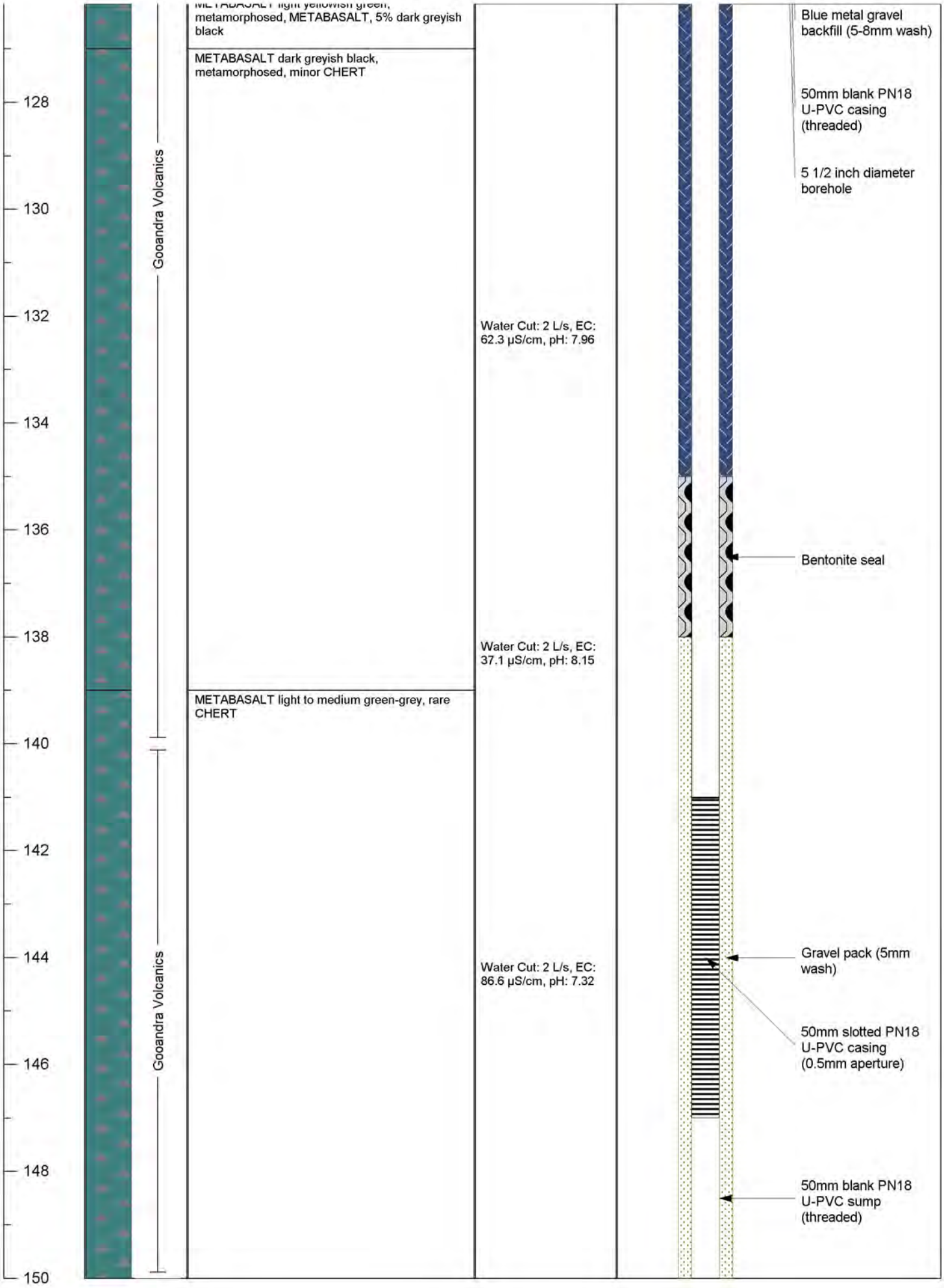
Gooandra Volcanics
METABASALT dark greyish black, 5% light yellowish green
METABASALT dark greyish black, 10% light yellowish green
METABASALT light yellowish green,
Water Cut: 2 L/s, Temp: 13.1°C, DO: 66.2%, DO: 6.96 ppm, EC: 86.9 µS/cm, TDS: 56.55 g/L, pH: 8.42, ORP: 122.8 mV
Water Cut: 2 L/s, Temp: 13°C, DO: 65.7%, DO: 6.93 ppm, EC: 85.6 µS/cm, TDS: 55.9 g/L, pH: 8.78, ORP: 99.8 mV
Water Cut: 2 L/s, Temp: 13.1°C, DO: 56.8%, DO: 5.97 ppm, EC: 86.9 µS/cm, TDS: 56.55 g/L, pH: 8.56, ORP: 95.1 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole


METABASALT light yellowish green, metamorphosed, METABASALT, 5% dark greyish black
METABASALT dark greyish black, metamorphosed, minor CHERT
METABASALT light to medium green-grey, rare CHERT
Gooandra Volcanics
Gooandra Volcanics
128
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140
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150
Water Cut: 2 L/s, EC: 62.3 µS/cm, pH: 7.96
Water Cut: 2 L/s, EC: 37.1 µS/cm, pH: 8.15
Water Cut: 2 L/s, EC: 86.6 µS/cm, pH: 7.32
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: MB03

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed:	22/01/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1373.0 mAHD
Drilling method:	Air rotary	**Easting:**	637491
Hydrogeologist:	S Cassidy	**Northing:**	6043212.7

Static Water Level: 5.715 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 6/02/18

Total depth: 101 mbgl **Screened depth:** 92 - 98 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		CLAY light creamy yellow, highly weathered, decomposed metamorphosed basalt appearing as silty clay		Cement grout	
2		CLAY light orangey yellow, highly weathered, decomposed metamorphosed basalt appearing as silty clay			
		CLAY medium brown, highly weathered, decomposed metamorphosed basalt appearing as silty clay			
4		CLAY medium orangey brown, highly weathered			
6		METABASALT medium reddish orange, highly weathered, moderate, quartz	Water Cut: 0.5 L/s, EC: 116.1 µS/cm, pH: 5.65		
		METABASALT medium orangey brown, highly weathered, moderate, quartz			
8				6 inch PVC surface casing	
10	Gooandra Volcanics				
12					
14					
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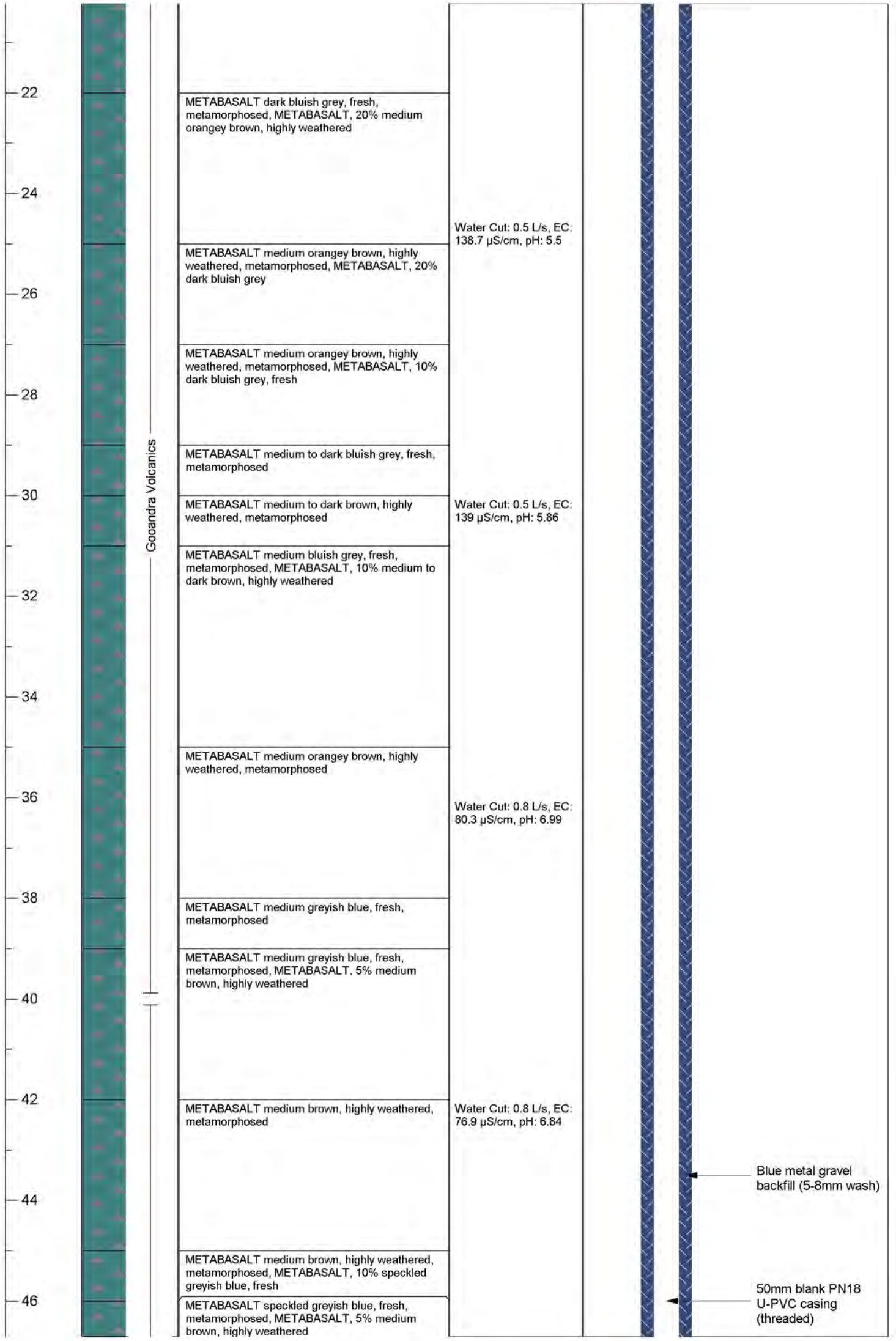
18					
20					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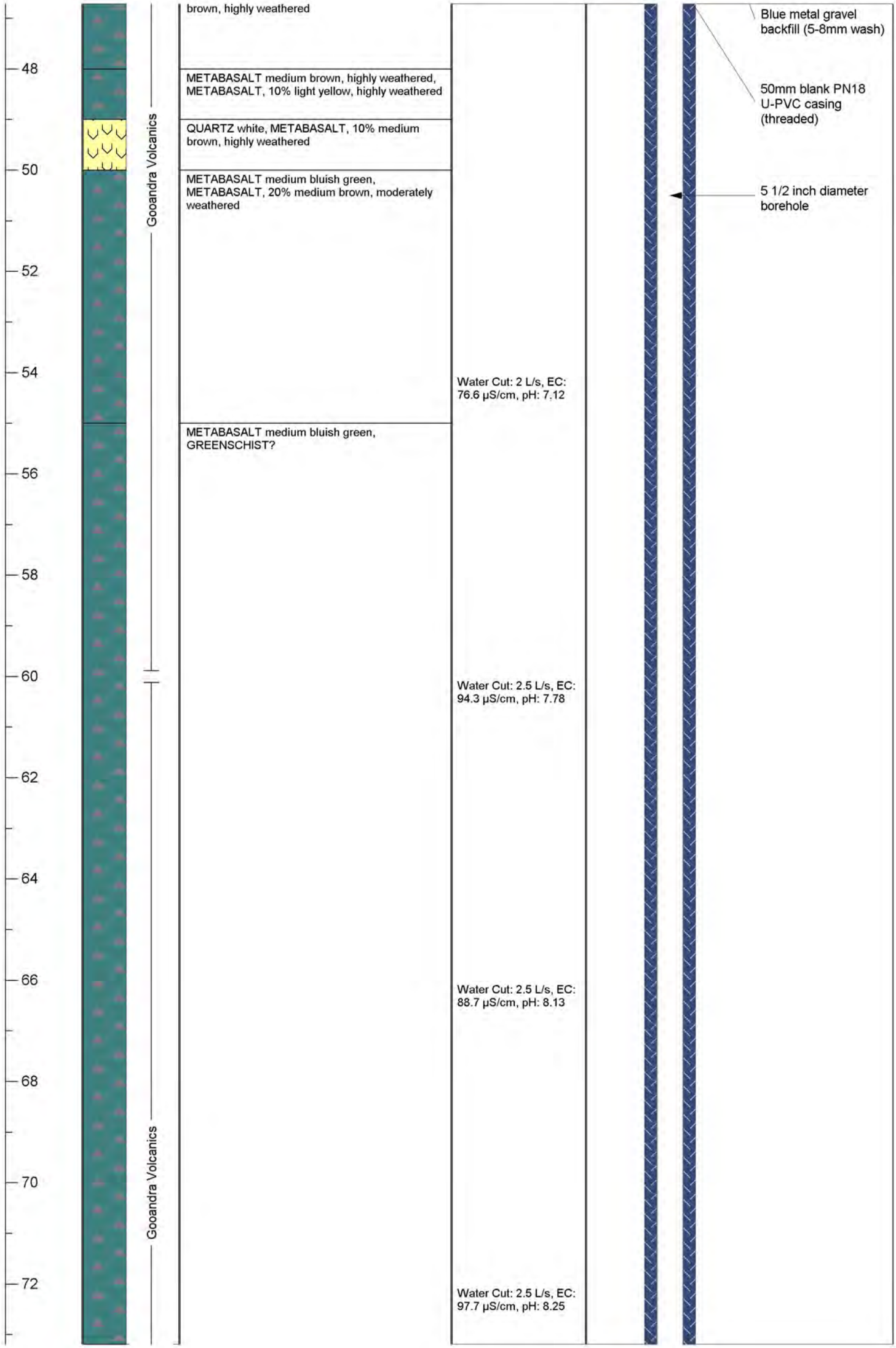
Gooandra Volcanics
METABASALT dark bluish grey, fresh, metamorphosed, METABASALT, 20% medium orangey brown, highly weathered
METABASALT medium orangey brown, highly weathered, metamorphosed, METABASALT, 20% dark bluish grey
METABASALT medium orangey brown, highly weathered, metamorphosed, METABASALT, 10% dark bluish grey, fresh
METABASALT medium to dark bluish grey, fresh, metamorphosed
METABASALT medium to dark brown, highly weathered, metamorphosed
METABASALT medium bluish grey, fresh, metamorphosed, METABASALT, 10% medium to dark brown, highly weathered
METABASALT medium orangey brown, highly weathered, metamorphosed
METABASALT medium greyish blue, fresh, metamorphosed
METABASALT medium greyish blue, fresh, metamorphosed, METABASALT, 5% medium brown, highly weathered
METABASALT medium brown, highly weathered, metamorphosed
METABASALT medium brown, highly weathered, metamorphosed, METABASALT, 10% speckled greyish blue, fresh
METABASALT speckled greyish blue, fresh, metamorphosed, METABASALT, 5% medium brown, highly weathered
Water Cut: 0.5 L/s, EC: 138.7 µS/cm, pH: 5.5
Water Cut: 0.5 L/s, EC: 139 µS/cm, pH: 5.86
Water Cut: 0.8 L/s, EC: 80.3 µS/cm, pH: 6.99
Water Cut: 0.8 L/s, EC: 76.9 µS/cm, pH: 6.84
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)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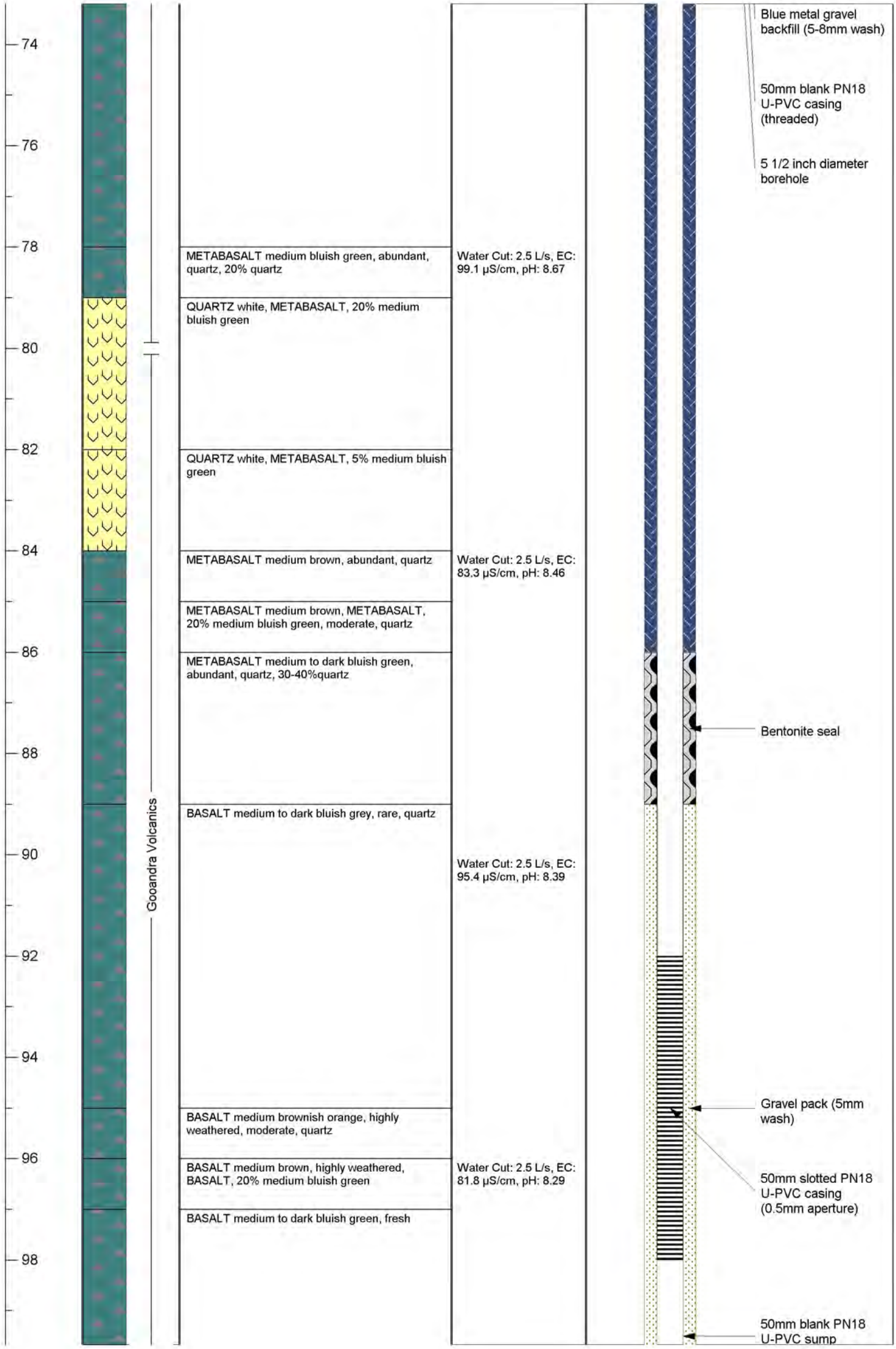
Gooandra Volcanics
Gooandra Volcanics
brown, highly weathered
METABASALT medium brown, highly weathered, METABASALT, 10% light yellow, highly weathered
QUARTZ white, METABASALT, 10% medium brown, highly weathered
METABASALT medium bluish green, METABASALT, 20% medium brown, moderately weathered
METABASALT medium bluish green, GREENSCHIST?
Water Cut: 2 L/s, EC: 76.6 µS/cm, pH: 7.12
Water Cut: 2.5 L/s, EC: 94.3 µS/cm, pH: 7.78
Water Cut: 2.5 L/s, EC: 88.7 µS/cm, pH: 8.13
Water Cut: 2.5 L/s, EC: 97.7 µS/cm, pH: 8.25
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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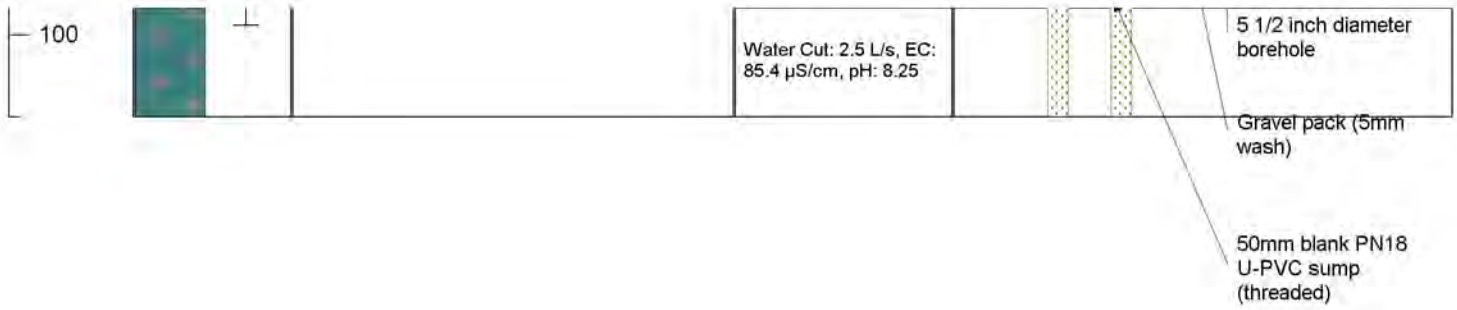
Gooandra Volcanics
METABASALT medium bluish green, abundant, quartz, 20% quartz
QUARTZ white, METABASALT, 20% medium bluish green
QUARTZ white, METABASALT, 5% medium bluish green
METABASALT medium brown, abundant, quartz
METABASALT medium brown, METABASALT, 20% medium bluish green, moderate, quartz
METABASALT medium to dark bluish green, abundant, quartz, 30-40%quartz
BASALT medium to dark bluish grey, rare, quartz
BASALT medium brownish orange, highly weathered, moderate, quartz
BASALT medium brown, highly weathered, BASALT, 20% medium bluish green
BASALT medium to dark bluish green, fresh
Water Cut: 2.5 L/s, EC: 99.1 µS/cm, pH: 8.67
Water Cut: 2.5 L/s, EC: 83.3 µS/cm, pH: 8.46
Water Cut: 2.5 L/s, EC: 95.4 µS/cm, pH: 8.39
Water Cut: 2.5 L/s, EC: 81.8 µS/cm, pH: 8.29
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump


100
Water Cut: 2.5 L/s, EC: 85.4 µS/cm, pH: 8.25
5 1/2 inch diameter borehole
Gravel pack (5mm wash)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: MB04A

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed: 6/02/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: G Jimenez

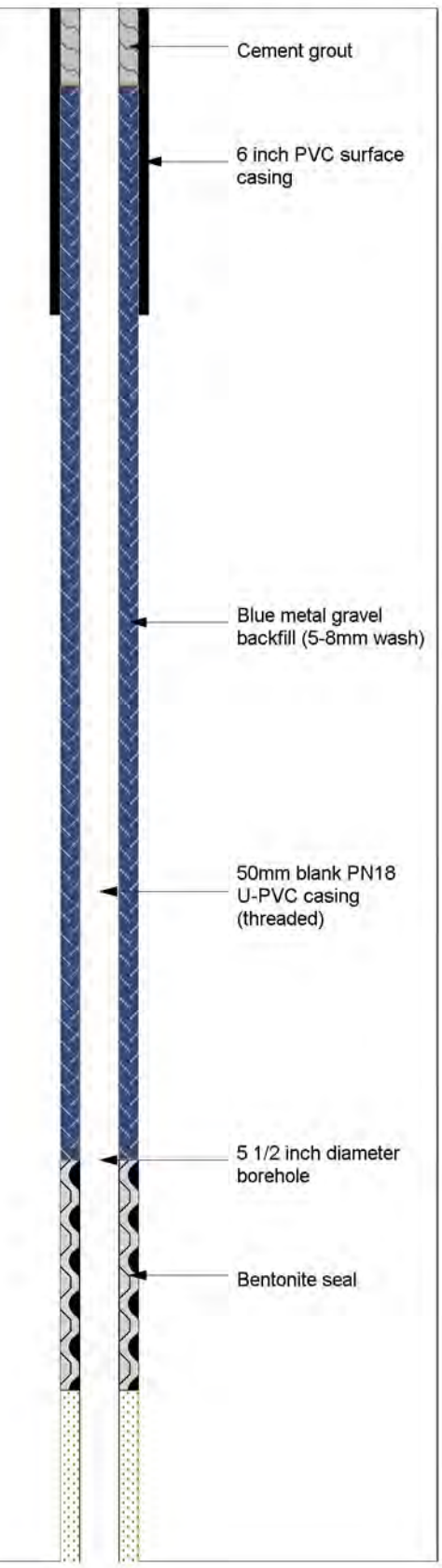
Project number: J17188
Elevation: 1330.0 mAHD
Easting: 640023.4
Northing: 6047809.3

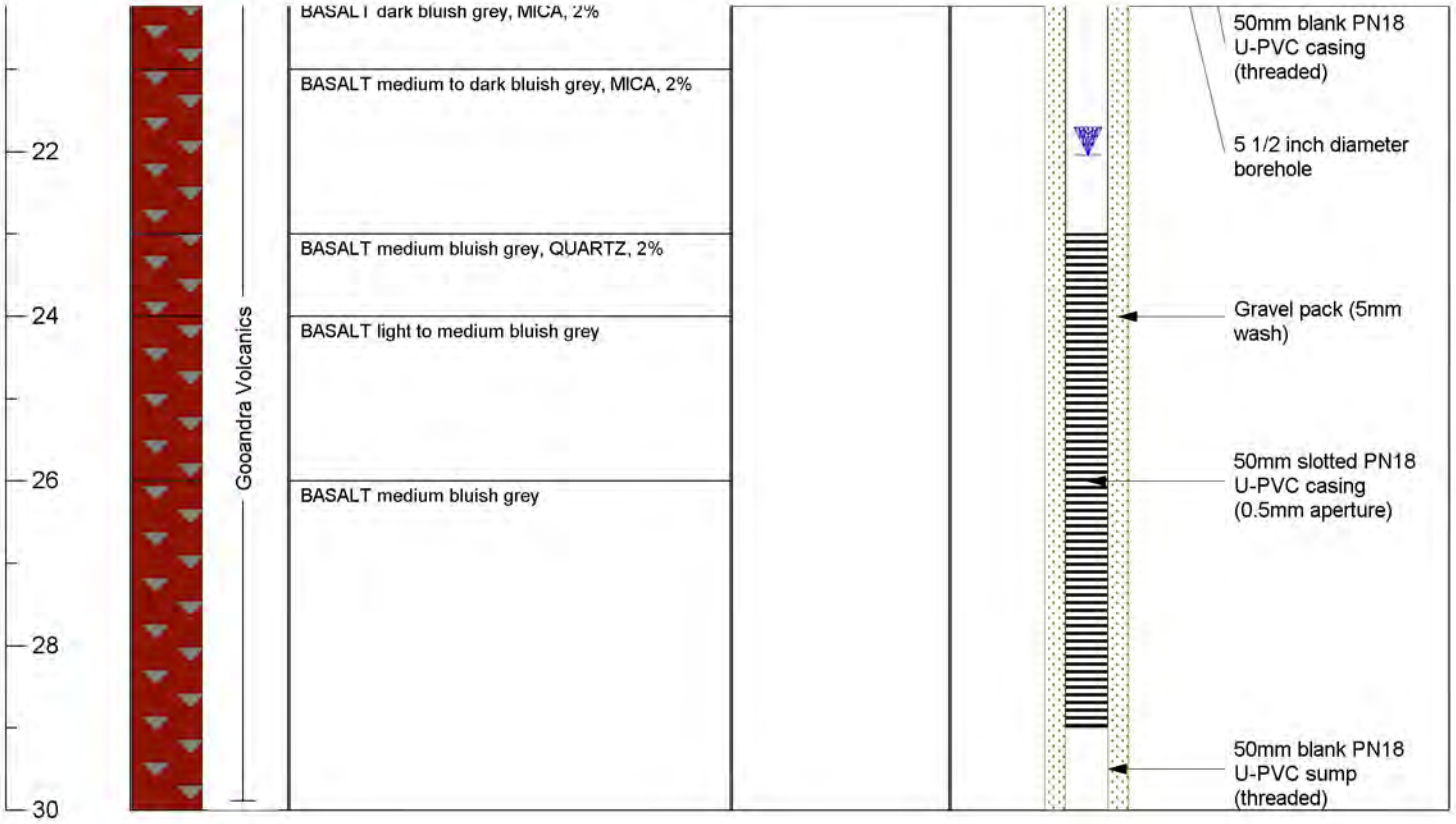
Static Water Level: 21.87 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 7/02/18

Total depth: 30 mbgl **Screened depth:** 23 - 29 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL medium brown, clayey, BASALT, 40% bluish grey			
		BASALT light to medium bluish grey			
2		BASALT medium bluish grey			
		BASALT medium bluish grey, unknown, 5% medium green			
4		BASALT light to medium bluish grey			
6					
8					
10					
12		BASALT medium to dark bluish green			
14					
		BASALT light bluish grey	no water intercepted during drilling		
16					
		BASALT light to medium bluish grey, QUARTZ, 5%			
18		BASALT light to medium greenish grey			
		BASALT light to medium greenish grey, MICA, 2%			
20		BASALT dark bluish grey, MICA, 2%			

Gooandra Volcanics




22
24
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30
Gooandra Volcanics
BASALT dark bluish grey, MICA, 2%
BASALT medium to dark bluish grey, MICA, 2%
BASALT medium bluish grey, QUARTZ, 2%
BASALT light to medium bluish grey
BASALT medium bluish grey
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: MB04B

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

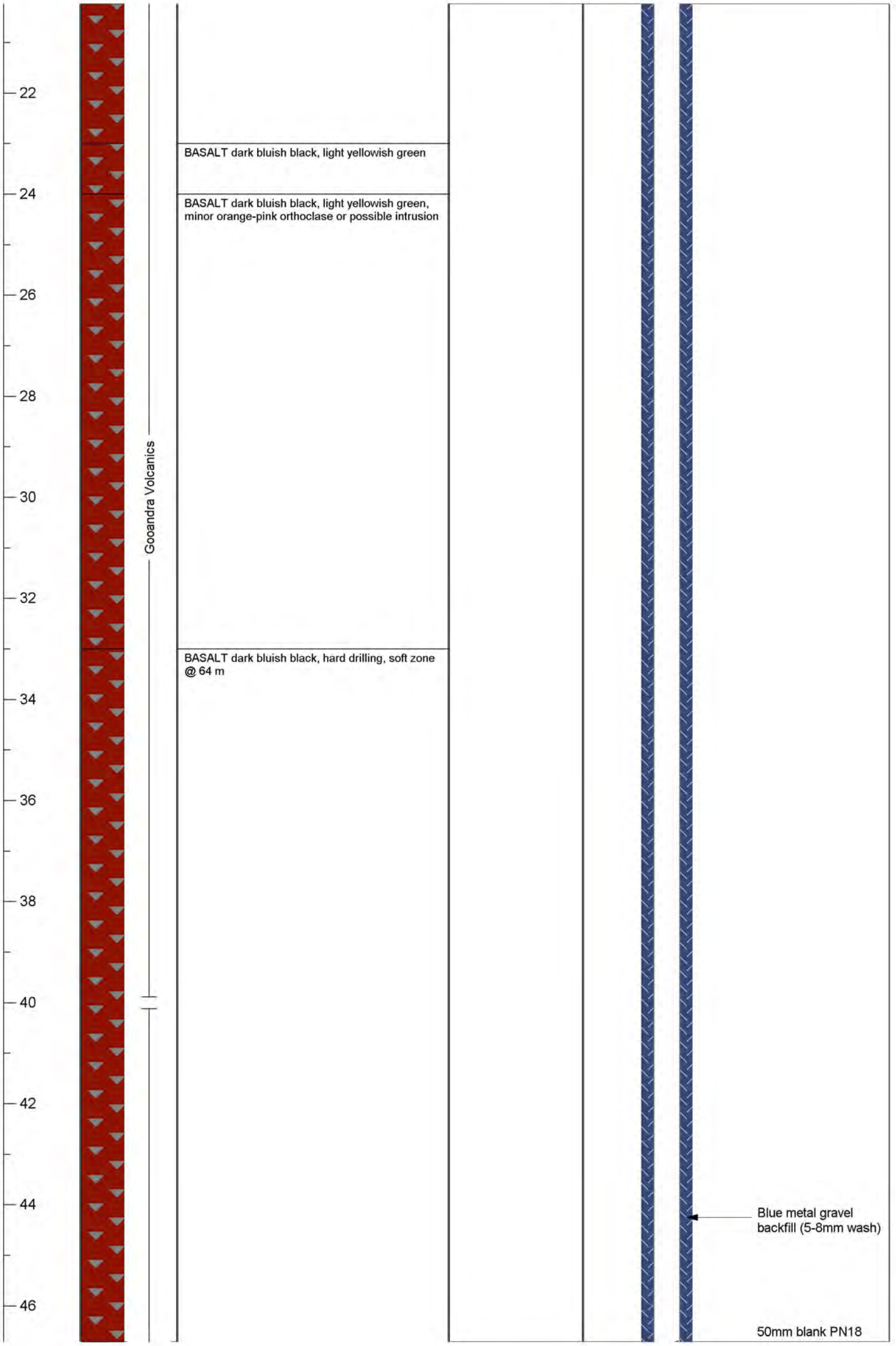
Date completed:	5/02/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1330.0 mAHD
Drilling method:	Air rotary	**Easting:**	640023.7
Hydrogeologist:	K Maher	**Northing:**	6047817.4

Static Water Level: 48.81 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 7/02/18

Total depth: 102.5 mbgl **Screened depth:** 93.5 - 99.5 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL medium to dark brown		Cement grout	
		BASALT light to medium greyish brown			
2		BASALT light to medium bluish grey, minor oxidation			
		BASALT dark bluish grey, minor oxidation			
4					
		BASALT dark bluish grey, minor oxidation, SILTSTONE, 20% dark brown		6 inch PVC surface casing	
6		BASALT dark bluish grey, light yellowish green, possible evidence of faulting or intrusion? Minor oxidation on fracture surfaces			
		BASALT dark bluish grey, light yellowish green, minor oxidation on fracture surfaces			
8					
10		BASALT dark bluish grey			
12					
14					
16					
18					
20					

Gooandra Volcanics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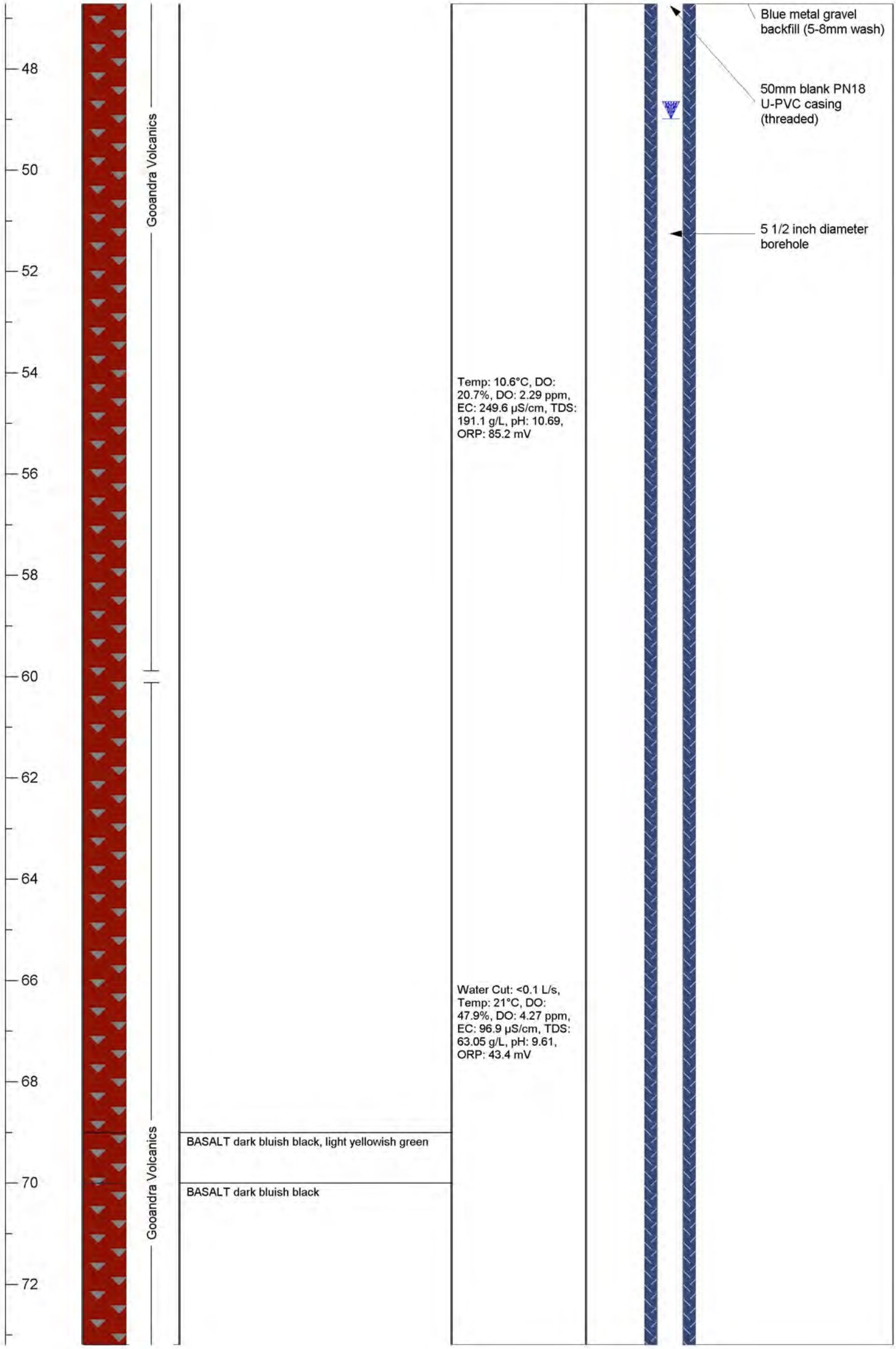
Gooandra Volcanics
BASALT dark bluish black, light yellowish green
BASALT dark bluish black, light yellowish green, minor orange-pink orthoclase or possible intrusion
BASALT dark bluish black, hard drilling, soft zone @ 64 m
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18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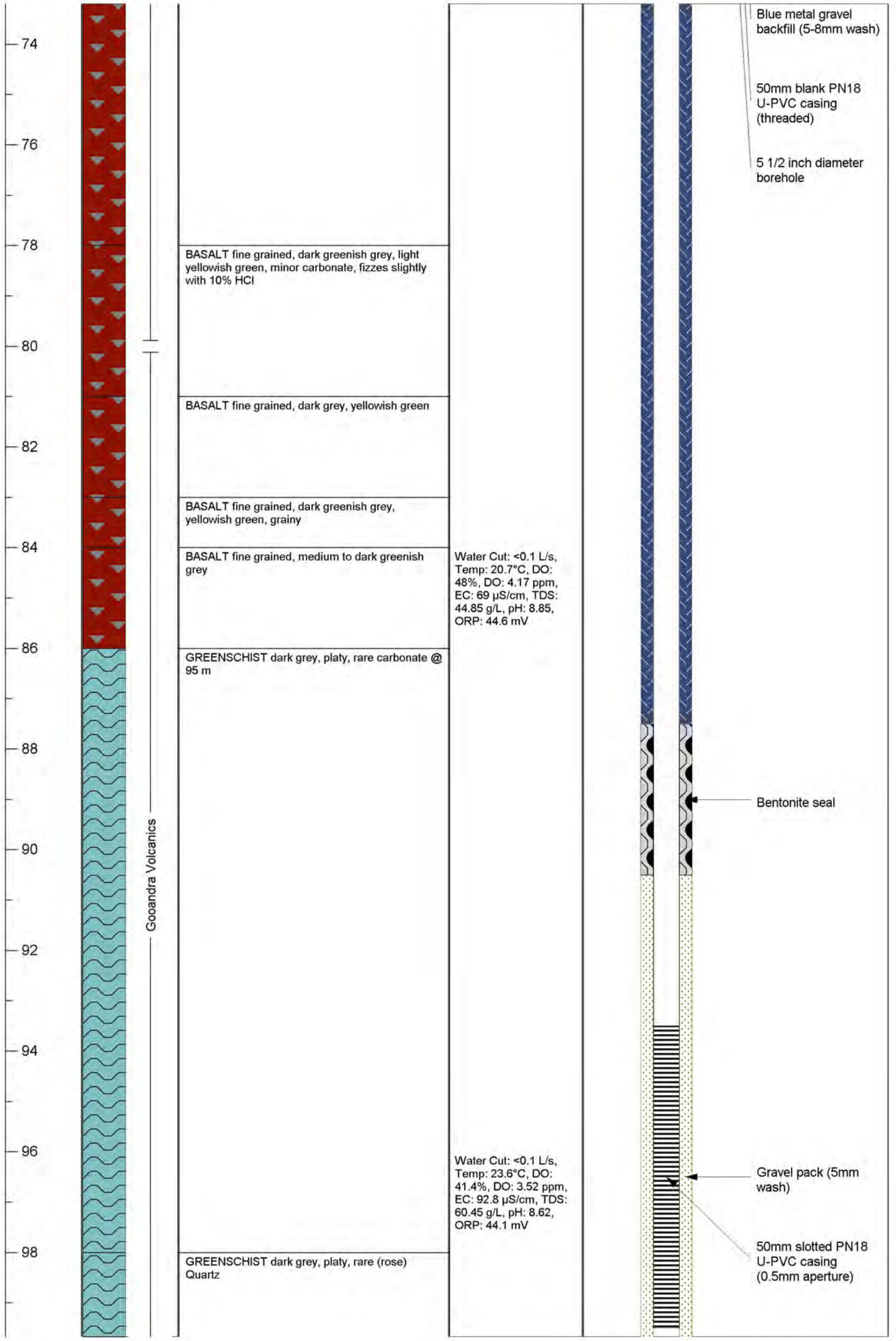
Gooandra Volcanics
Gooandra Volcanics
BASALT dark bluish black, light yellowish green
BASALT dark bluish black
Temp: 10.6°C, DO: 20.7%, DO: 2.29 ppm, EC: 249.6 µS/cm, TDS: 191.1 g/L, pH: 10.69, ORP: 85.2 mV
Water Cut: <0.1 L/s, Temp: 21°C, DO: 47.9%, DO: 4.27 ppm, EC: 96.9 µS/cm, TDS: 63.05 g/L, pH: 9.61, ORP: 43.4 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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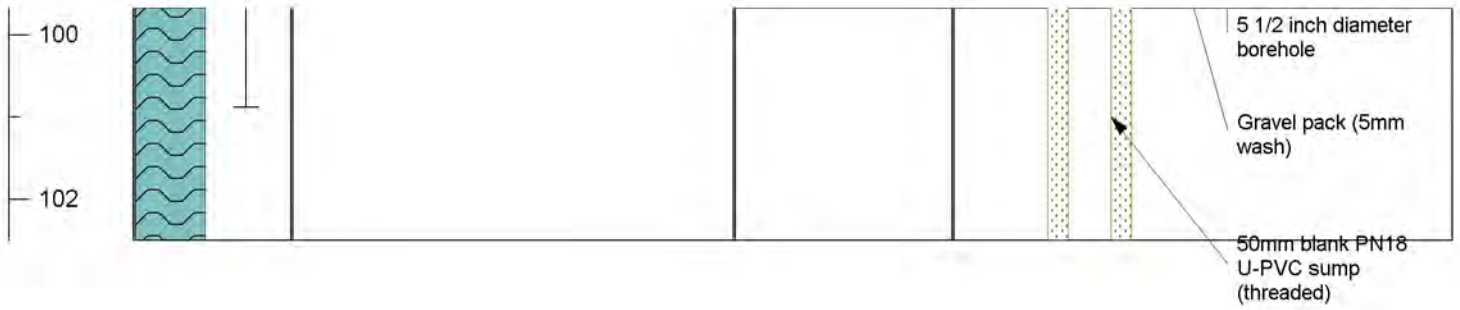
Gooandra Volcanics
BASALT fine grained, dark greenish grey, light yellowish green, minor carbonate, fizzes slightly with 10% HCl
BASALT fine grained, dark grey, yellowish green
BASALT fine grained, dark greenish grey, yellowish green, grainy
BASALT fine grained, medium to dark greenish grey
GREENSCHIST dark grey, platy, rare carbonate @ 95 m
GREENSCHIST dark grey, platy, rare (rose) Quartz
Water Cut: <0.1 L/s, Temp: 20.7°C, DO: 48%, DO: 4.17 ppm, EC: 69 µS/cm, TDS: 44.85 g/L, pH: 8.85, ORP: 44.6 mV
Water Cut: <0.1 L/s, Temp: 23.6°C, DO: 41.4%, DO: 3.52 ppm, EC: 92.8 µS/cm, TDS: 60.45 g/L, pH: 8.62, ORP: 44.1 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)


100
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5 1/2 inch diameter borehole
Gravel pack (5mm wash)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: MB06A

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed:	5/04/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1145.4 mAHD
Drilling method:	Air rotary	**Easting:**	628723.4
Hydrogeologist:	K Maher	**Northing:**	6048391.5

Static Water Level: 4.57 mbgl **Screened Formation:** Boraig Group **Date:** 5/04/18

Total depth: 14 mbgl **Screened depth:** 9 - 12 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL dark brown			
2	Boraig Group	VOLCANIC ROCK, UNDIFFERENTIATED dark reddish orange, extremely weathered, CLAY, 30% reddish orange, extremely weathered, rounded pebbles/inclusins within unit	moisture	Cement grout; Blue metal gravel backfill (5-8mm wash); 50mm blank PN18 U-PVC casing (threaded); Bentonite seal; 5 1/2 inch diameter borehole; Gravel pack (5mm wash); 50mm slotted PN18 U-PVC casing (0.5mm aperture); 50mm blank PN18 U-PVC sump (threaded)	
4					
6					
8					
10					
12			Water Cut: 0.1 L/s, Temp: 19.6°C, DO: 40.6%, DO: 3.72 ppm, EC: 88.2 µS/cm, TDS: 57.2 g/L, pH: 7.68, ORP: 125 mV		
14					

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WATER MONITORING BORE LOG

Bore ID: MB06B

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

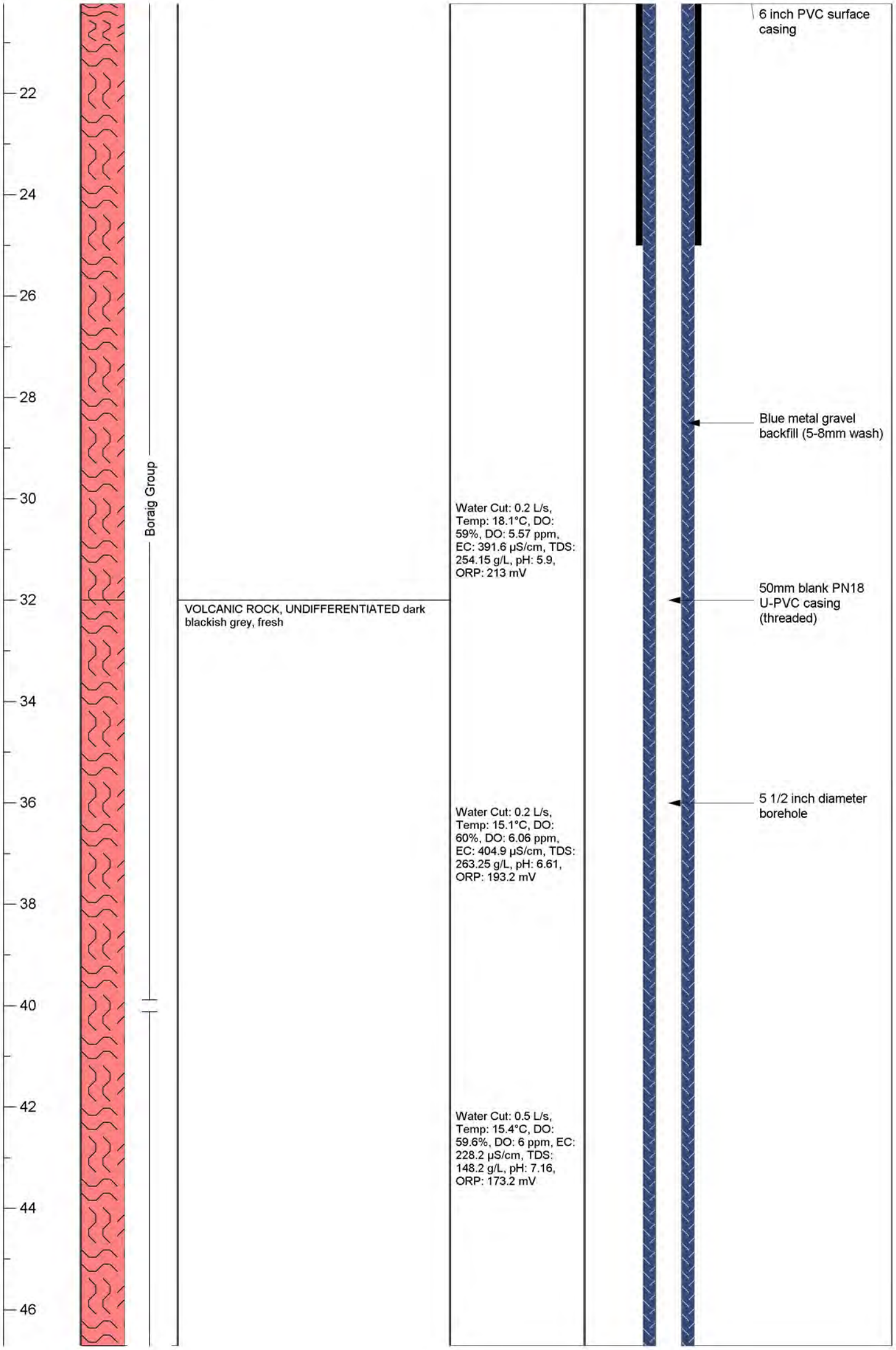
Date completed: 4/04/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: K Maher

Project number: J17188
Elevation: 1145.4 mAHD
Easting: 628719.8
Northing: 6048397.0

Static Water Level: 4.51 mbgl **Screened Formation:** Boraig Group **Date:** 5/04/18

Total depth: 72 mbgl **Screened depth:** 64 - 70 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL dark brown		Cement grout	
2		VOLCANIC ROCK, UNDIFFERENTIATED (? DACITE) dark reddish orange, extremely weathered, CLAY, 30% dark reddish orange, rounded pebbles/inclusions within unit			
4					
6					
8					
10	Boraig Group				
12			first water, issuficient volume to sample	6 inch PVC surface casing	
14					
16					
18			Water Cut: 0.2 L/s, Temp: 14.6°C, DO: 55.2%, DO: 5.57 ppm, EC: 28.5 µS/cm, TDS: 18.85 g/L, pH: 9.58, ORP: 148.7 mV		
20		VOLCANIC ROCK, UNDIFFERENTIATED orangey brown, highly weathered			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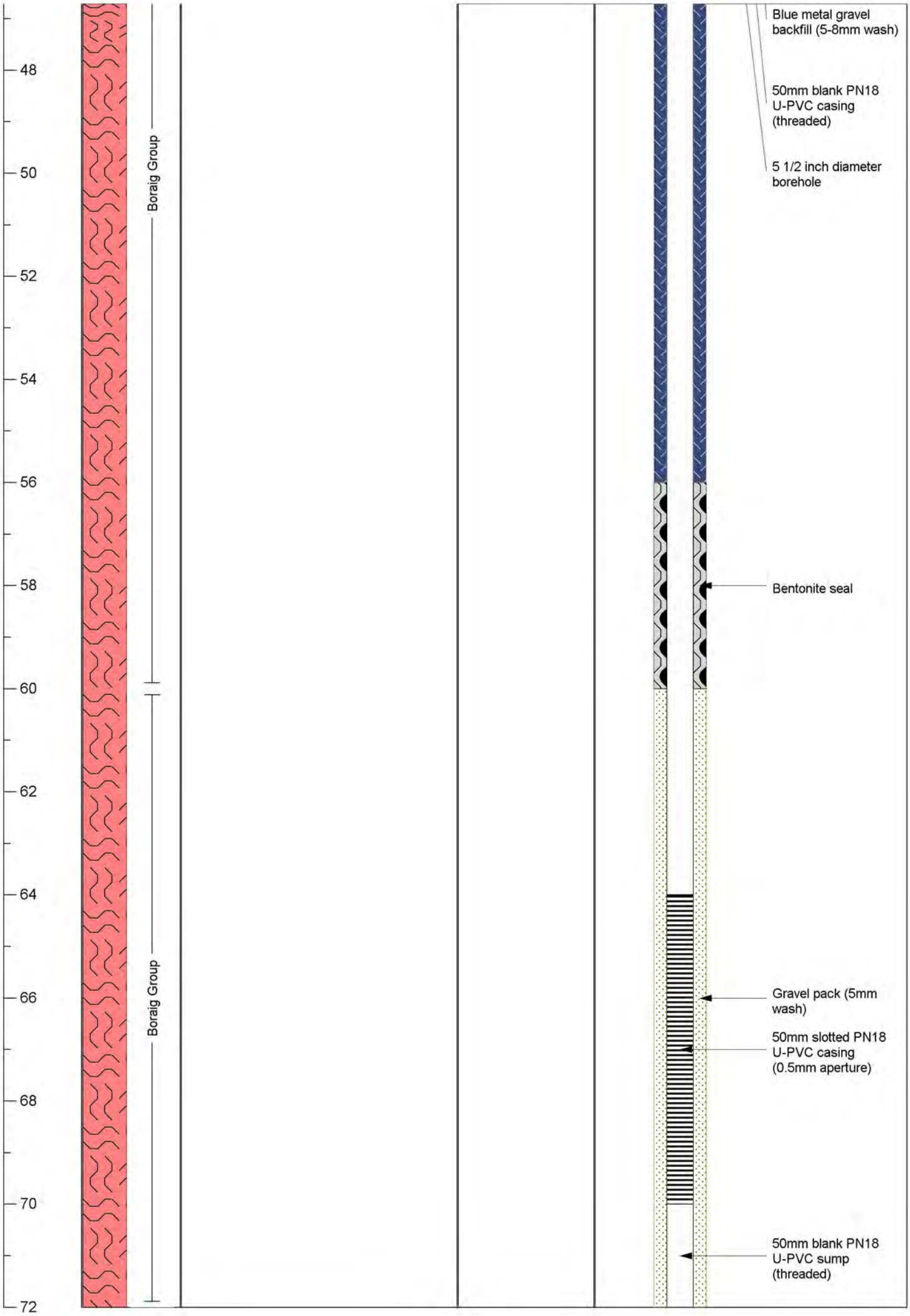
Boraig Group
VOLCANIC ROCK, UNDIFFERENTIATED dark blackish grey, fresh
Water Cut: 0.2 L/s, Temp: 18.1°C, DO: 59%, DO: 5.57 ppm, EC: 391.6 µS/cm, TDS: 254.15 g/L, pH: 5.9, ORP: 213 mV
Water Cut: 0.2 L/s, Temp: 15.1°C, DO: 60%, DO: 6.06 ppm, EC: 404.9 µS/cm, TDS: 263.25 g/L, pH: 6.61, ORP: 193.2 mV
Water Cut: 0.5 L/s, Temp: 15.4°C, DO: 59.6%, DO: 6 ppm, EC: 228.2 µS/cm, TDS: 148.2 g/L, pH: 7.16, ORP: 173.2 mV
6 inch PVC surface casing
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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Boraig Group
Boraig Group
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: MB07A

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

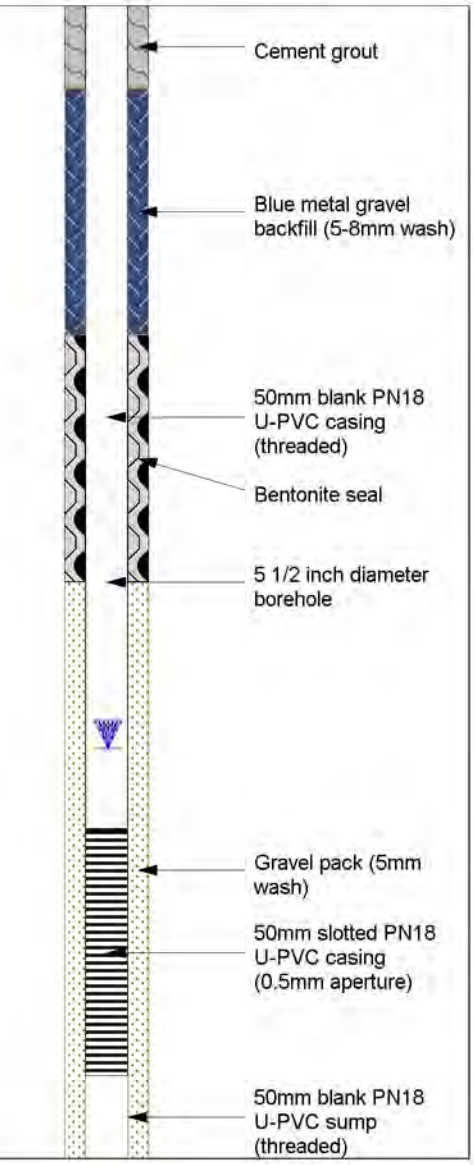
Date completed:	22/02/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1265.0 mAHD
Drilling method:	Air rotary	**Easting:**	641051.0
Hydrogeologist:	K Maher	**Northing:**	6042294.1

Static Water Level: 8.85 mbgl **Screened Formation:** Tantangara Formation **Date:** 23/02/18

Total depth: 14 mbgl **Screened depth:** 10 - 13 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL dark brown			
		CLAY dark reddish brown			
2		CLAY dark reddish brown, extremely weathered, moist			
4					
		CHERT (?) creamy white, CLAY, 30% creamy white, QUARTZ, 10% sub-angular fragments			
6		SILTSTONE light to medium orangey brown, smooth, CLAY, 20% orangey brown, highly weathered			
		SILTSTONE medium orangey brown, highly weathered, SILTSTONE, 5% green, rounded pebbles and cobbles present. Possible river channel			
8		SILTSTONE medium orangey brown, highly weathered, SILTSTONE, 40% reddish black, highly weathered			
		SILTSTONE dark reddish black, extremely oxidised, SILTSTONE, 10% reddish brown, highly oxidised	first moisture, insufficient volume to sample first water		
10					
12		SILTSTONE dark greyish black	Water Cut: 0.3 L/s, Temp: 19.2°C, DO: 63.1%, DO: 5.81 ppm, EC: 101 µS/cm, TDS: 65.65 g/L, pH: 7.07, ORP: 138.6 mV		
14					

Tantangara Formation



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WATER MONITORING BORE LOG

Bore ID: MB07B

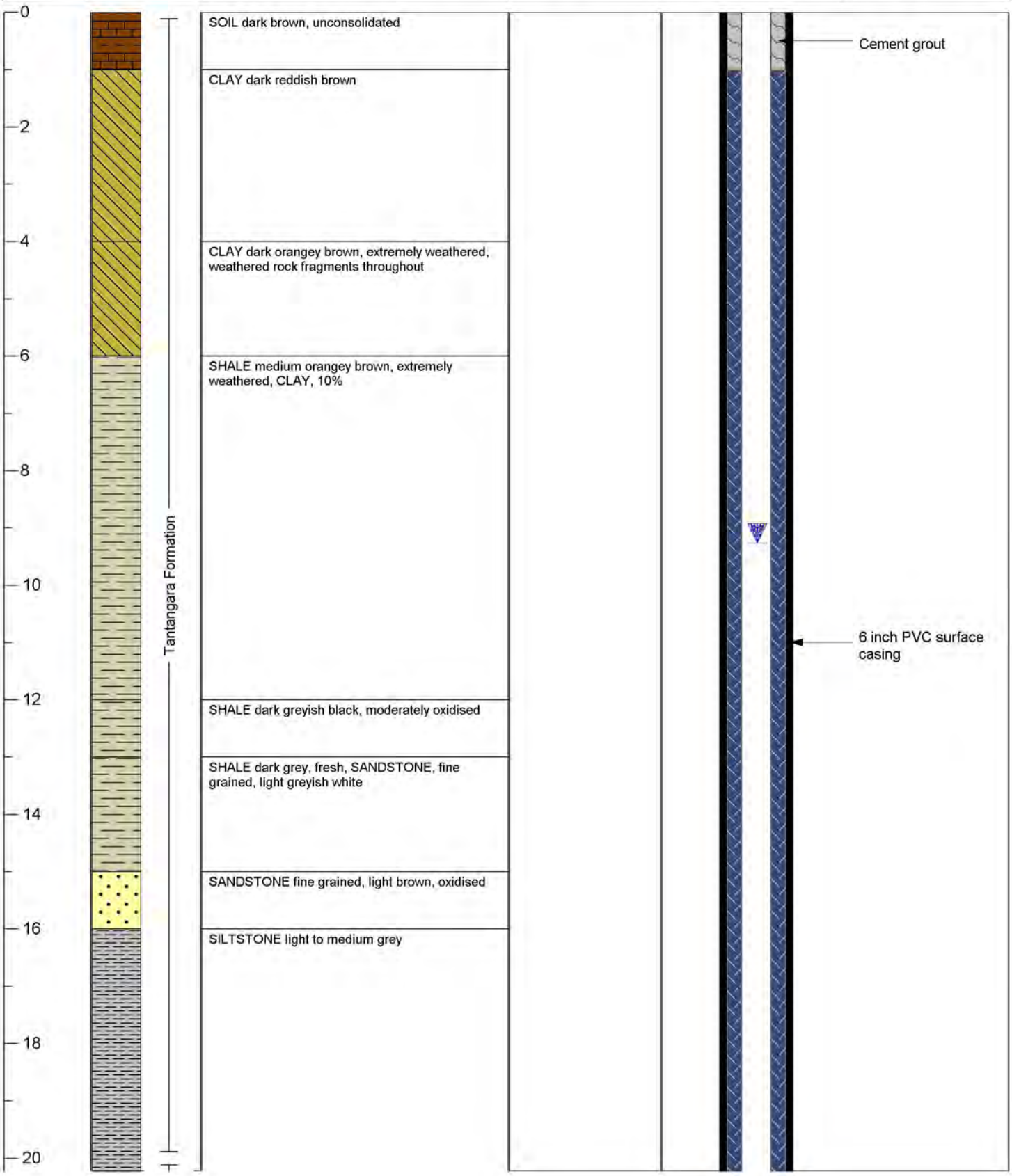
Client: Snowy Hydro **Project:** Snowy Hydro 2.0

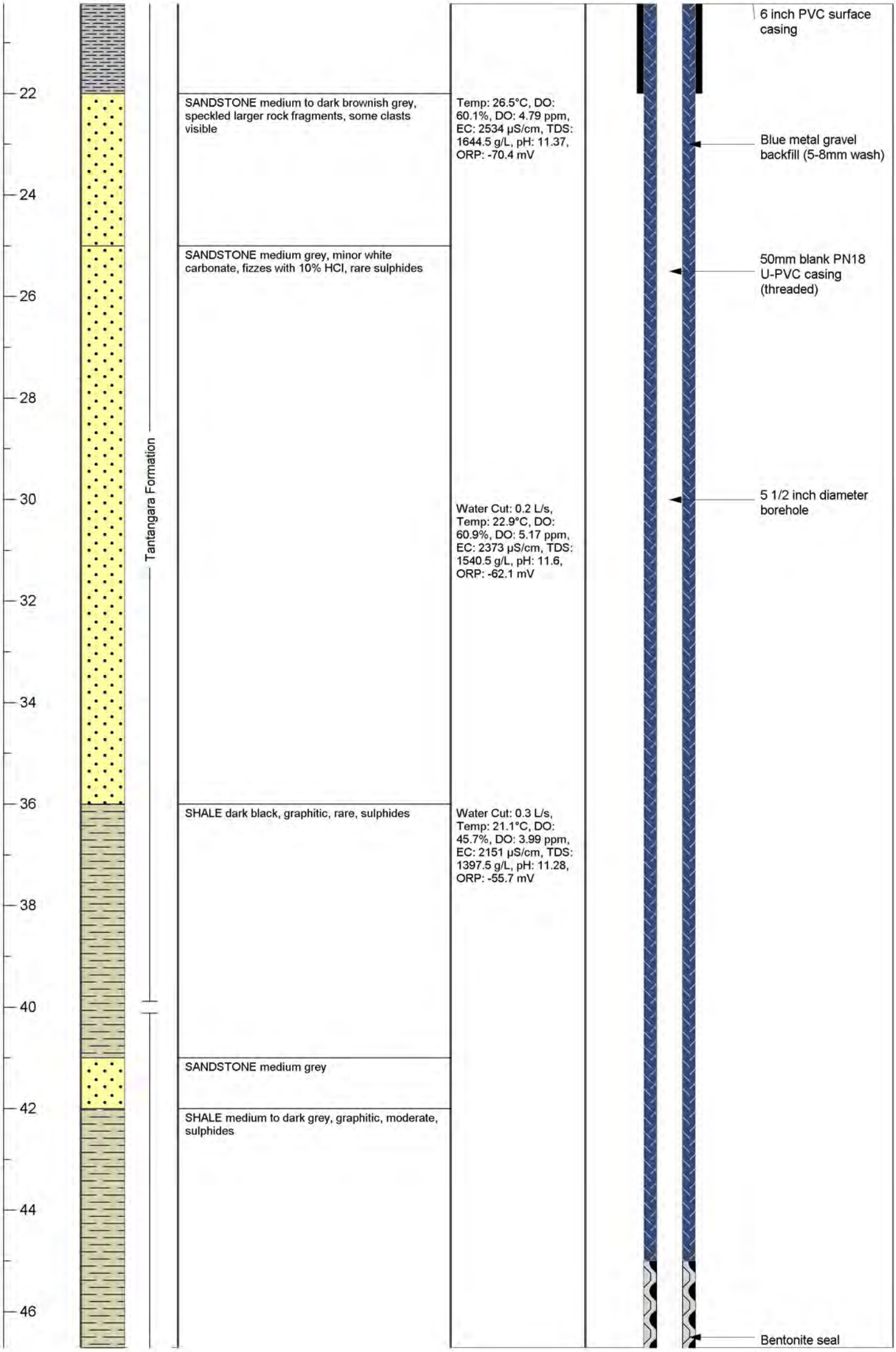
Date completed:	21/01/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1265.0 mAHD
Drilling method:	Air rotary	**Easting:**	641042.9
Hydrogeologist:	K Maher	**Northing:**	6042294.0

Static Water Level: 9.09 mbgl **Screened Formation:** Tantangara Formation **Date:** 23/02/18

Total depth: 60 mbgl **Screened depth:** 51 - 57 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes

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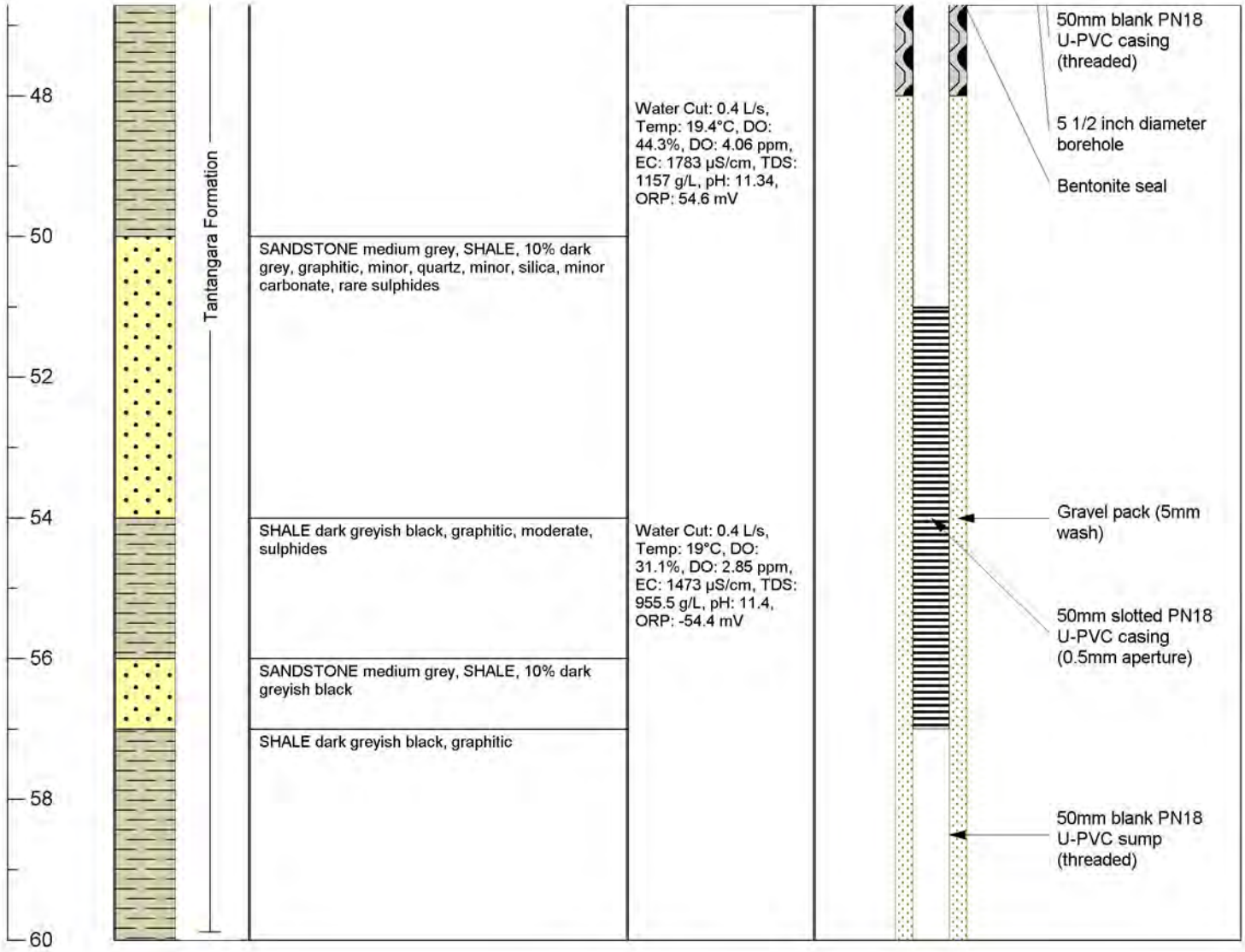
Tantangara Formation
SANDSTONE medium to dark brownish grey, speckled larger rock fragments, some clasts visible
SANDSTONE medium grey, minor white carbonate, fizzes with 10% HCl, rare sulphides
SHALE dark black, graphitic, rare, sulphides
SANDSTONE medium grey
SHALE medium to dark grey, graphitic, moderate, sulphides
Temp: 26.5°C, DO: 60.1%, DO: 4.79 ppm, EC: 2534 µS/cm, TDS: 1644.5 g/L, pH: 11.37, ORP: -70.4 mV
Water Cut: 0.2 L/s, Temp: 22.9°C, DO: 60.9%, DO: 5.17 ppm, EC: 2373 µS/cm, TDS: 1540.5 g/L, pH: 11.6, ORP: -62.1 mV
Water Cut: 0.3 L/s, Temp: 21.1°C, DO: 45.7%, DO: 3.99 ppm, EC: 2151 µS/cm, TDS: 1397.5 g/L, pH: 11.28, ORP: -55.7 mV
6 inch PVC surface casing
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal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Tantangara Formation
SANDSTONE medium grey, SHALE, 10% dark grey, graphitic, minor, quartz, minor, silica, minor carbonate, rare sulphides
SHALE dark greyish black, graphitic, moderate, sulphides
SANDSTONE medium grey, SHALE, 10% dark greyish black
SHALE dark greyish black, graphitic
Water Cut: 0.4 L/s, Temp: 19.4°C, DO: 44.3%, DO: 4.06 ppm, EC: 1783 µS/cm, TDS: 1157 g/L, pH: 11.34, ORP: 54.6 mV
Water Cut: 0.4 L/s, Temp: 19°C, DO: 31.1%, DO: 2.85 ppm, EC: 1473 µS/cm, TDS: 955.5 g/L, pH: 11.4, ORP: -54.4 mV
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: TMB01A

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed:	22/03/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	581.2 mAHD
Drilling method:	Air rotary	**Easting:**	627670.5
Hydrogeologist:	K Maher	**Northing:**	6038074.1

Static Water Level: 5.1 mbgl **Screened Formation:** Boraig Group **Date:** 27/03/18

Total depth: 14 mbgl **Screened depth:** 11 - 14 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL medium reddish brown		Cement grout	
2		COLLUVIUM pebbly to cobbly, river gravels		6 inch steel surface casing; Blue metal gravel backfill (5-8mm wash)	
4		IGNIMBRITE medium reddish purple, UNKNOWN, light to medium green		Bentonite seal; 50mm blank PN18 U-PVC casing (threaded)	
6				5 1/2 inch diameter borehole	
8		TUFF light creamy green, IGNIMBRITE, 20% medium reddish purple			
10		IGNIMBRITE medium reddish purple, UNKNOWN, medium green		Gravel pack (5mm wash)	
12			Water Cut: 0.1 L/s, Temp: 24.9°C, DO: 52.7%, DO: 4.31 ppm, EC: 642 µS/cm, TDS: 416 g/L, pH: 8.08, ORP: 29.3 mV	50mm slotted PN18 U-PVC casing (0.5mm aperture)	
14					

Boraig Group

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WATER MONITORING BORE LOG

Bore ID: TMB01B

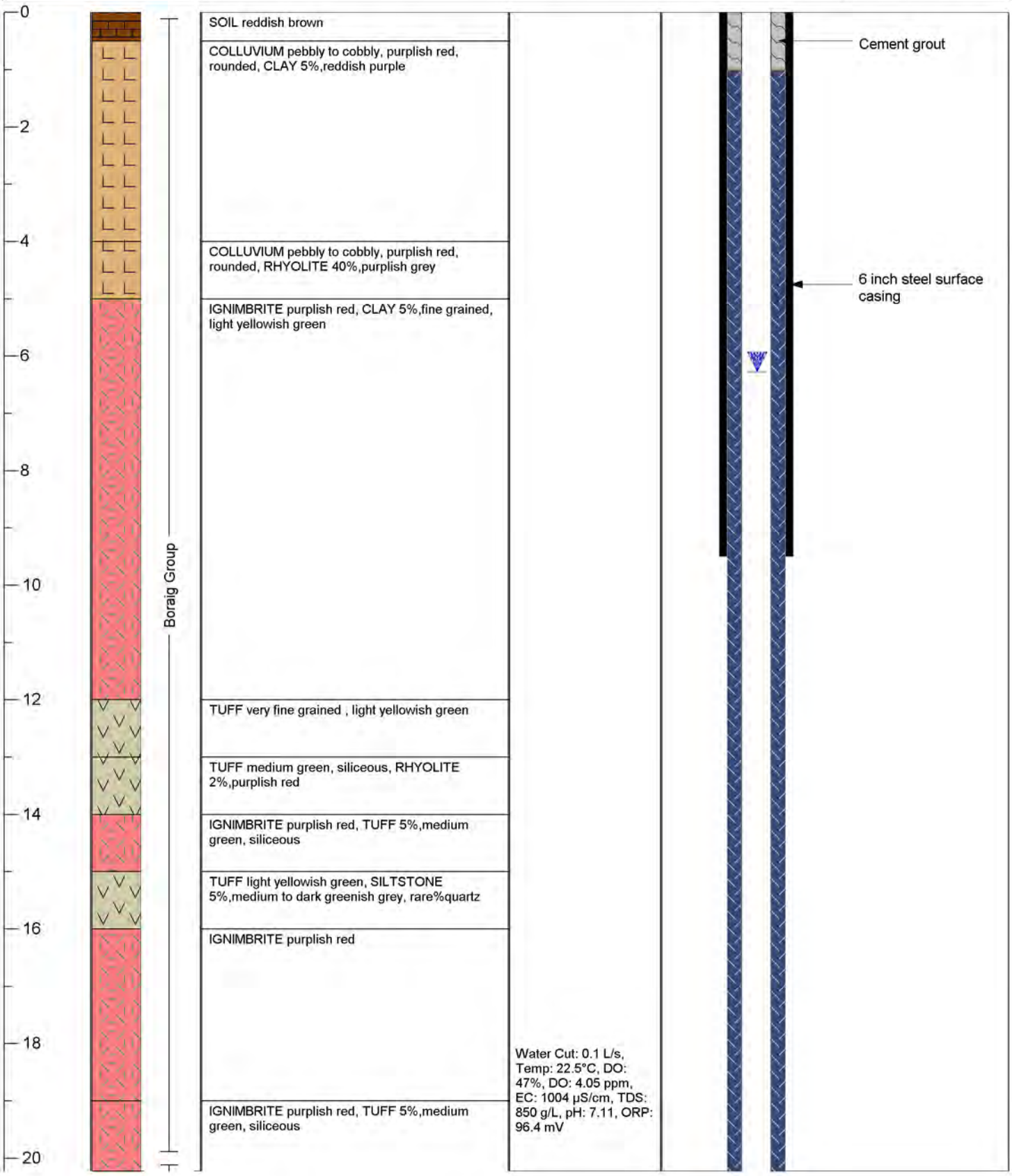
Client: Snowy Hydro **Project:** Snowy Hydro 2.0

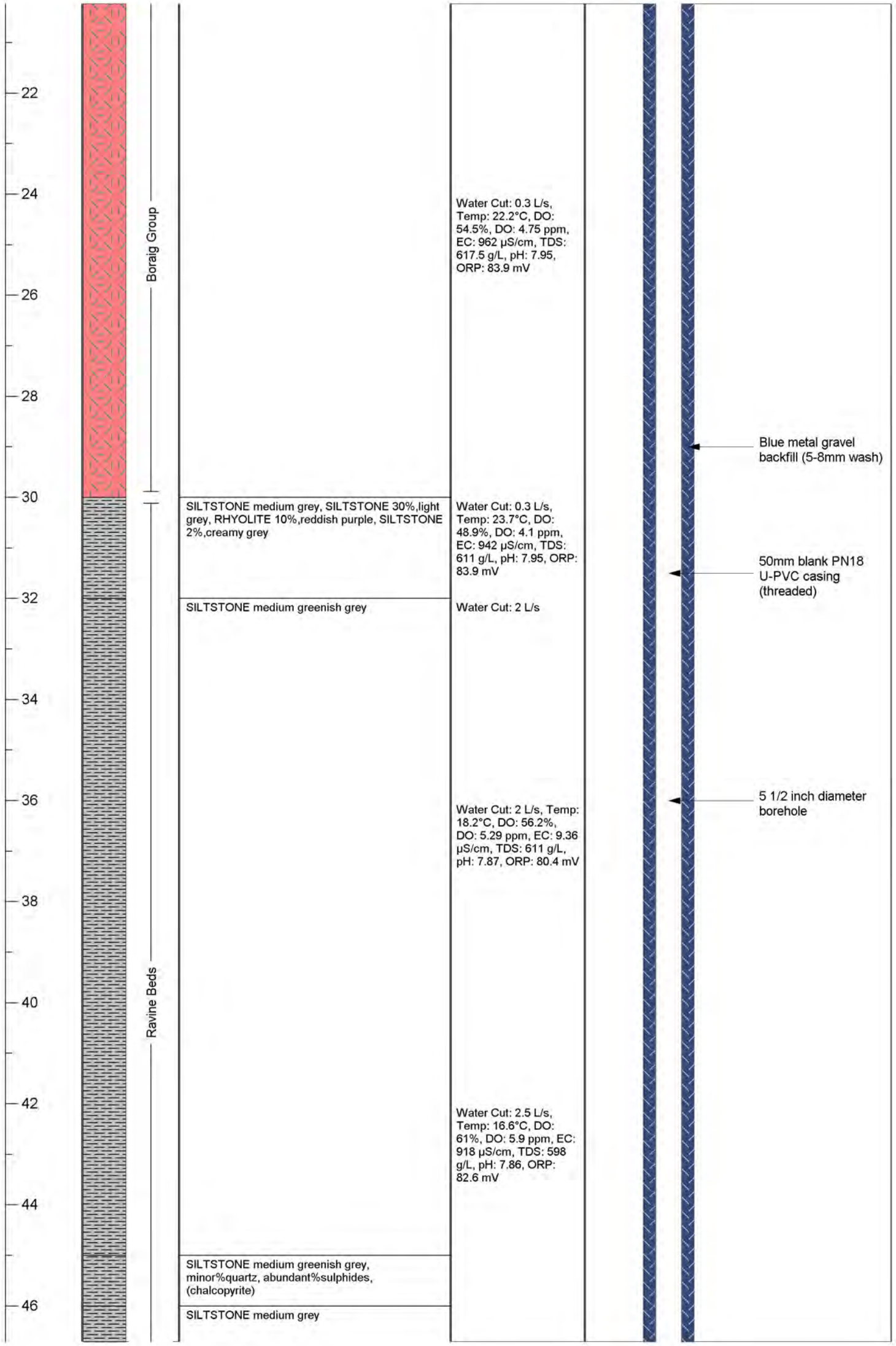
Date completed:	22/03/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	581.8 mAHD
Drilling method:	Air rotary	**Easting:**	627677.7
Hydrogeologist:	K Maher	**Northing:**	6038070.0

Static Water Level: 6.1 mbgl **Screened Formation:** Ravine Beds **Date:** 27/03/18

Total depth: 72 mbgl **Screened depth:** 63 - 69 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes

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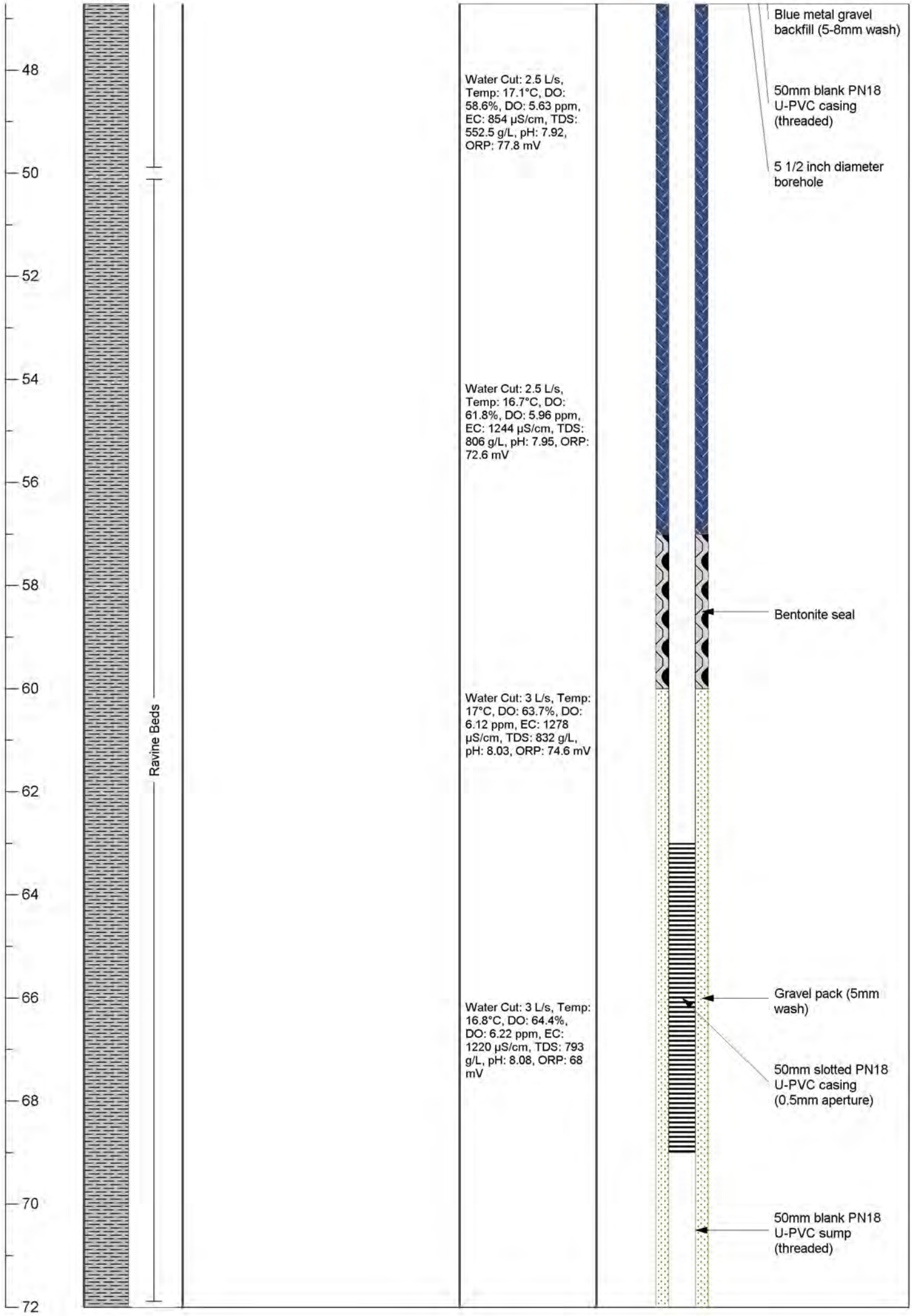
Boraig Group
Ravine Beds
SILTSTONE medium grey, SILTSTONE 30%,light grey, RHYOLITE 10%,reddish purple, SILTSTONE 2%,creamy grey
SILTSTONE medium greenish grey
SILTSTONE medium greenish grey, minor%quartz, abundant%sulphides, (chalcopyrite)
SILTSTONE medium grey
Water Cut: 0.3 L/s, Temp: 22.2°C, DO: 54.5%, DO: 4.75 ppm, EC: 962 µS/cm, TDS: 617.5 g/L, pH: 7.95, ORP: 83.9 mV
Water Cut: 0.3 L/s, Temp: 23.7°C, DO: 48.9%, DO: 4.1 ppm, EC: 942 µS/cm, TDS: 611 g/L, pH: 7.95, ORP: 83.9 mV
Water Cut: 2 L/s
Water Cut: 2 L/s, Temp: 18.2°C, DO: 56.2%, DO: 5.29 ppm, EC: 9.36 µS/cm, TDS: 611 g/L, pH: 7.87, ORP: 80.4 mV
Water Cut: 2.5 L/s, Temp: 16.6°C, DO: 61%, DO: 5.9 ppm, EC: 918 µS/cm, TDS: 598 g/L, pH: 7.86, ORP: 82.6 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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Ravine Beds
Water Cut: 2.5 L/s, Temp: 17.1°C, DO: 58.6%, DO: 5.63 ppm, EC: 854 µS/cm, TDS: 552.5 g/L, pH: 7.92, ORP: 77.8 mV
Water Cut: 2.5 L/s, Temp: 16.7°C, DO: 61.8%, DO: 5.96 ppm, EC: 1244 µS/cm, TDS: 806 g/L, pH: 7.95, ORP: 72.6 mV
Water Cut: 3 L/s, Temp: 17°C, DO: 63.7%, DO: 6.12 ppm, EC: 1278 µS/cm, TDS: 832 g/L, pH: 8.03, ORP: 74.6 mV
Water Cut: 3 L/s, Temp: 16.8°C, DO: 64.4%, DO: 6.22 ppm, EC: 1220 µS/cm, TDS: 793 g/L, pH: 8.08, ORP: 68 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: TMB02A

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed:	26/02/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1469.6m AHD
Drilling method:	Air rotary	**Easting:**	634554.0
Hydrogeologist:	K Maher	**Northing:**	6038586.4

Static Water Level: 5.6 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 26/02/18

Total depth: 15 mbgl **Screened depth:** 11 - 14 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0 – 2		SOIL dark brown		Cement grout	
2 – 4		CLAY light yellowish brown, highly weathered		Blue metal gravel backfill (5-8mm wash)	
4 – 8	Gooandra Volcanics	CLAY medium orange, extremely weathered		50mm blank PN18 U-PVC casing (threaded); Bentonite seal; 5 1/2 inch diameter borehole	
8 – 14		CLAY medium yellowish brown, highly weathered	Water Cut: 0.3 L/s	Gravel pack (5mm wash); 50mm slotted PN18 U-PVC casing (0.5mm aperture); 50mm blank PN18 U-PVC sump (threaded)	

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WATER MONITORING BORE LOG

Bore ID: TMB02B

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed: 1/03/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: K Maher

Project number: J17188
Elevation: 1472.3 mAHD
Easting: 634548.5
Northing: 6038606.6

Static Water Level: 7.13 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 1/03/18

Total depth: 200 mbgl **Screened depth:** 191 - 197 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes
0		SOIL dark brown, CLAY, 20% orangey brown, extremely weathered		Cement grout	
2		CLAY orange, extremely weathered			
4					
6					
8				6 inch steel surface casing	
10	Gooandra Volcanics	GREENSCHIST light to medium orange, extremely weathered, thinly bedded/platy, micaceous, dark reddish brown oxidation			
12		GREENSCHIST light to medium orange, extremely weathered, micaceous, platy	Water Cut: 0.2 L/s, Temp: 10.1°C, DO: 69.4%, DO: 7.89 ppm, EC: 28.8 µS/cm, TDS: 18.85 g/L, pH: 8.48, ORP: 218.7 mV		
14					
16					
18			Water Cut: 0.3 L/s, Temp: 12.6°C, DO: 70.1%, DO: 7.44 ppm, EC: 18.4 µS/cm, TDS: 11.7 g/L, pH: 8, ORP: 199 mV		
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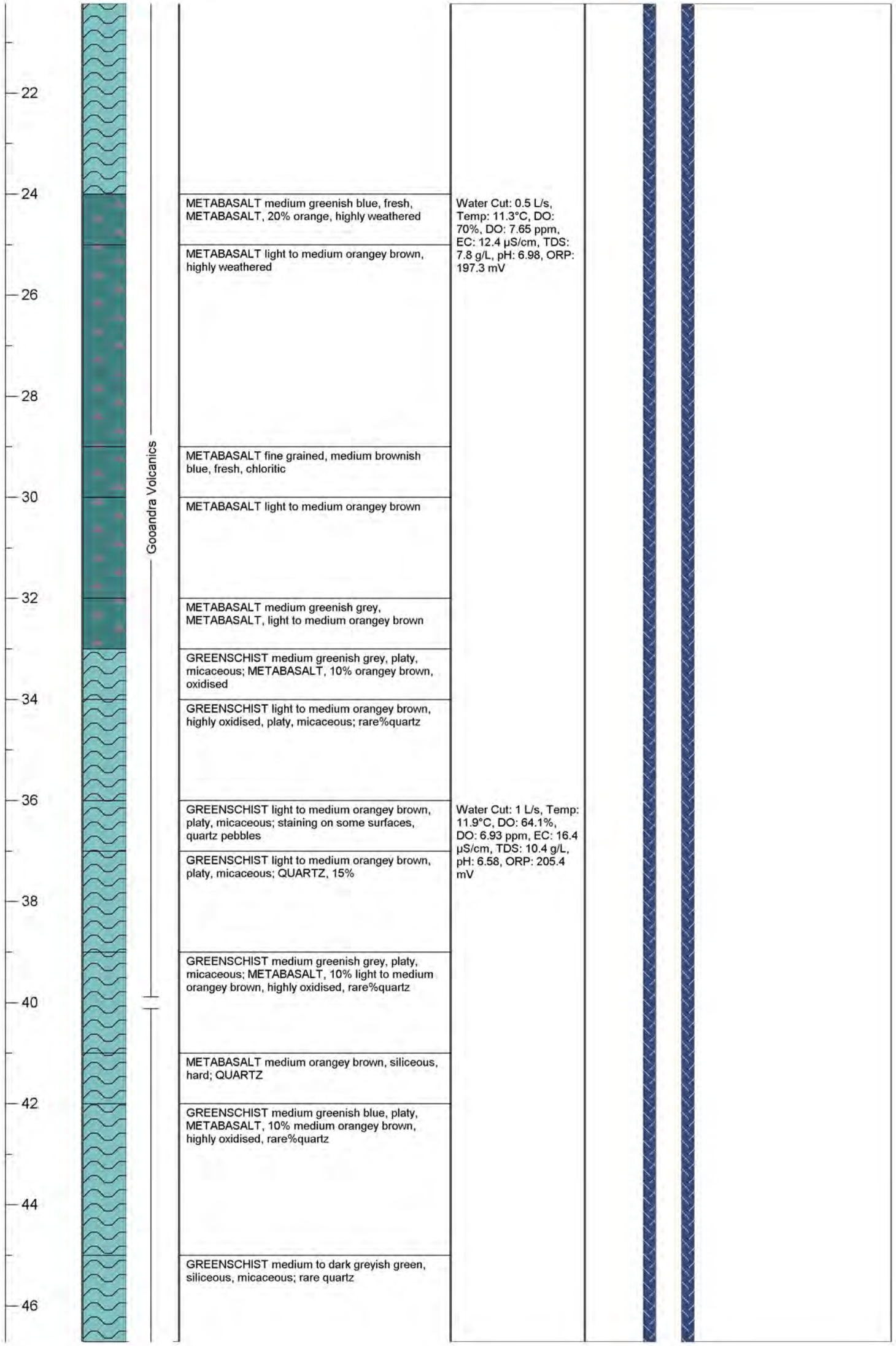
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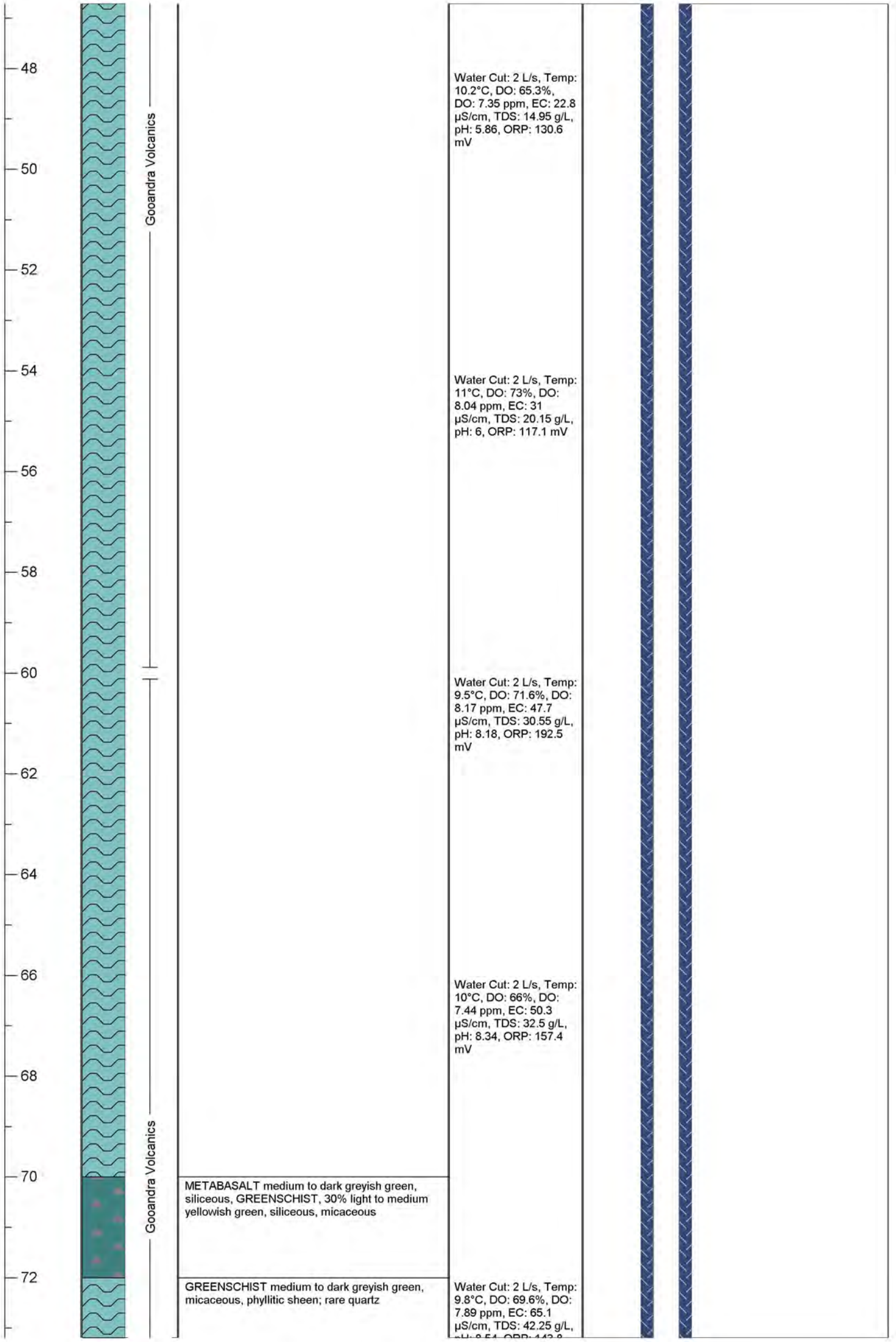
Gooandra Volcanics
METABASALT medium greenish blue, fresh, METABASALT, 20% orange, highly weathered
METABASALT light to medium orangey brown, highly weathered
METABASALT fine grained, medium brownish blue, fresh, chloritic
METABASALT light to medium orangey brown
METABASALT medium greenish grey, METABASALT, light to medium orangey brown
GREENSCHIST medium greenish grey, platy, micaceous; METABASALT, 10% orangey brown, oxidised
GREENSCHIST light to medium orangey brown, highly oxidised, platy, micaceous; rare%quartz
GREENSCHIST light to medium orangey brown, platy, micaceous; staining on some surfaces, quartz pebbles
GREENSCHIST light to medium orangey brown, platy, micaceous; QUARTZ, 15%
GREENSCHIST medium greenish grey, platy, micaceous; METABASALT, 10% light to medium orangey brown, highly oxidised, rare%quartz
METABASALT medium orangey brown, siliceous, hard; QUARTZ
GREENSCHIST medium greenish blue, platy, METABASALT, 10% medium orangey brown, highly oxidised, rare%quartz
GREENSCHIST medium to dark greyish green, siliceous, micaceous; rare quartz
Water Cut: 0.5 L/s, Temp: 11.3°C, DO: 70%, DO: 7.65 ppm, EC: 12.4 µS/cm, TDS: 7.8 g/L, pH: 6.98, ORP: 197.3 mV
Water Cut: 1 L/s, Temp: 11.9°C, DO: 64.1%, DO: 6.93 ppm, EC: 16.4 µS/cm, TDS: 10.4 g/L, pH: 6.58, ORP: 205.4 mV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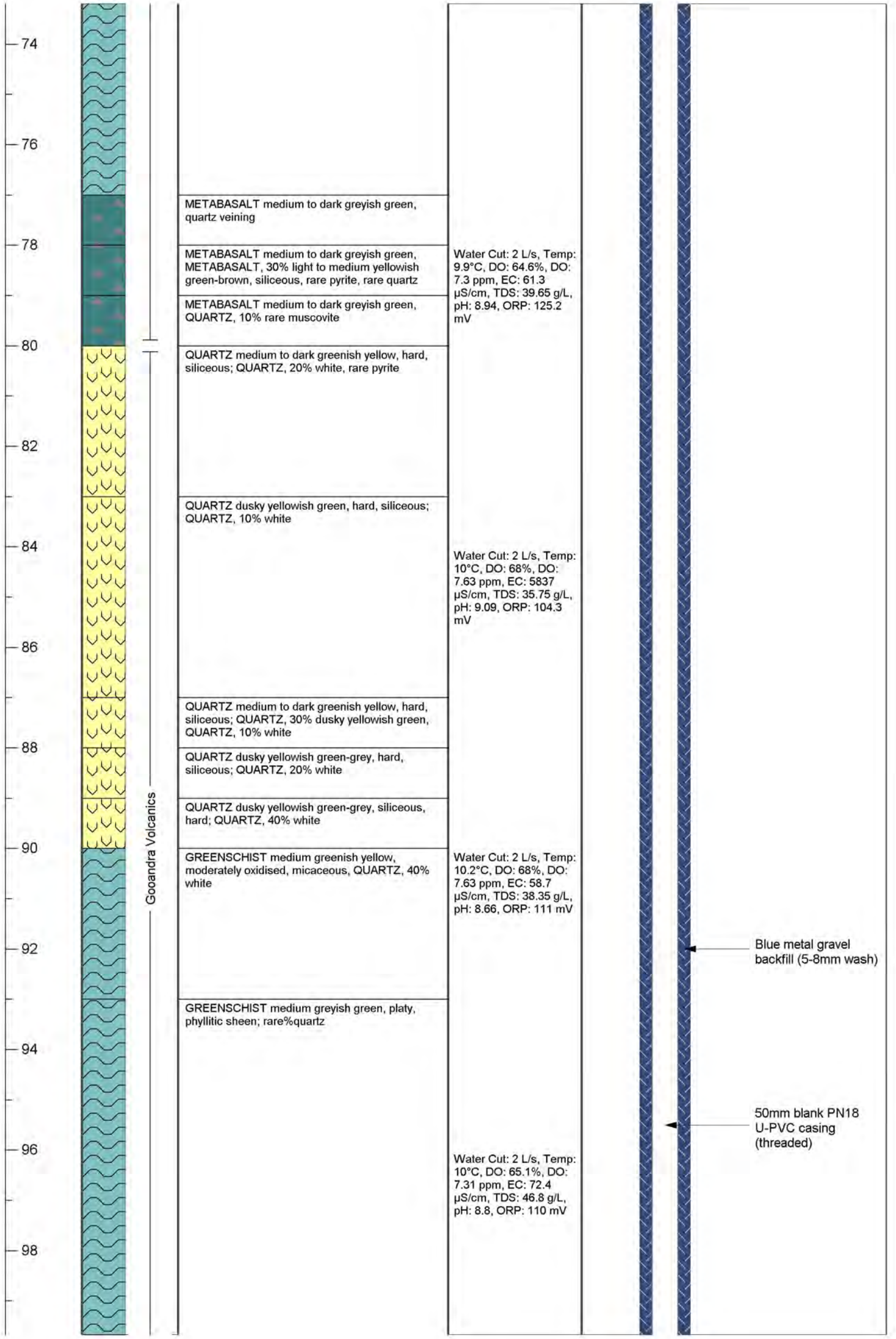
Gooandra Volcanics
Gooandra Volcanics
METABASALT medium to dark greyish green, siliceous, GREENSCHIST, 30% light to medium yellowish green, siliceous, micaceous
GREENSCHIST medium to dark greyish green, micaceous, phyllitic sheen; rare quartz
Water Cut: 2 L/s, Temp: 10.2°C, DO: 65.3%, DO: 7.35 ppm, EC: 22.8 µS/cm, TDS: 14.95 g/L, pH: 5.86, ORP: 130.6 mV
Water Cut: 2 L/s, Temp: 11°C, DO: 73%, DO: 8.04 ppm, EC: 31 µS/cm, TDS: 20.15 g/L, pH: 6, ORP: 117.1 mV
Water Cut: 2 L/s, Temp: 9.5°C, DO: 71.6%, DO: 8.17 ppm, EC: 47.7 µS/cm, TDS: 30.55 g/L, pH: 8.18, ORP: 192.5 mV
Water Cut: 2 L/s, Temp: 10°C, DO: 66%, DO: 7.44 ppm, EC: 50.3 µS/cm, TDS: 32.5 g/L, pH: 8.34, ORP: 157.4 mV
Water Cut: 2 L/s, Temp: 9.8°C, DO: 69.6%, DO: 7.89 ppm, EC: 65.1 µS/cm, TDS: 42.25 g/L,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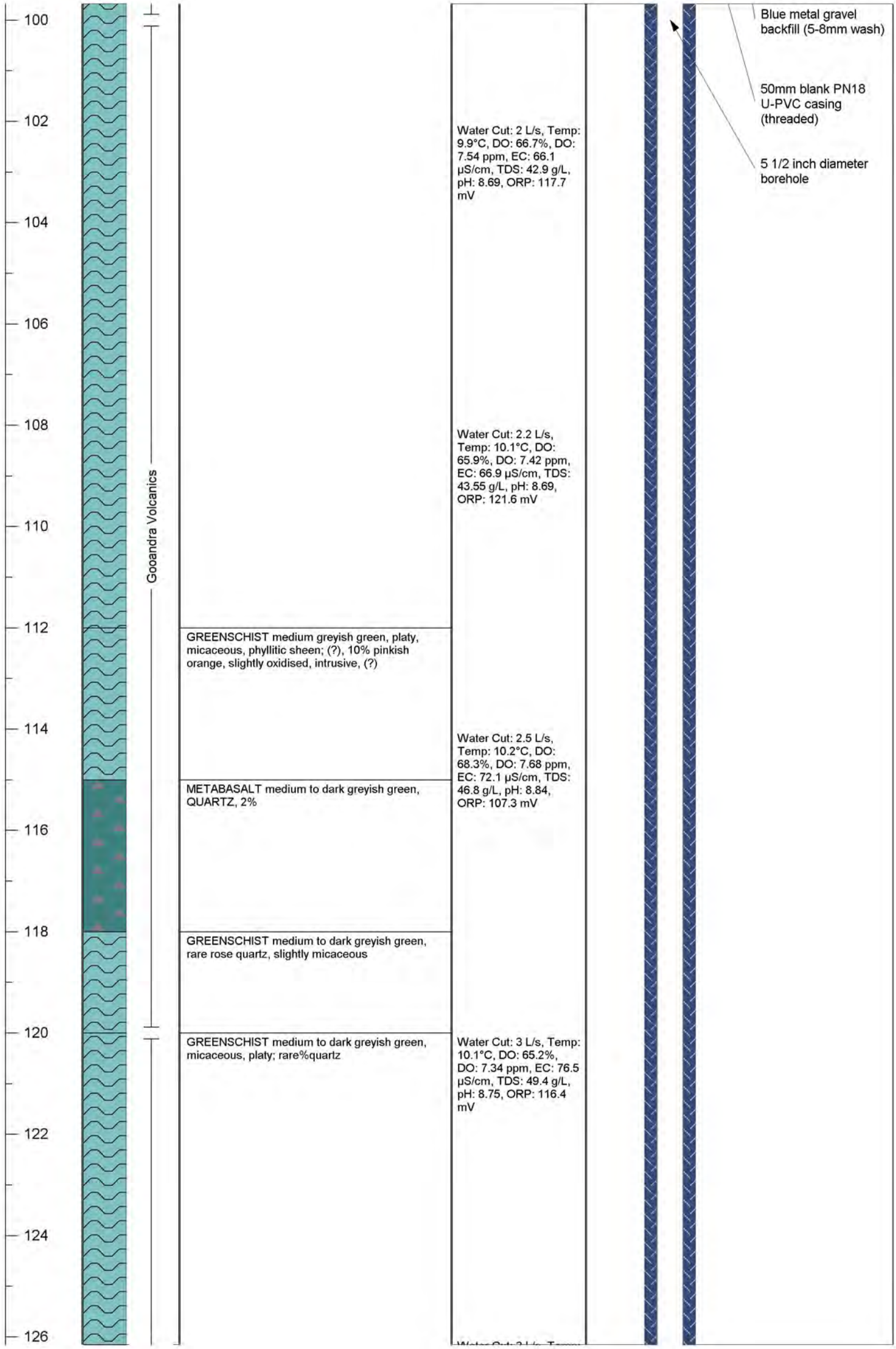
Gooandra Volcanics
METABASALT medium to dark greyish green, quartz veining
METABASALT medium to dark greyish green, METABASALT, 30% light to medium yellowish green-brown, siliceous, rare pyrite, rare quartz
METABASALT medium to dark greyish green, QUARTZ, 10% rare muscovite
QUARTZ medium to dark greenish yellow, hard, siliceous; QUARTZ, 20% white, rare pyrite
QUARTZ dusky yellowish green, hard, siliceous; QUARTZ, 10% white
QUARTZ medium to dark greenish yellow, hard, siliceous; QUARTZ, 30% dusky yellowish green, QUARTZ, 10% white
QUARTZ dusky yellowish green-grey, hard, siliceous; QUARTZ, 20% white
QUARTZ dusky yellowish green-grey, siliceous, hard; QUARTZ, 40% white
GREENSCHIST medium greenish yellow, moderately oxidised, micaceous, QUARTZ, 40% white
GREENSCHIST medium greyish green, platy, phyllitic sheen; rare%quartz
Water Cut: 2 L/s, Temp: 9.9°C, DO: 64.6%, DO: 7.3 ppm, EC: 61.3 µS/cm, TDS: 39.65 g/L, pH: 8.94, ORP: 125.2 mV
Water Cut: 2 L/s, Temp: 10°C, DO: 68%, DO: 7.63 ppm, EC: 5837 µS/cm, TDS: 35.75 g/L, pH: 9.09, ORP: 104.3 mV
Water Cut: 2 L/s, Temp: 10.2°C, DO: 68%, DO: 7.63 ppm, EC: 58.7 µS/cm, TDS: 38.35 g/L, pH: 8.66, ORP: 111 mV
Water Cut: 2 L/s, Temp: 10°C, DO: 65.1%, DO: 7.31 ppm, EC: 72.4 µS/cm, TDS: 46.8 g/L, pH: 8.8, ORP: 110 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)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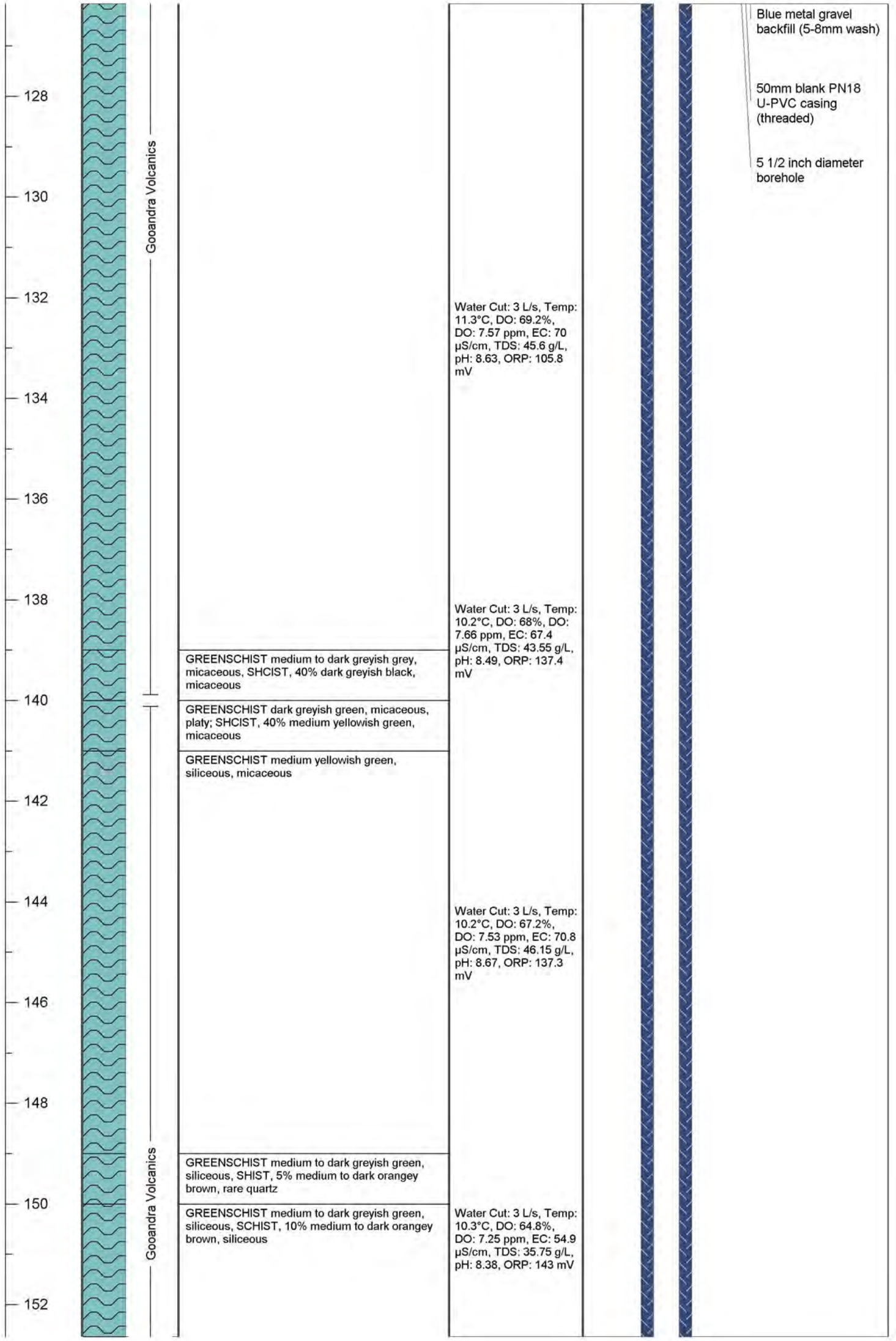
Gooandra Volcanics
GREENSCHIST medium greyish green, platy, micaceous, phyllitic sheen; (?), 10% pinkish orange, slightly oxidised, intrusive, (?)
METABASALT medium to dark greyish green, QUARTZ, 2%
GREENSCHIST medium to dark greyish green, rare rose quartz, slightly micaceous
GREENSCHIST medium to dark greyish green, micaceous, platy; rare%quartz
Water Cut: 2 L/s, Temp: 9.9°C, DO: 66.7%, DO: 7.54 ppm, EC: 66.1 µS/cm, TDS: 42.9 g/L, pH: 8.69, ORP: 117.7 mV
Water Cut: 2.2 L/s, Temp: 10.1°C, DO: 65.9%, DO: 7.42 ppm, EC: 66.9 µS/cm, TDS: 43.55 g/L, pH: 8.69, ORP: 121.6 mV
Water Cut: 2.5 L/s, Temp: 10.2°C, DO: 68.3%, DO: 7.68 ppm, EC: 72.1 µS/cm, TDS: 46.8 g/L, pH: 8.84, ORP: 107.3 mV
Water Cut: 3 L/s, Temp: 10.1°C, DO: 65.2%, DO: 7.34 ppm, EC: 76.5 µS/cm, TDS: 49.4 g/L, pH: 8.75, ORP: 116.4 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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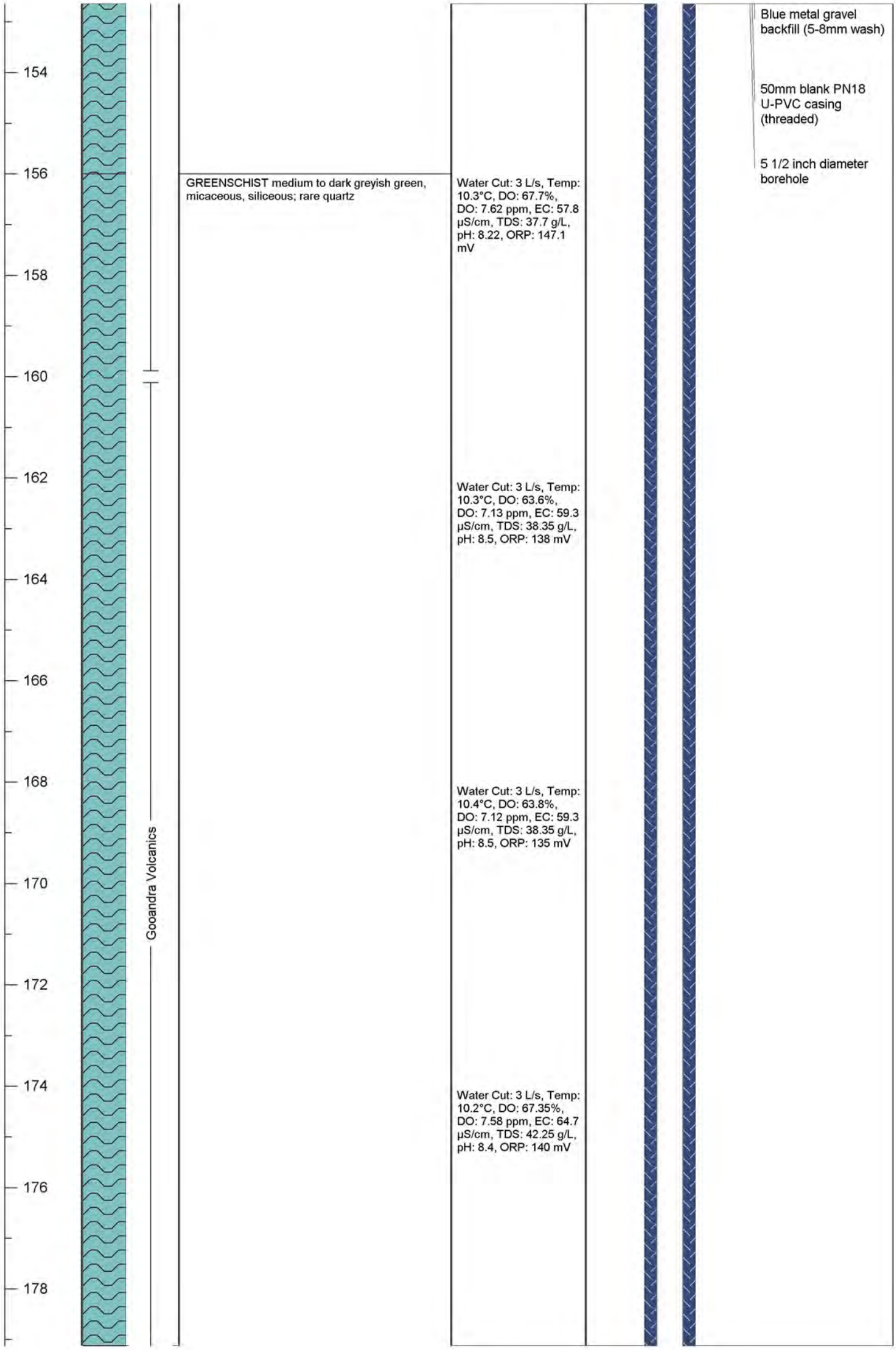
Gooandra Volcanics
Gooandra Volcanics
GREENSCHIST medium to dark greyish grey, micaceous, SHCIST, 40% dark greyish black, micaceous
GREENSCHIST dark greyish green, micaceous, platy; SHCIST, 40% medium yellowish green, micaceous
GREENSCHIST medium yellowish green, siliceous, micaceous
GREENSCHIST medium to dark greyish green, siliceous, SHIST, 5% medium to dark orangey brown, rare quartz
GREENSCHIST medium to dark greyish green, siliceous, SCHIST, 10% medium to dark orangey brown, siliceous
Water Cut: 3 L/s, Temp: 11.3°C, DO: 69.2%, DO: 7.57 ppm, EC: 70 µS/cm, TDS: 45.6 g/L, pH: 8.63, ORP: 105.8 mV
Water Cut: 3 L/s, Temp: 10.2°C, DO: 68%, DO: 7.66 ppm, EC: 67.4 µS/cm, TDS: 43.55 g/L, pH: 8.49, ORP: 137.4 mV
Water Cut: 3 L/s, Temp: 10.2°C, DO: 67.2%, DO: 7.53 ppm, EC: 70.8 µS/cm, TDS: 46.15 g/L, pH: 8.67, ORP: 137.3 mV
Water Cut: 3 L/s, Temp: 10.3°C, DO: 64.8%, DO: 7.25 ppm, EC: 54.9 µS/cm, TDS: 35.75 g/L, pH: 8.38, ORP: 143 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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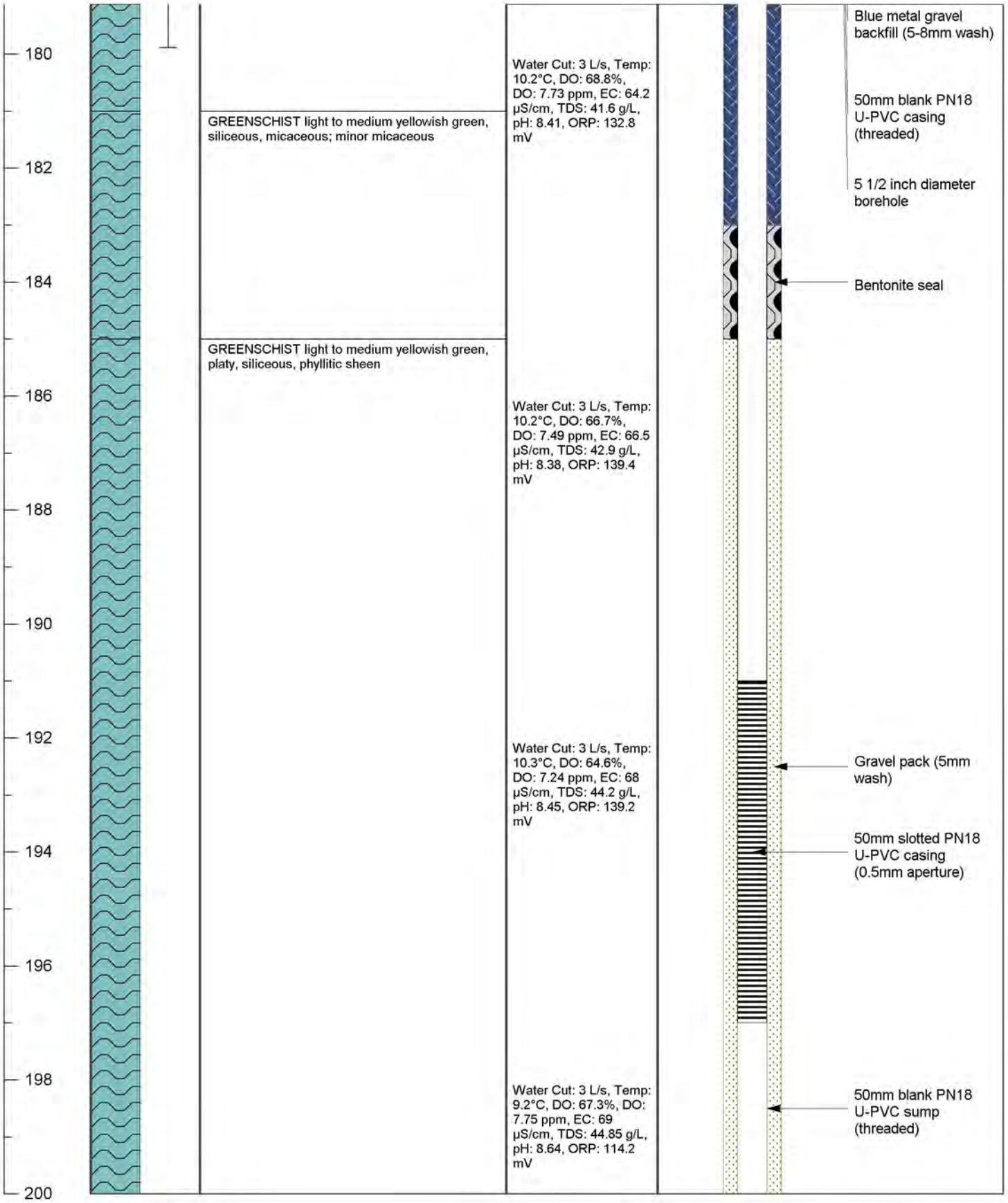
Gooandra Volcanics
GREENSCHIST medium to dark greyish green, micaceous, siliceous; rare quartz
Water Cut: 3 L/s, Temp: 10.3°C, DO: 67.7%, DO: 7.62 ppm, EC: 57.8 µS/cm, TDS: 37.7 g/L, pH: 8.22, ORP: 147.1 mV
Water Cut: 3 L/s, Temp: 10.3°C, DO: 63.6%, DO: 7.13 ppm, EC: 59.3 µS/cm, TDS: 38.35 g/L, pH: 8.5, ORP: 138 mV
Water Cut: 3 L/s, Temp: 10.4°C, DO: 63.8%, DO: 7.12 ppm, EC: 59.3 µS/cm, TDS: 38.35 g/L, pH: 8.5, ORP: 135 mV
Water Cut: 3 L/s, Temp: 10.2°C, DO: 67.35%, DO: 7.58 ppm, EC: 64.7 µS/cm, TDS: 42.25 g/L, pH: 8.4, ORP: 140 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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GREENSCHIST light to medium yellowish green, siliceous, micaceous; minor micaceous
GREENSCHIST light to medium yellowish green, platy, siliceous, phyllitic sheen
Water Cut: 3 L/s, Temp: 10.2°C, DO: 68.8%, DO: 7.73 ppm, EC: 64.2 µS/cm, TDS: 41.6 g/L, pH: 8.41, ORP: 132.8 mV
Water Cut: 3 L/s, Temp: 10.2°C, DO: 66.7%, DO: 7.49 ppm, EC: 66.5 µS/cm, TDS: 42.9 g/L, pH: 8.38, ORP: 139.4 mV
Water Cut: 3 L/s, Temp: 10.3°C, DO: 64.6%, DO: 7.24 ppm, EC: 68 µS/cm, TDS: 44.2 g/L, pH: 8.45, ORP: 139.2 mV
Water Cut: 3 L/s, Temp: 9.2°C, DO: 67.3%, DO: 7.75 ppm, EC: 69 µS/cm, TDS: 44.85 g/L, pH: 8.64, ORP: 114.2 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: TMB03A

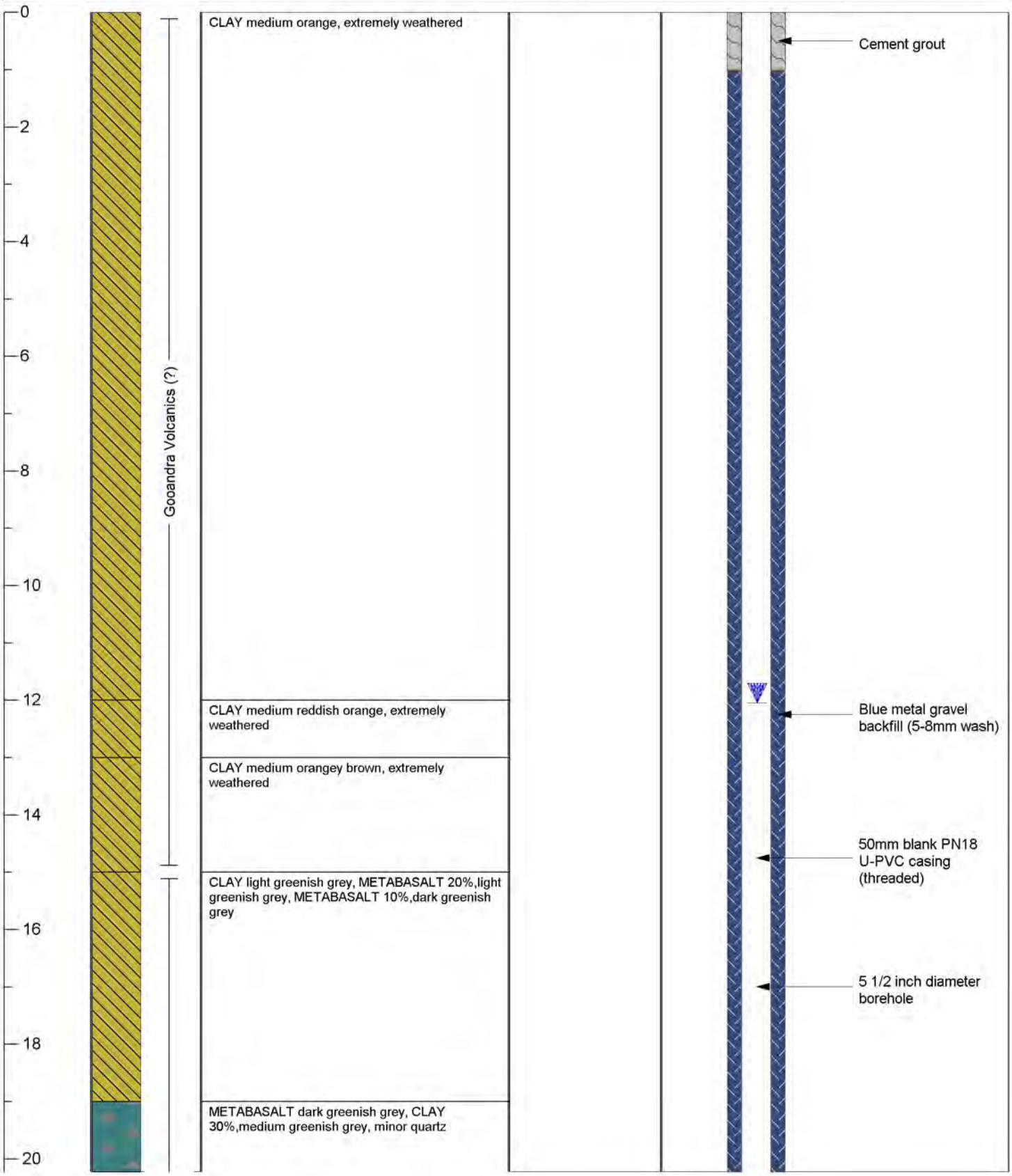
Client: Snowy Hydro **Project:** Snowy Hydro 2.0

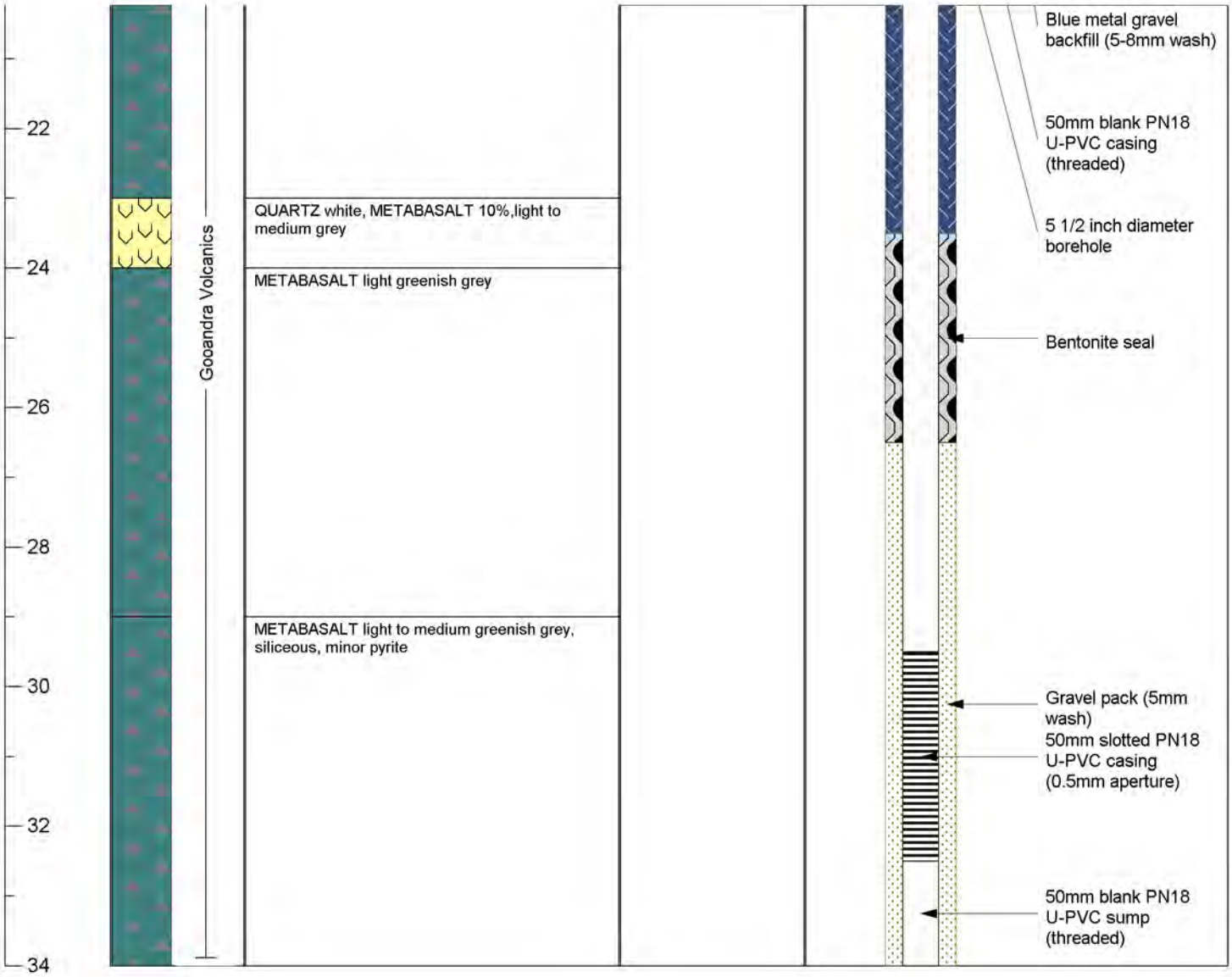
Date completed:	31/01/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	1477.7 mAHD
Drilling method:	Air rotary	**Easting:**	636224.2
Hydrogeologist:	K Maher	**Northing:**	6038504.3

Static Water Level: 11.87 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 6/02/18

Total depth: 34 mbgl **Screened depth:** 29.5 - 32.5 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes

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Gooandra Volcanics
QUARTZ white, METABASALT 10%,light to medium grey
METABASALT light greenish grey
METABASALT light to medium greenish grey, siliceous, minor pyrite
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: TMB03B

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed: 30/01/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: K Maher

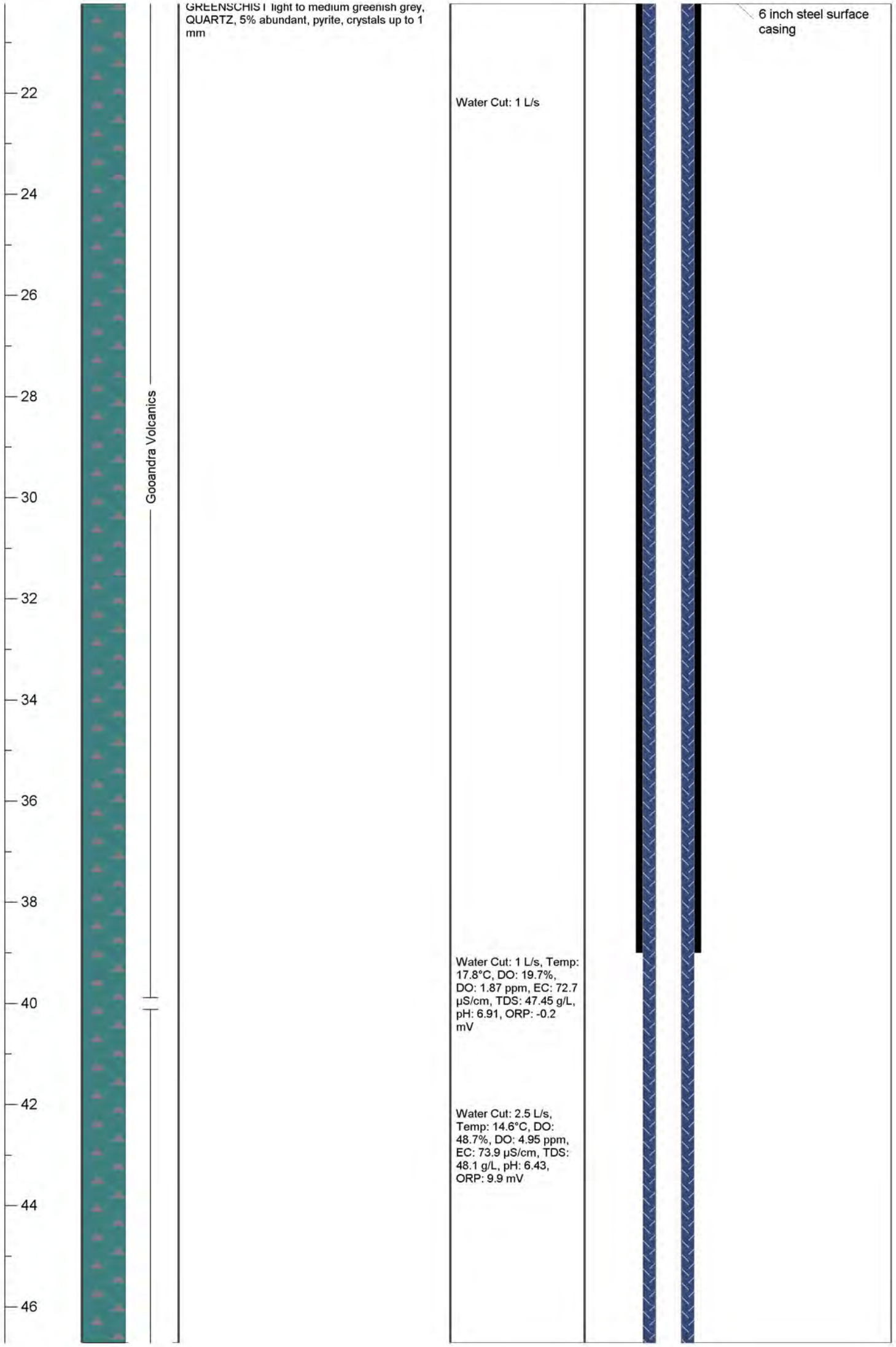
Project number: J17188
Elevation: 1477.6 mAHD
Easting: 636215.2
Northing: 6038505.1

Static Water Level: 17.685 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 6/02/18

Total depth: 150 mbgl **Screened depth:** 141 - 147 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes
0		SOIL dark brown		Cement grout	
		CLAY medium greenish brown, highly weathered			
2		CLAY light to medium brownish grey, highly weathered			
4		CLAY medium to dark orange, extremely weathered			
6		CLAY medium orange, extremely weathered			
		CLAY light to medium orange, highly weathered			
8		CLAY light orange			
		CLAY light greenish grey	first water, filled on rod change		
10		BASALT medium greenish brown, highly weathered, CLAY, 10%			
12		BASALT medium to dark greenish grey, BASALT, 20% dark grey, soft, easily broken			
14					
		BASALT medium grey, BASALT, 5% dark brown, minor quartz, pyrite			
16		BASALT dark greenish brown, slightly oxidised, soft, easily broken			
18		METABASALT light greenish grey, abundant, pyrite		6 inch steel surface casing	
20		GREENSCHIST light to medium greenish grey,			

Gooandra Volcanics (?)


GREENSCHIST light to medium greenish grey, QUARTZ, 5% abundant, pyrite, crystals up to 1 mm
Gooandra Volcanics
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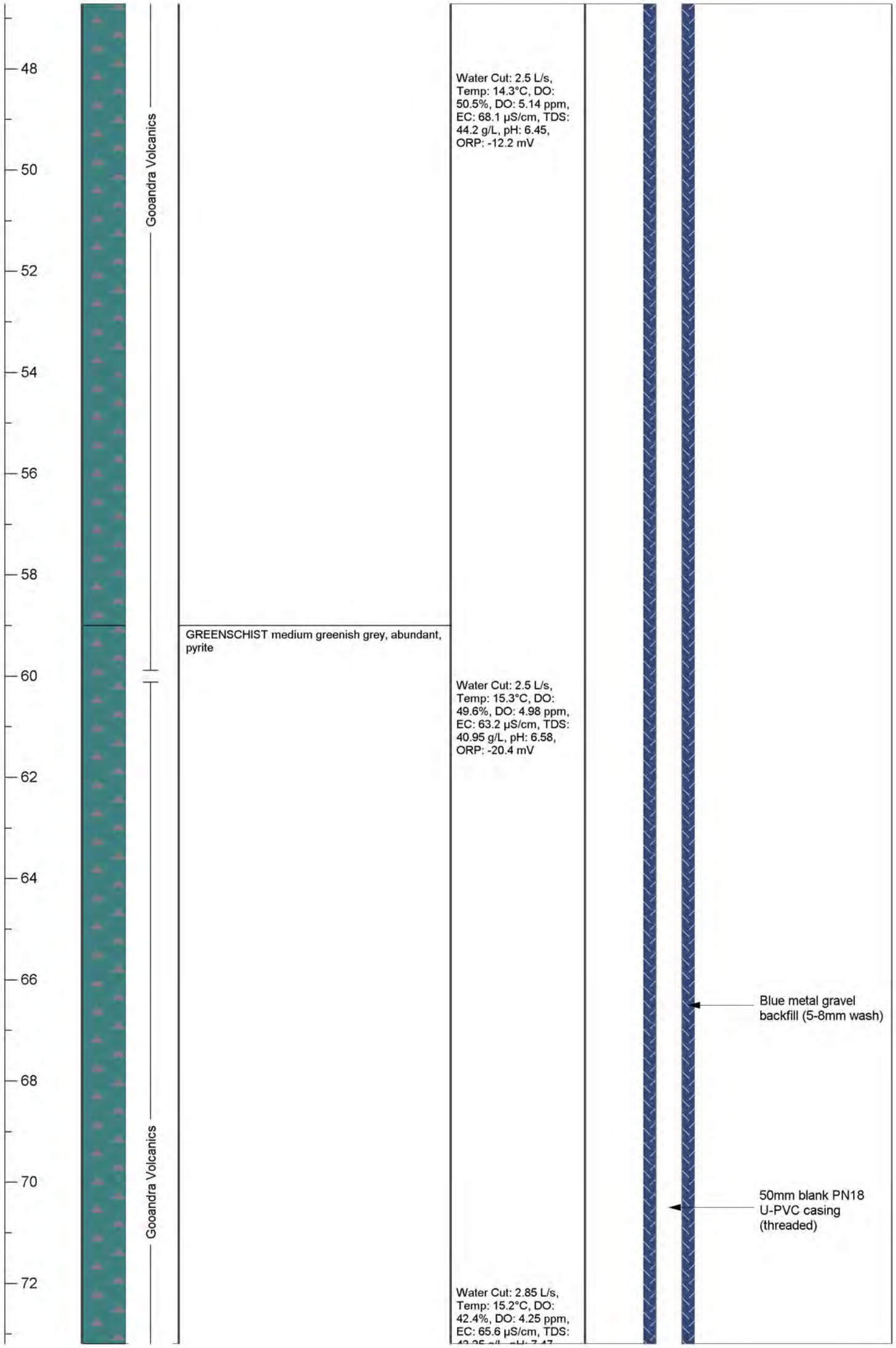
46
Water Cut: 1 L/s
Water Cut: 1 L/s, Temp: 17.8°C, DO: 19.7%, DO: 1.87 ppm, EC: 72.7 µS/cm, TDS: 47.45 g/L, pH: 6.91, ORP: -0.2 mV
Water Cut: 2.5 L/s, Temp: 14.6°C, DO: 48.7%, DO: 4.95 ppm, EC: 73.9 µS/cm, TDS: 48.1 g/L, pH: 6.43, ORP: 9.9 mV
6 inch steel surface casing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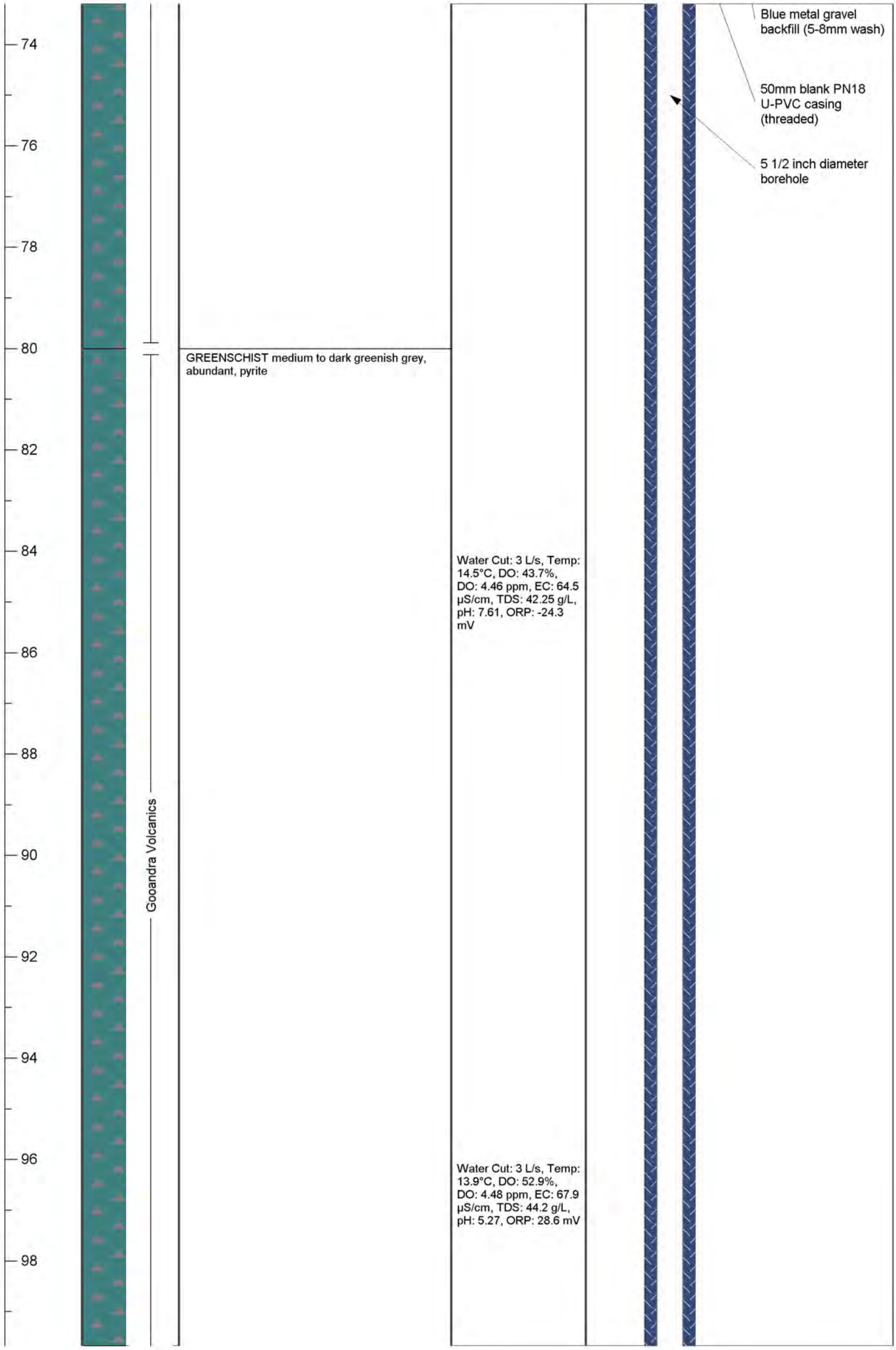
Gooandra Volcanics
Gooandra Volcanics
GREENSCHIST medium greenish grey, abundant, pyrite
Water Cut: 2.5 L/s, Temp: 14.3°C, DO: 50.5%, DO: 5.14 ppm, EC: 68.1 µS/cm, TDS: 44.2 g/L, pH: 6.45, ORP: -12.2 mV
Water Cut: 2.5 L/s, Temp: 15.3°C, DO: 49.6%, DO: 4.98 ppm, EC: 63.2 µS/cm, TDS: 40.95 g/L, pH: 6.58, ORP: -20.4 mV
Water Cut: 2.85 L/s, Temp: 15.2°C, DO: 42.4%, DO: 4.25 ppm, EC: 65.6 µS/cm, TDS:
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)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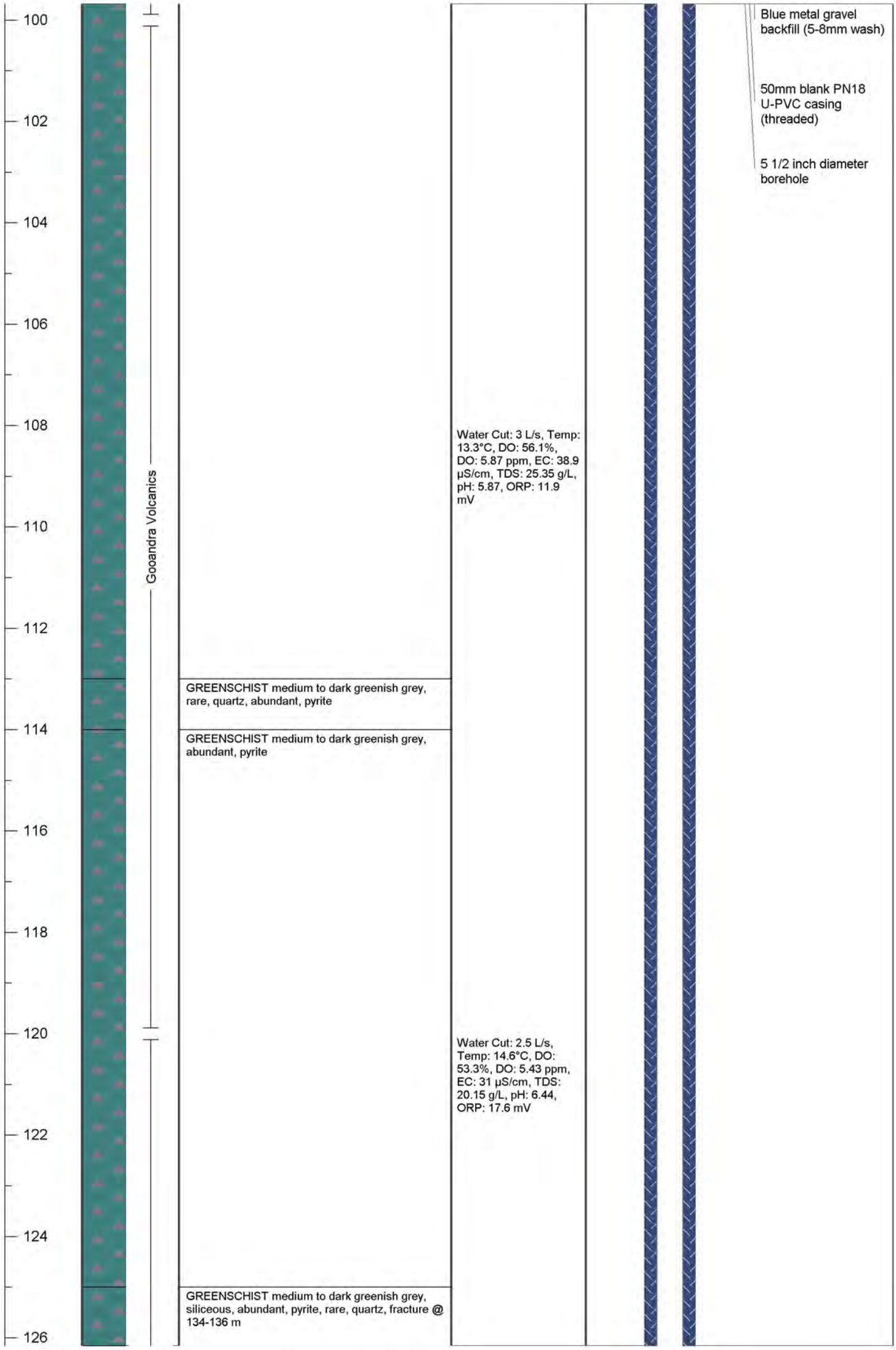
Gooandra Volcanics
GREENSCHIST medium to dark greenish grey, abundant, pyrite
Water Cut: 3 L/s, Temp: 14.5°C, DO: 43.7%, DO: 4.46 ppm, EC: 64.5 µS/cm, TDS: 42.25 g/L, pH: 7.61, ORP: -24.3 mV
Water Cut: 3 L/s, Temp: 13.9°C, DO: 52.9%, DO: 4.48 ppm, EC: 67.9 µS/cm, TDS: 44.2 g/L, pH: 5.27, ORP: 28.6 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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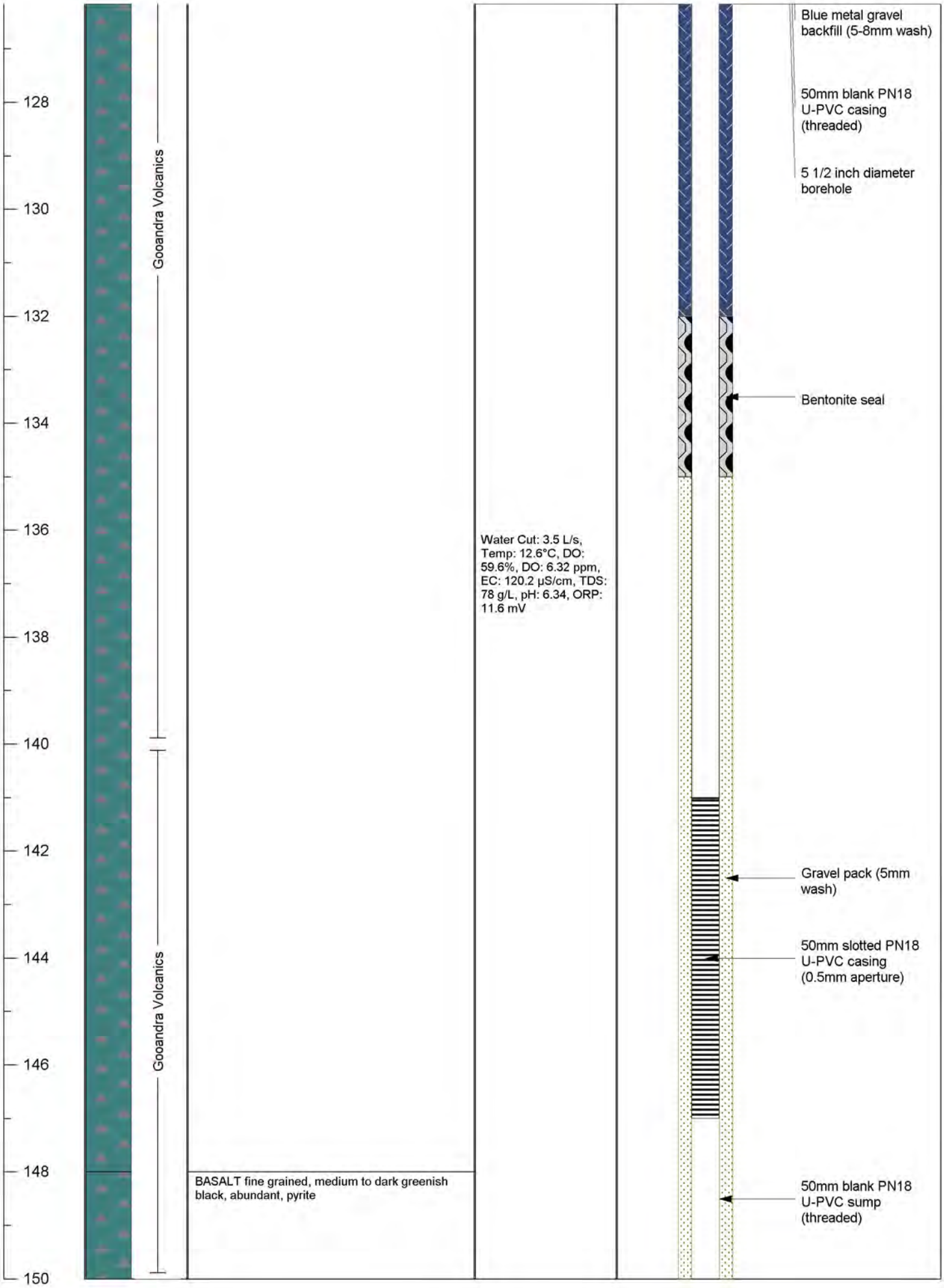
Gooandra Volcanics
GREENSCHIST medium to dark greenish grey, rare, quartz, abundant, pyrite
GREENSCHIST medium to dark greenish grey, abundant, pyrite
GREENSCHIST medium to dark greenish grey, siliceous, abundant, pyrite, rare, quartz, fracture @ 134-136 m
Water Cut: 3 L/s, Temp: 13.3°C, DO: 56.1%, DO: 5.87 ppm, EC: 38.9 µS/cm, TDS: 25.35 g/L, pH: 5.87, ORP: 11.9 mV
Water Cut: 2.5 L/s, Temp: 14.6°C, DO: 53.3%, DO: 5.43 ppm, EC: 31 µS/cm, TDS: 20.15 g/L, pH: 6.44, ORP: 17.6 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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Gooandra Volcanics
Gooandra Volcanics
BASALT fine grained, medium to dark greenish black, abundant, pyrite
Water Cut: 3.5 L/s, Temp: 12.6°C, DO: 59.6%, DO: 6.32 ppm, EC: 120.2 µS/cm, TDS: 78 g/L, pH: 6.34, ORP: 11.6 mV
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)

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WATER MONITORING BORE LOG

Bore ID: TMB03C

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed: 3/03/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: I Frawley

Project number: J17188
Elevation: 1478 mAHD
Easting: 636220.7
Northing: 6038495.1

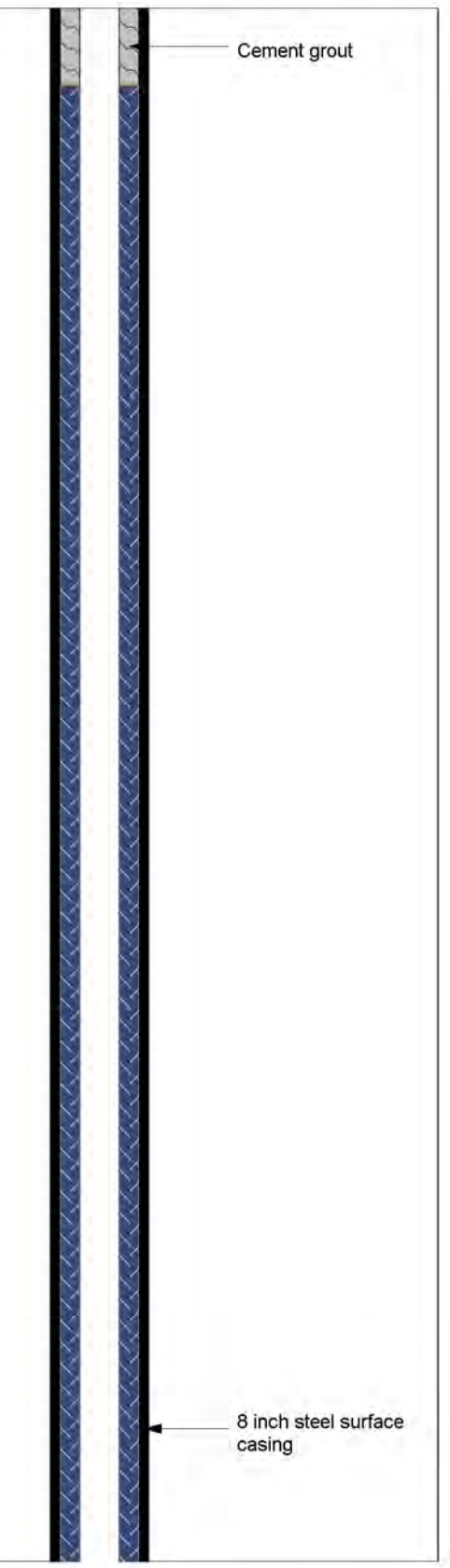
Static Water Level: 21.94 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 20/03/18

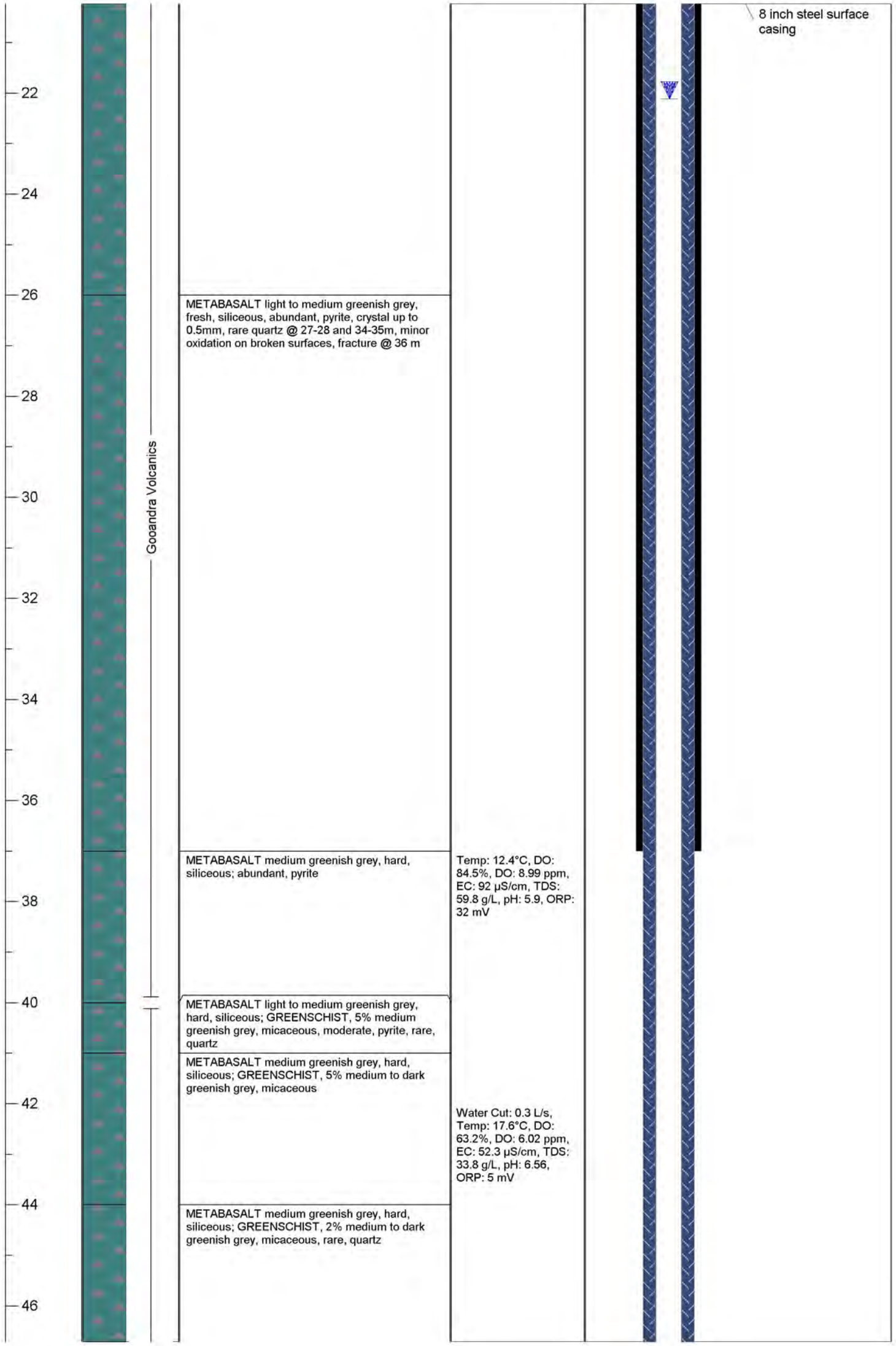
Total depth: 250 mbgl **Screened depth:** 237 - 249 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		SOIL dark brown			
		CLAY pinkish orange, highly weathered, decompsed basalt/metabasalt			
		CLAY medium brownish orange, highly weathered			
2		CLAY light yellowish orange, highly weathered			
4					
6		CLAY medium orangey brown, highly weathered			
8					
		CLAY light bluish grey, moderately weathered, decomposed metabasalt			
10					
12					
14					
16		METABASALT medium greenish grey, moderately weathered, decompsed, weak, crumbles in hand			
		METABASALT medium to dark greenish grey, moderate, pyrite, oxidation on broken surfaces, fracture @ 24m			
18					
20					

Gooandra Volcanics (?)

Gooandra Volcanics




8 inch steel surface casing
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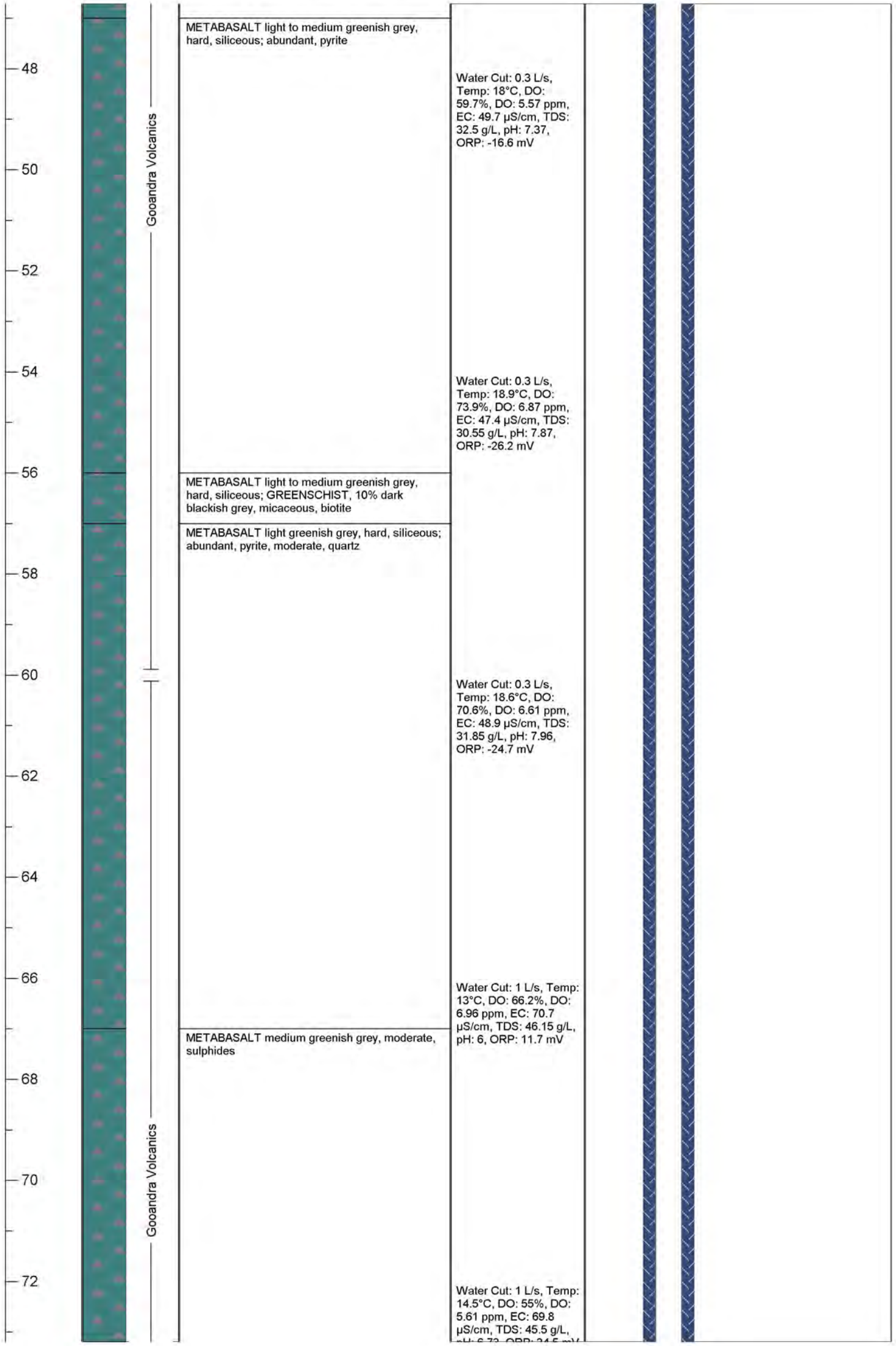
Gooandra Volcanics
METABASALT light to medium greenish grey, fresh, siliceous, abundant, pyrite, crystal up to 0.5mm, rare quartz @ 27-28 and 34-35m, minor oxidation on broken surfaces, fracture @ 36 m
METABASALT medium greenish grey, hard, siliceous; abundant, pyrite
Temp: 12.4°C, DO: 84.5%, DO: 8.99 ppm, EC: 92 µS/cm, TDS: 59.8 g/L, pH: 5.9, ORP: 32 mV
METABASALT light to medium greenish grey, hard, siliceous; GREENSCHIST, 5% medium greenish grey, micaceous, moderate, pyrite, rare, quartz
METABASALT medium greenish grey, hard, siliceous; GREENSCHIST, 5% medium to dark greenish grey, micaceous
Water Cut: 0.3 L/s, Temp: 17.6°C, DO: 63.2%, DO: 6.02 ppm, EC: 52.3 µS/cm, TDS: 33.8 g/L, pH: 6.56, ORP: 5 mV
METABASALT medium greenish grey, hard, siliceous; GREENSCHIST, 2% medium to dark greenish grey, micaceous, rare, quartz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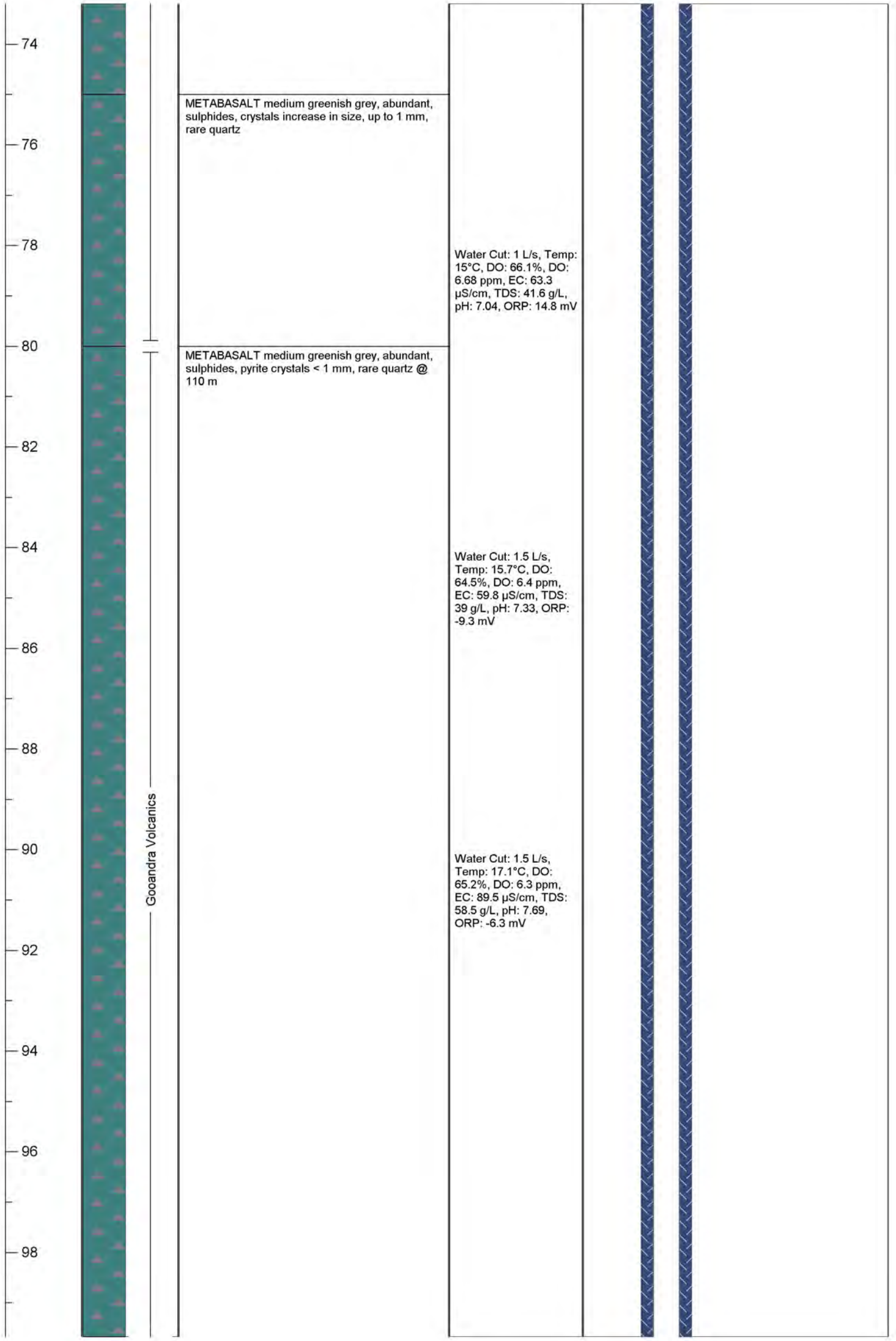
Gooandra Volcanics
Gooandra Volcanics
METABASALT light to medium greenish grey, hard, siliceous; abundant, pyrite
METABASALT light to medium greenish grey, hard, siliceous; GREENSCHIST, 10% dark blackish grey, micaceous, biotite
METABASALT light greenish grey, hard, siliceous; abundant, pyrite, moderate, quartz
METABASALT medium greenish grey, moderate, sulphides
Water Cut: 0.3 L/s, Temp: 18°C, DO: 59.7%, DO: 5.57 ppm, EC: 49.7 µS/cm, TDS: 32.5 g/L, pH: 7.37, ORP: -16.6 mV
Water Cut: 0.3 L/s, Temp: 18.9°C, DO: 73.9%, DO: 6.87 ppm, EC: 47.4 µS/cm, TDS: 30.55 g/L, pH: 7.87, ORP: -26.2 mV
Water Cut: 0.3 L/s, Temp: 18.6°C, DO: 70.6%, DO: 6.61 ppm, EC: 48.9 µS/cm, TDS: 31.85 g/L, pH: 7.96, ORP: -24.7 mV
Water Cut: 1 L/s, Temp: 13°C, DO: 66.2%, DO: 6.96 ppm, EC: 70.7 µS/cm, TDS: 46.15 g/L, pH: 6, ORP: 11.7 mV
Water Cut: 1 L/s, Temp: 14.5°C, DO: 55%, DO: 5.61 ppm, EC: 69.8 µS/cm, TDS: 45.5 g/L,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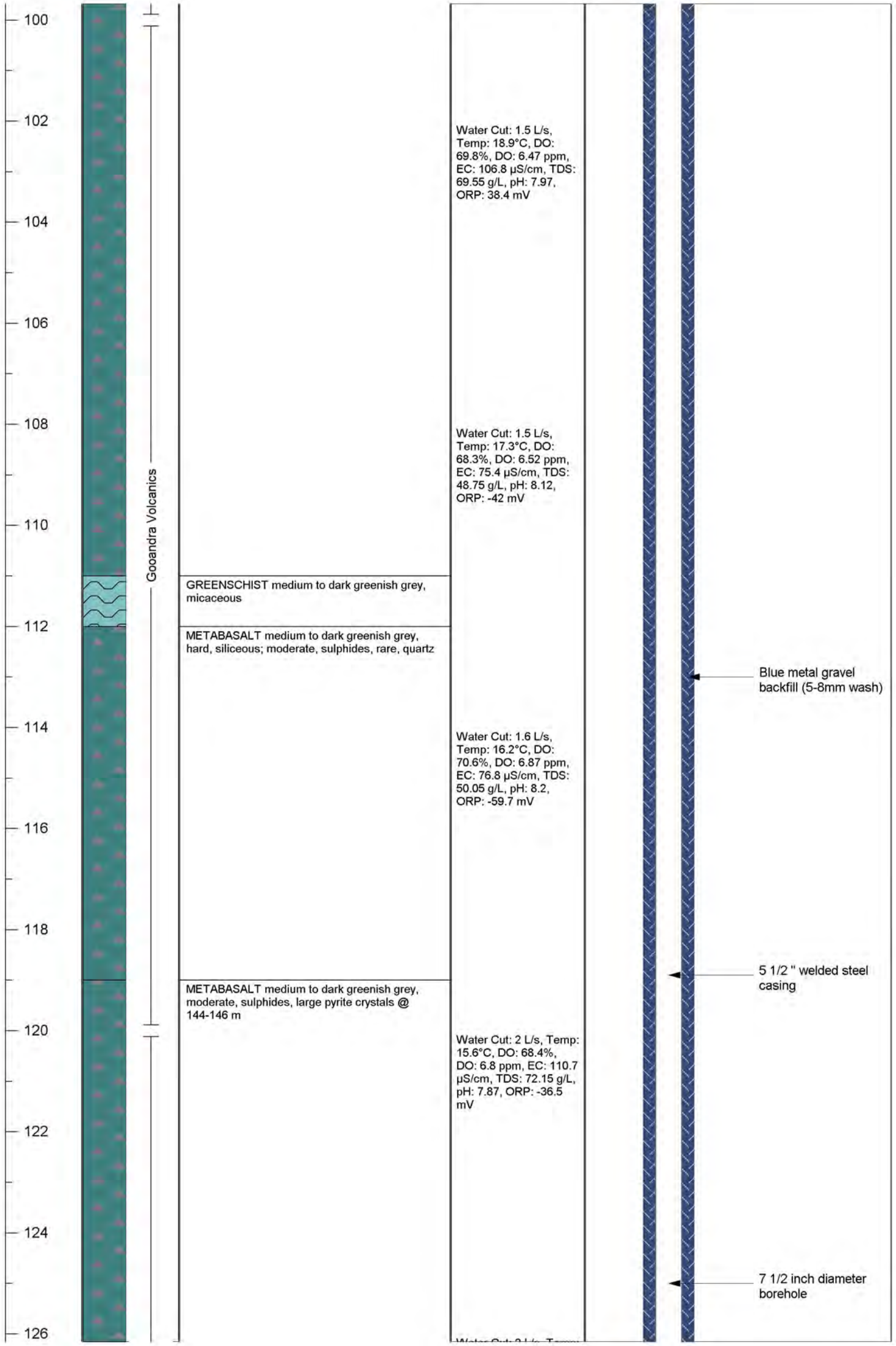
98
METABASALT medium greenish grey, abundant, sulphides, crystals increase in size, up to 1 mm, rare quartz
METABASALT medium greenish grey, abundant, sulphides, pyrite crystals < 1 mm, rare quartz @ 110 m
Gooandra Volcanics
Water Cut: 1 L/s, Temp: 15°C, DO: 66.1%, DO: 6.68 ppm, EC: 63.3 µS/cm, TDS: 41.6 g/L, pH: 7.04, ORP: 14.8 mV
Water Cut: 1.5 L/s, Temp: 15.7°C, DO: 64.5%, DO: 6.4 ppm, EC: 59.8 µS/cm, TDS: 39 g/L, pH: 7.33, ORP: -9.3 mV
Water Cut: 1.5 L/s, Temp: 17.1°C, DO: 65.2%, DO: 6.3 ppm, EC: 89.5 µS/cm, TDS: 58.5 g/L, pH: 7.69, ORP: -6.3 mV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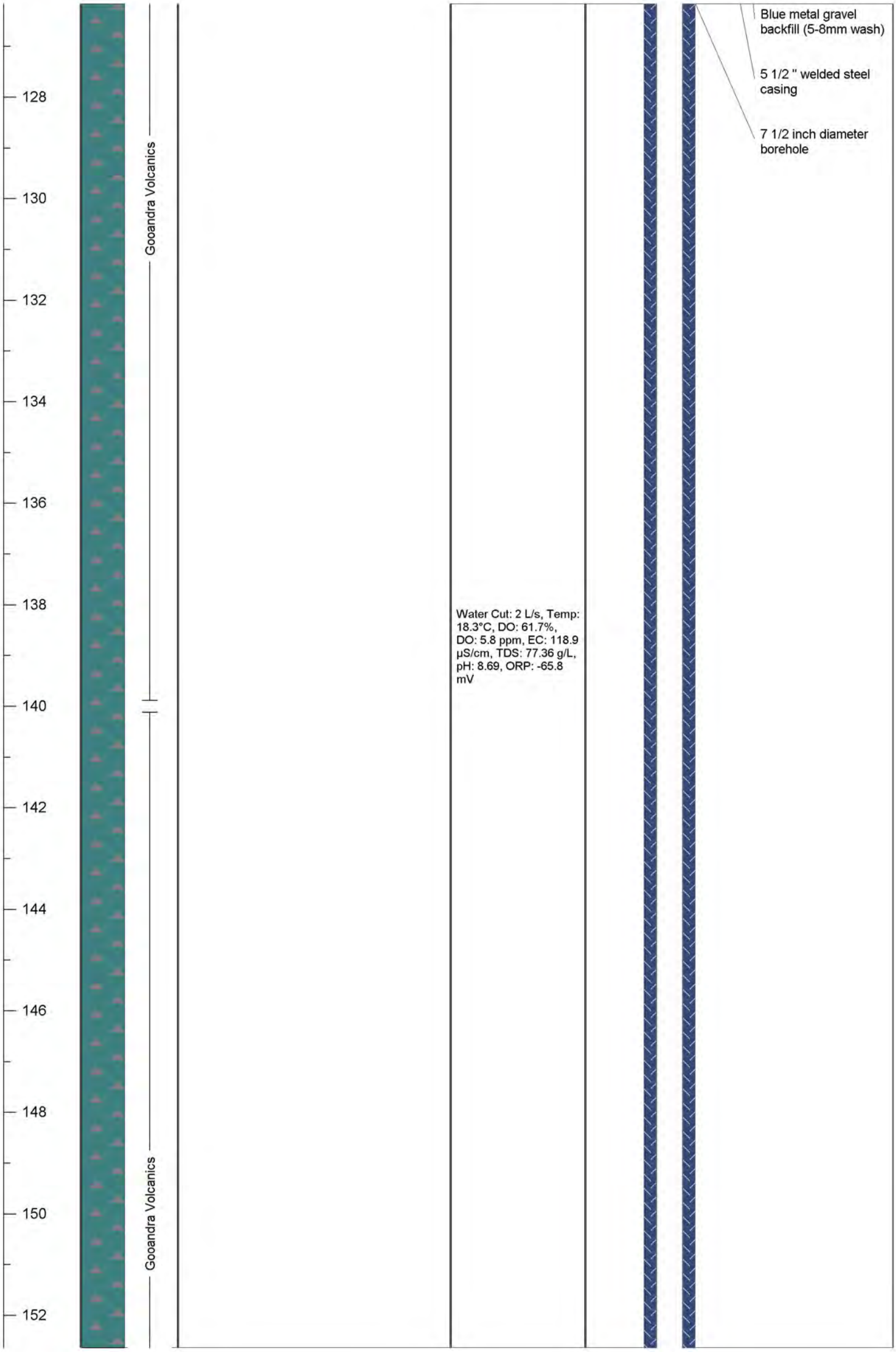
Gooandra Volcanics
GREENSCHIST medium to dark greenish grey, micaceous
METABASALT medium to dark greenish grey, hard, siliceous; moderate, sulphides, rare, quartz
METABASALT medium to dark greenish grey, moderate, sulphides, large pyrite crystals @ 144-146 m
Water Cut: 1.5 L/s, Temp: 18.9°C, DO: 69.8%, DO: 6.47 ppm, EC: 106.8 µS/cm, TDS: 69.55 g/L, pH: 7.97, ORP: 38.4 mV
Water Cut: 1.5 L/s, Temp: 17.3°C, DO: 68.3%, DO: 6.52 ppm, EC: 75.4 µS/cm, TDS: 48.75 g/L, pH: 8.12, ORP: -42 mV
Water Cut: 1.6 L/s, Temp: 16.2°C, DO: 70.6%, DO: 6.87 ppm, EC: 76.8 µS/cm, TDS: 50.05 g/L, pH: 8.2, ORP: -59.7 mV
Water Cut: 2 L/s, Temp: 15.6°C, DO: 68.4%, DO: 6.8 ppm, EC: 110.7 µS/cm, TDS: 72.15 g/L, pH: 7.87, ORP: -36.5 mV
Blue metal gravel backfill (5-8mm wash)
5 1/2 " welded steel casing
7 1/2 inch diameter borehole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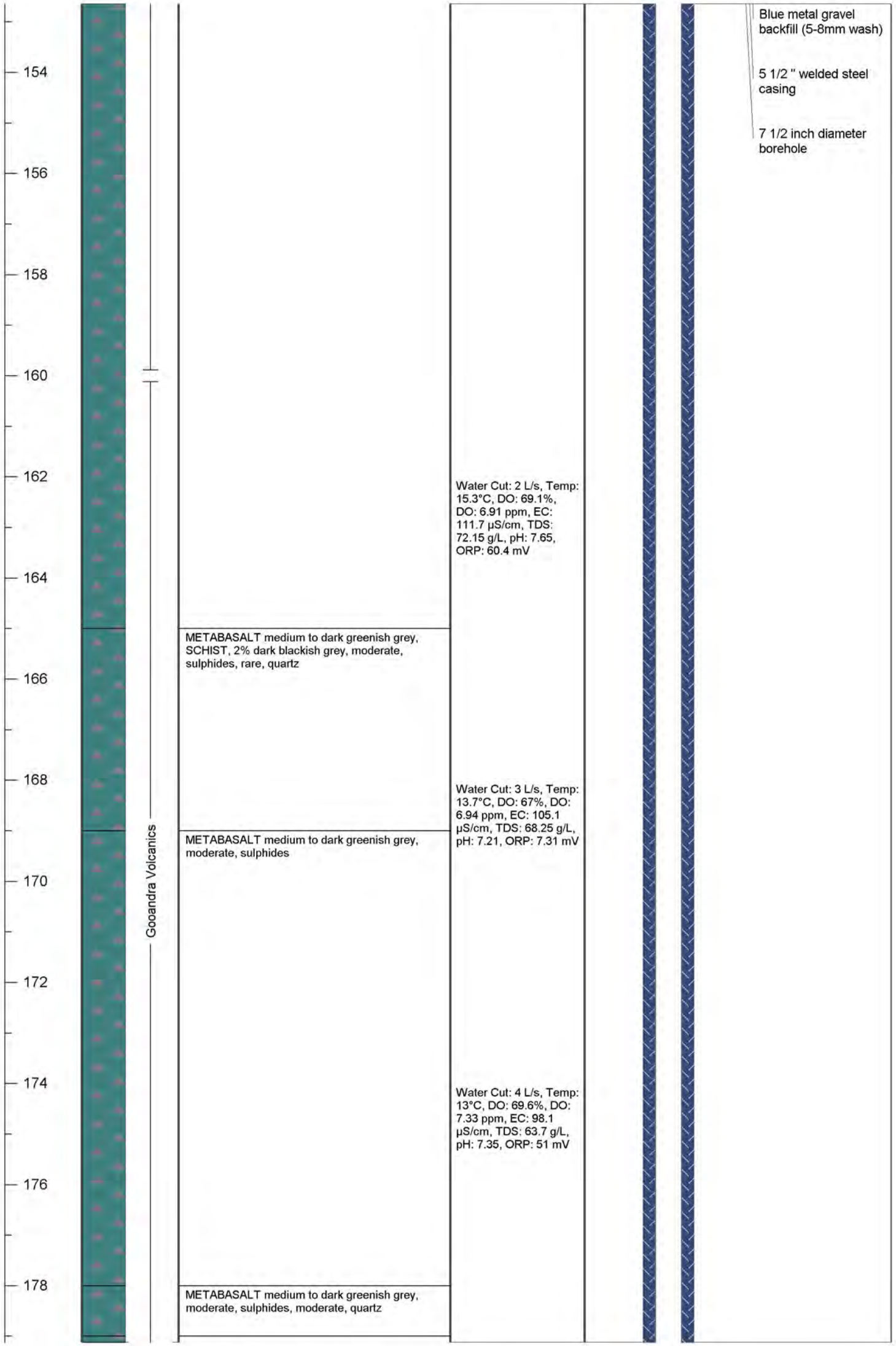
Gooandra Volcanics
Gooandra Volcanics
Water Cut: 2 L/s, Temp: 18.3°C, DO: 61.7%, DO: 5.8 ppm, EC: 118.9 µS/cm, TDS: 77.36 g/L, pH: 8.69, ORP: -65.8 mV
Blue metal gravel backfill (5-8mm wash)
5 1/2 " welded steel casing
7 1/2 inch diameter borehole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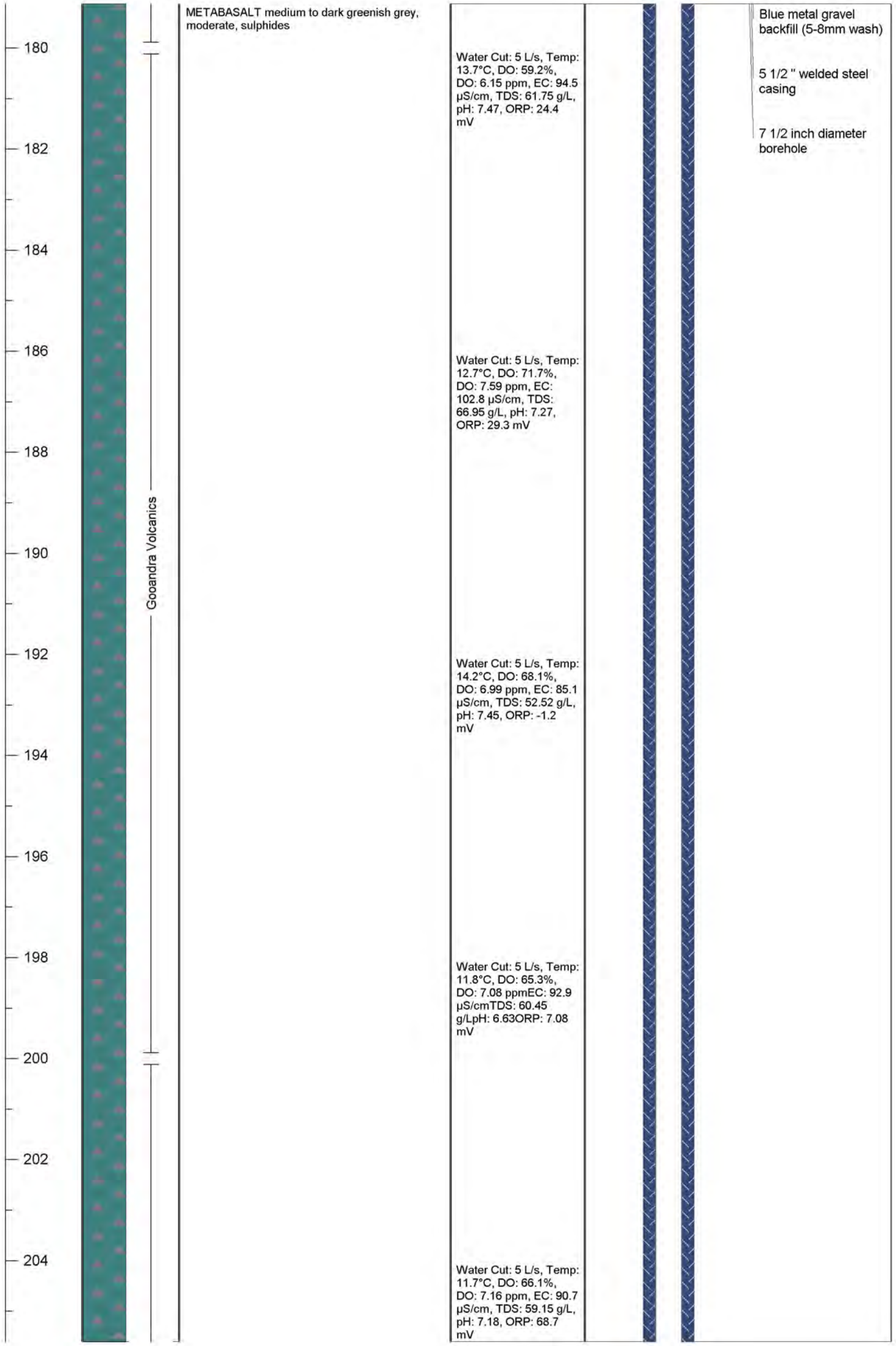
Gooandra Volcanics
METABASALT medium to dark greenish grey, SCHIST, 2% dark blackish grey, moderate, sulphides, rare, quartz
METABASALT medium to dark greenish grey, moderate, sulphides
METABASALT medium to dark greenish grey, moderate, sulphides, moderate, quartz
Water Cut: 2 L/s, Temp: 15.3°C, DO: 69.1%, DO: 6.91 ppm, EC: 111.7 µS/cm, TDS: 72.15 g/L, pH: 7.65, ORP: 60.4 mV
Water Cut: 3 L/s, Temp: 13.7°C, DO: 67%, DO: 6.94 ppm, EC: 105.1 µS/cm, TDS: 68.25 g/L, pH: 7.21, ORP: 7.31 mV
Water Cut: 4 L/s, Temp: 13°C, DO: 69.6%, DO: 7.33 ppm, EC: 98.1 µS/cm, TDS: 63.7 g/L, pH: 7.35, ORP: 51 mV
Blue metal gravel backfill (5-8mm wash)
5 1/2 " welded steel casing
7 1/2 inch diameter borehole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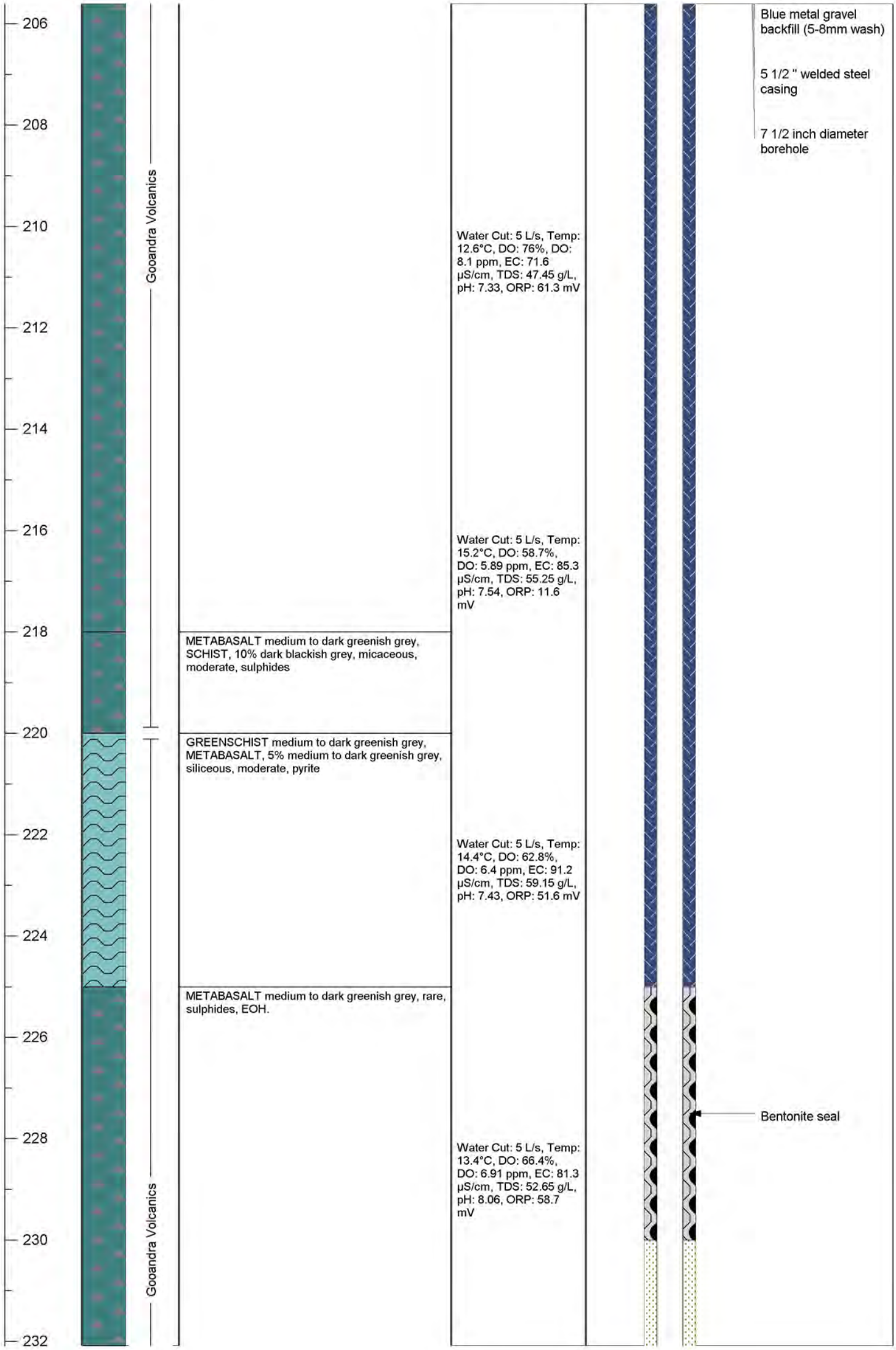
Gooandra Volcanics
METABASALT medium to dark greenish grey, moderate, sulphides
Water Cut: 5 L/s, Temp: 13.7°C, DO: 59.2%, DO: 6.15 ppm, EC: 94.5 µS/cm, TDS: 61.75 g/L, pH: 7.47, ORP: 24.4 mV
Water Cut: 5 L/s, Temp: 12.7°C, DO: 71.7%, DO: 7.59 ppm, EC: 102.8 µS/cm, TDS: 66.95 g/L, pH: 7.27, ORP: 29.3 mV
Water Cut: 5 L/s, Temp: 14.2°C, DO: 68.1%, DO: 6.99 ppm, EC: 85.1 µS/cm, TDS: 52.52 g/L, pH: 7.45, ORP: -1.2 mV
Water Cut: 5 L/s, Temp: 11.8°C, DO: 65.3%, DO: 7.08 ppmEC: 92.9 µS/cmTDS: 60.45 g/LpH: 6.63ORP: 7.08 mV
Water Cut: 5 L/s, Temp: 11.7°C, DO: 66.1%, DO: 7.16 ppm, EC: 90.7 µS/cm, TDS: 59.15 g/L, pH: 7.18, ORP: 68.7 mV
Blue metal gravel backfill (5-8mm wash)
5 1/2 " welded steel casing
7 1/2 inch diameter borehole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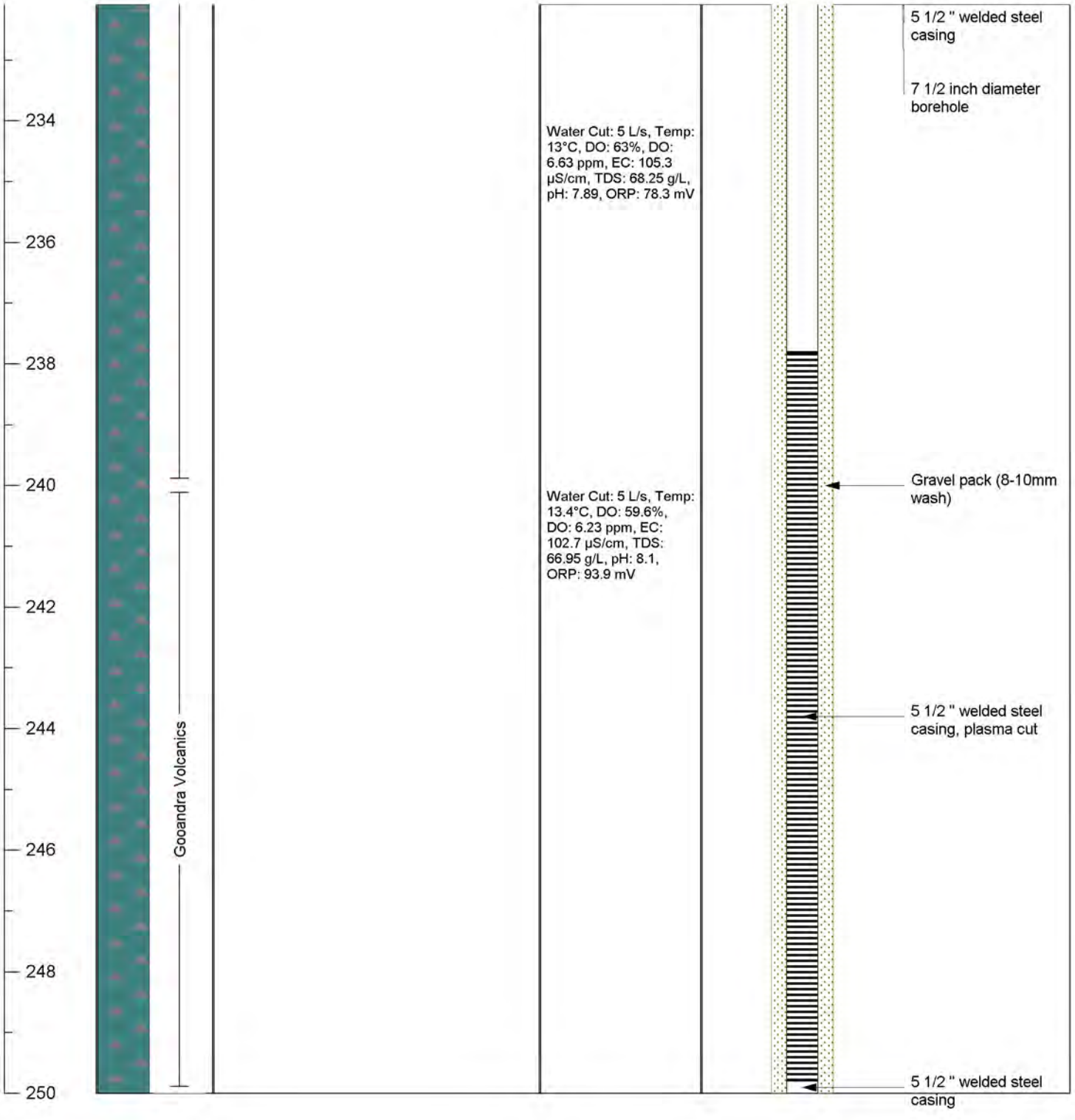
Gooandra Volcanics
Gooandra Volcanics
METABASALT medium to dark greenish grey, SCHIST, 10% dark blackish grey, micaceous, moderate, sulphides
GREENSCHIST medium to dark greenish grey, METABASALT, 5% medium to dark greenish grey, siliceous, moderate, pyrite
METABASALT medium to dark greenish grey, rare, sulphides, EOH.
Water Cut: 5 L/s, Temp: 12.6°C, DO: 76%, DO: 8.1 ppm, EC: 71.6 µS/cm, TDS: 47.45 g/L, pH: 7.33, ORP: 61.3 mV
Water Cut: 5 L/s, Temp: 15.2°C, DO: 58.7%, DO: 5.89 ppm, EC: 85.3 µS/cm, TDS: 55.25 g/L, pH: 7.54, ORP: 11.6 mV
Water Cut: 5 L/s, Temp: 14.4°C, DO: 62.8%, DO: 6.4 ppm, EC: 91.2 µS/cm, TDS: 59.15 g/L, pH: 7.43, ORP: 51.6 mV
Water Cut: 5 L/s, Temp: 13.4°C, DO: 66.4%, DO: 6.91 ppm, EC: 81.3 µS/cm, TDS: 52.65 g/L, pH: 8.06, ORP: 58.7 mV
Blue metal gravel backfill (5-8mm wash)
5 1/2 " welded steel casing
7 1/2 inch diameter borehole
Bentonite seal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Gooandra Volcanics
Water Cut: 5 L/s, Temp: 13°C, DO: 63%, DO: 6.63 ppm, EC: 105.3 µS/cm, TDS: 68.25 g/L, pH: 7.89, ORP: 78.3 mV
Water Cut: 5 L/s, Temp: 13.4°C, DO: 59.6%, DO: 6.23 ppm, EC: 102.7 µS/cm, TDS: 66.95 g/L, pH: 8.1, ORP: 93.9 mV
5 1/2 " welded steel casing
7 1/2 inch diameter borehole
Gravel pack (8-10mm wash)
5 1/2 " welded steel casing, plasma cut
5 1/2 " welded steel casing

EMM
www.emmconsulting.com.au
Suite 01, 20 Chandos Street
St Leonards NSW 2065
T: 02 9493 9500
F:02 9493 9599

WATER MONITORING BORE LOG

Bore ID: TMB04

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

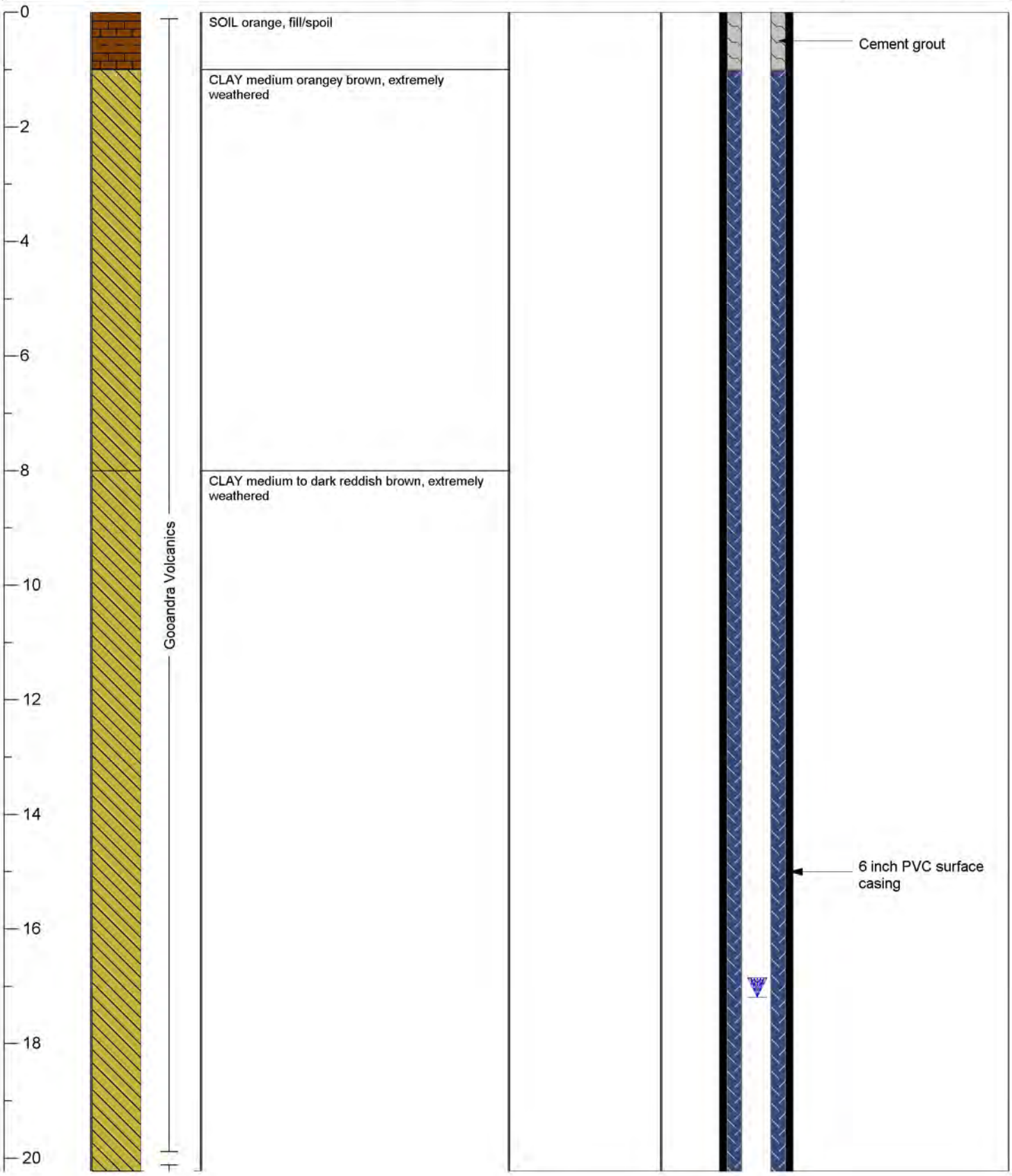
Date completed: 16/02/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: I Frawley

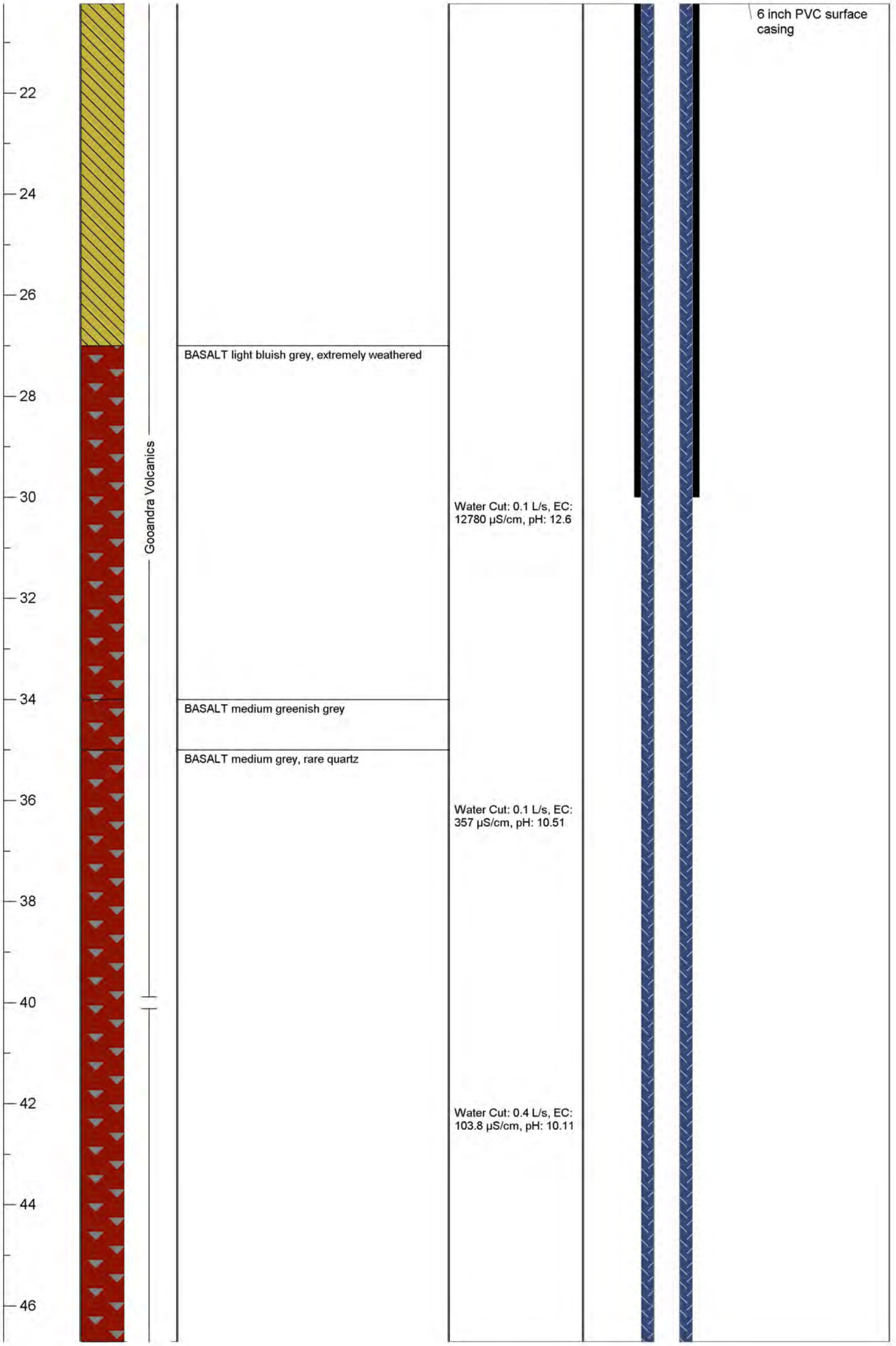
Project number: J17188
Elevation: 1345.8 mAHD
Easting: 639018.2
Northing: 6038261.2

Static Water Level: 17.02 mbgl **Screened Formation:** Gooandra Volcanics **Date:** 21/02/18

Total depth: 200 mbgl **Screened depth:** 191 - 197 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes

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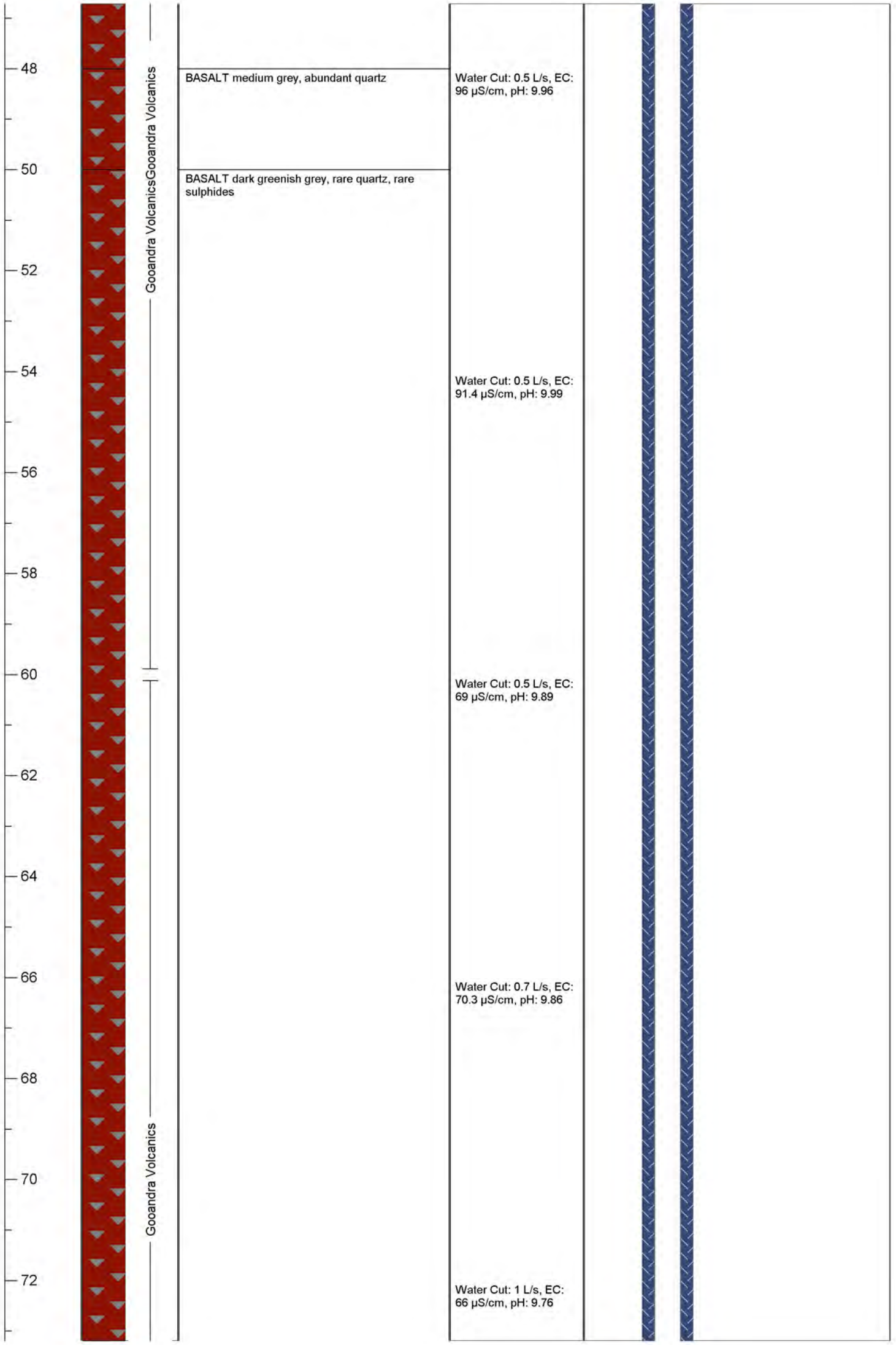
Gooandra Volcanics
BASALT light bluish grey, extremely weathered
BASALT medium greenish grey
BASALT medium grey, rare quartz
Water Cut: 0.1 L/s, EC: 12780 µS/cm, pH: 12.6
Water Cut: 0.1 L/s, EC: 357 µS/cm, pH: 10.51
Water Cut: 0.4 L/s, EC: 103.8 µS/cm, pH: 10.11
6 inch PVC surface casing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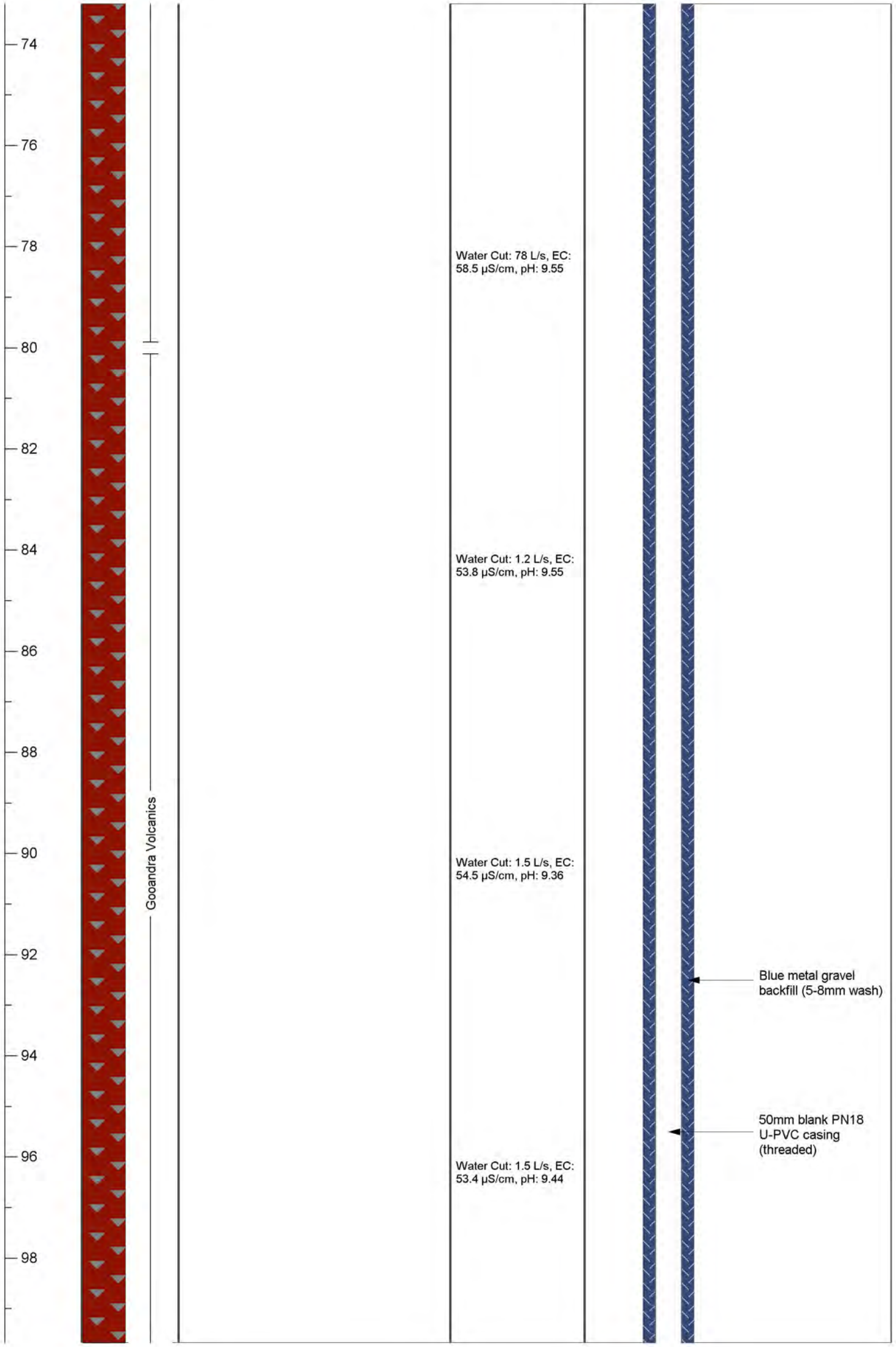
Gooandra Volcanics
Gooandra Volcanics
Gooandra Volcanics
BASALT medium grey, abundant quartz
BASALT dark greenish grey, rare quartz, rare sulphides
Water Cut: 0.5 L/s, EC: 96 µS/cm, pH: 9.96
Water Cut: 0.5 L/s, EC: 91.4 µS/cm, pH: 9.99
Water Cut: 0.5 L/s, EC: 69 µS/cm, pH: 9.89
Water Cut: 0.7 L/s, EC: 70.3 µS/cm, pH: 9.86
Water Cut: 1 L/s, EC: 66 µS/cm, pH: 9.76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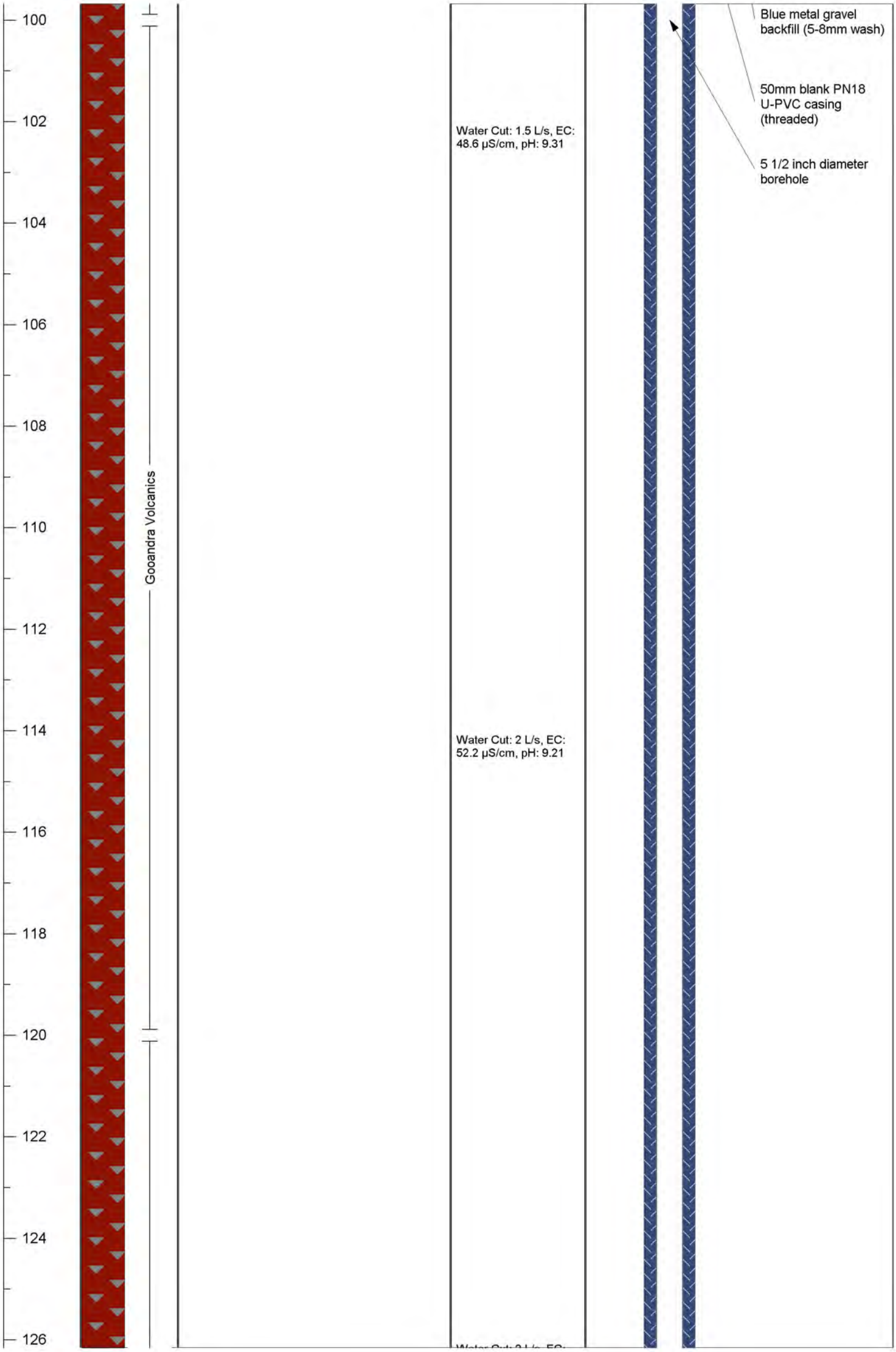
Gooandra Volcanics
Water Cut: 78 L/s, EC: 58.5 µS/cm, pH: 9.55
Water Cut: 1.2 L/s, EC: 53.8 µS/cm, pH: 9.55
Water Cut: 1.5 L/s, EC: 54.5 µS/cm, pH: 9.36
Water Cut: 1.5 L/s, EC: 53.4 µS/cm, pH: 9.44
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)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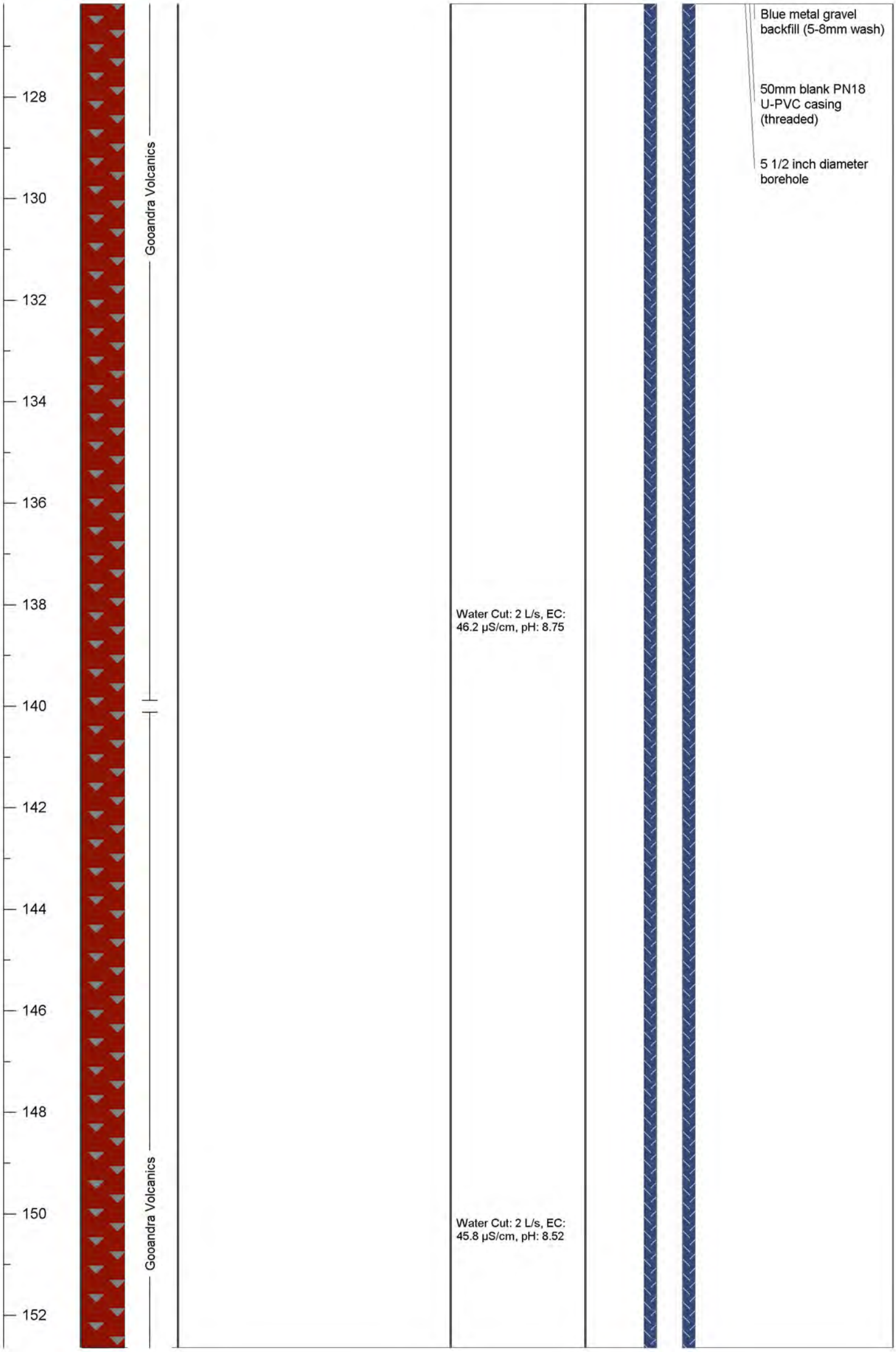
Gooandra Volcanics
Water Cut: 1.5 L/s, EC: 48.6 µS/cm, pH: 9.31
Water Cut: 2 L/s, EC: 52.2 µS/cm, pH: 9.21
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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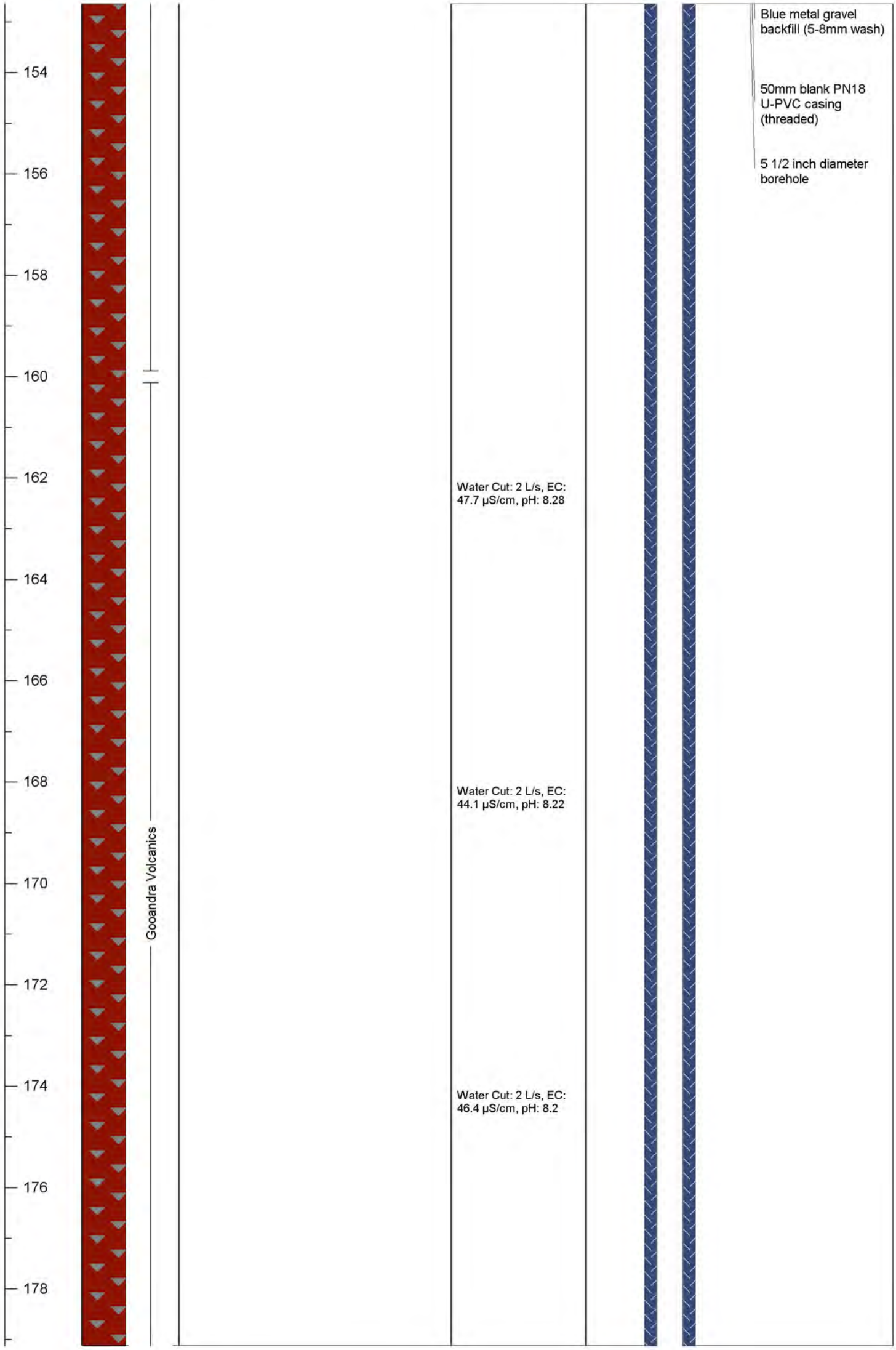
Gooandra Volcanics
Gooandra Volcanics
Water Cut: 2 L/s, EC: 46.2 µS/cm, pH: 8.75
Water Cut: 2 L/s, EC: 45.8 µS/cm, pH: 8.52
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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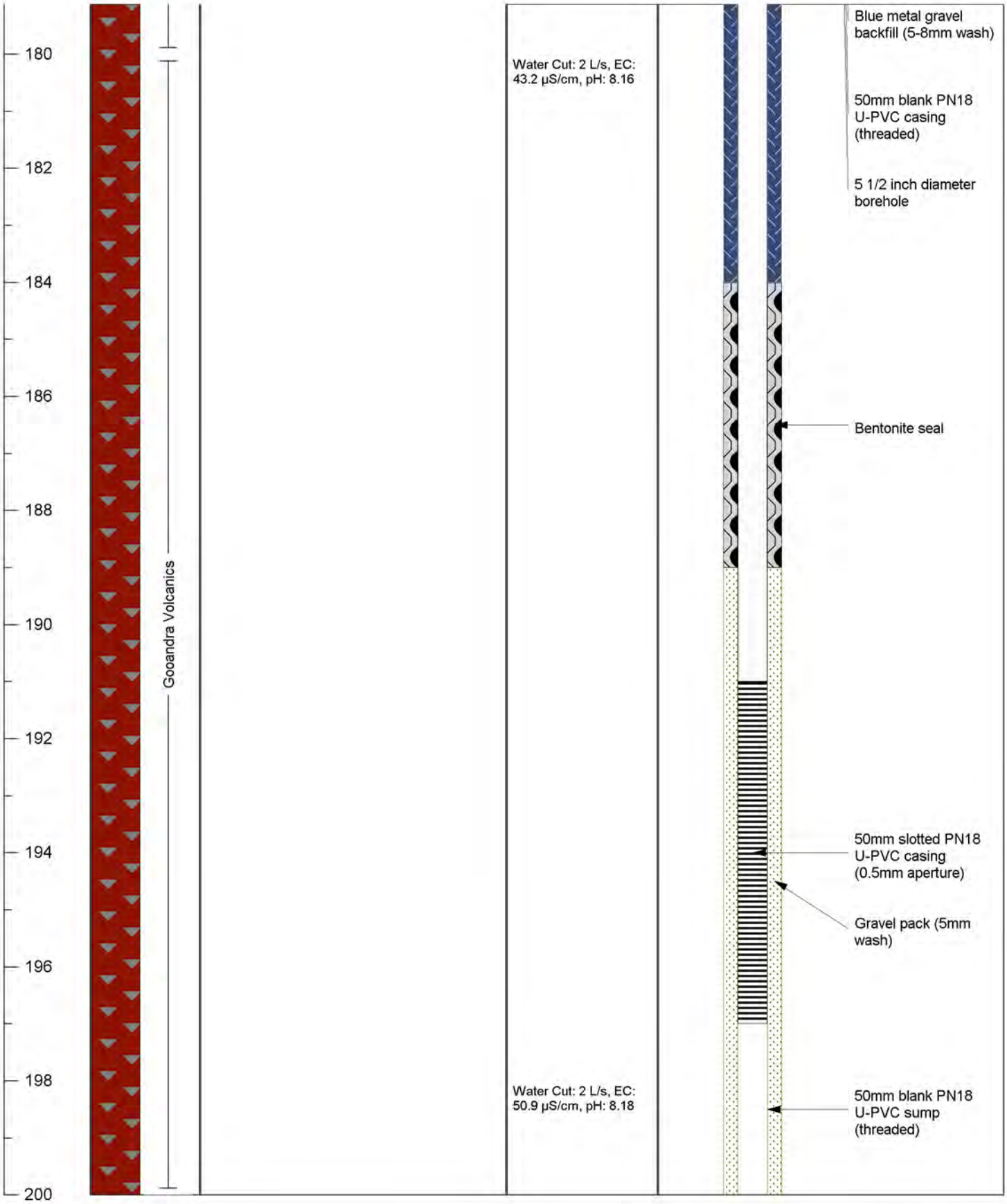
Gooandra Volcanics
Water Cut: 2 L/s, EC: 47.7 µS/cm, pH: 8.28
Water Cut: 2 L/s, EC: 44.1 µS/cm, pH: 8.22
Water Cut: 2 L/s, EC: 46.4 µS/cm, pH: 8.2
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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Gooandra Volcanics
Water Cut: 2 L/s, EC: 43.2 µS/cm, pH: 8.16
Water Cut: 2 L/s, EC: 50.9 µS/cm, pH: 8.18
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
50mm slotted PN18 U-PVC casing (0.5mm aperture)
Gravel pack (5mm wash)
50mm blank PN18 U-PVC sump (threaded)

www.emmconsulting.com.au
Suite 01, 20 Chandos Street
St Leonards NSW 2065
T: 02 9493 9500
F:02 9493 9599

WATER MONITORING BORE LOG

Bore ID: TMB05A

Client: Snowy Hydro **Project:** Snowy Hydro 2.0

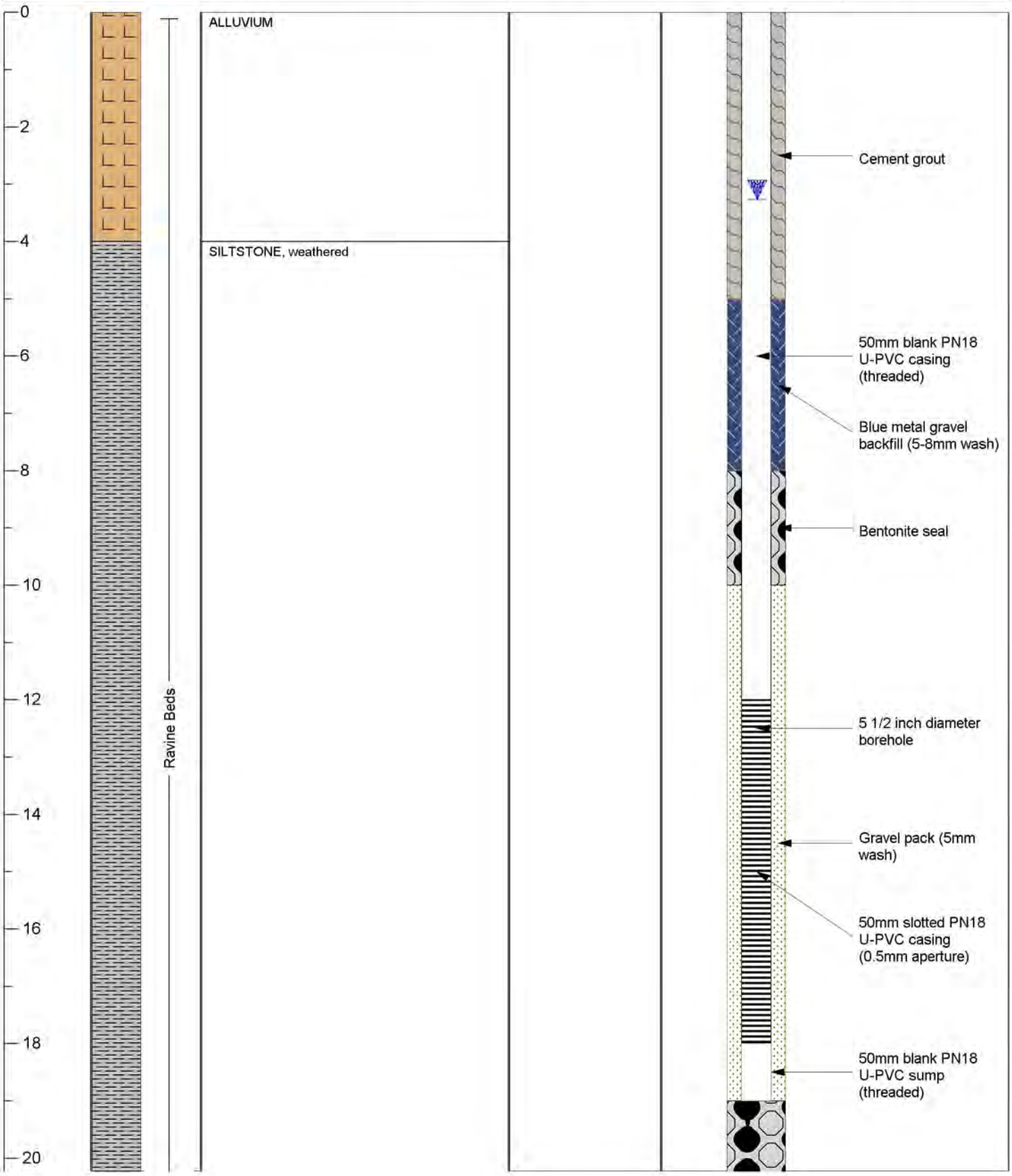
Date completed: 3/03/18
Drilling contractor: Highland Drilling
Drilling method: Air rotary
Hydrogeologist: K Maher

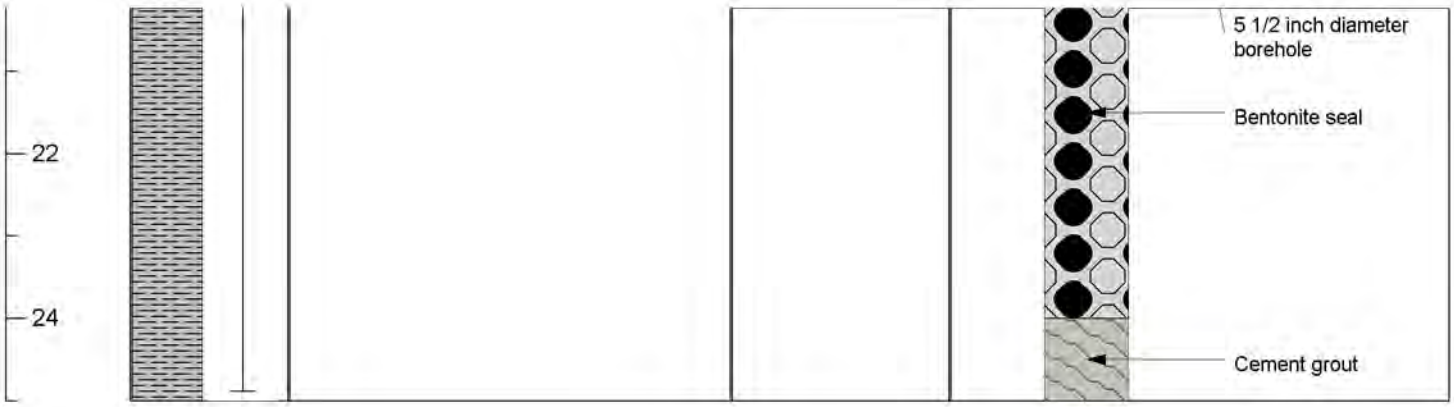
Project number: J17188
Elevation: 601.7 mAHD
Easting: 628370.9
Northing: 6039896

Static Water Level: 3.1 mbgl **Screened Formation:** Ravine Beds **Date:**

Total depth: 21 mbgl **Screened depth:** 12 - 18 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram	
				Diagram	Design notes




22
24
5 1/2 inch diameter borehole
Bentonite seal
Cement grout

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Suite 01, 20 Chandos Street
St Leonards NSW 2065
T: 02 9493 9500
F:02 9493 9599

WATER MONITORING BORE LOG

Bore ID: TMB05B

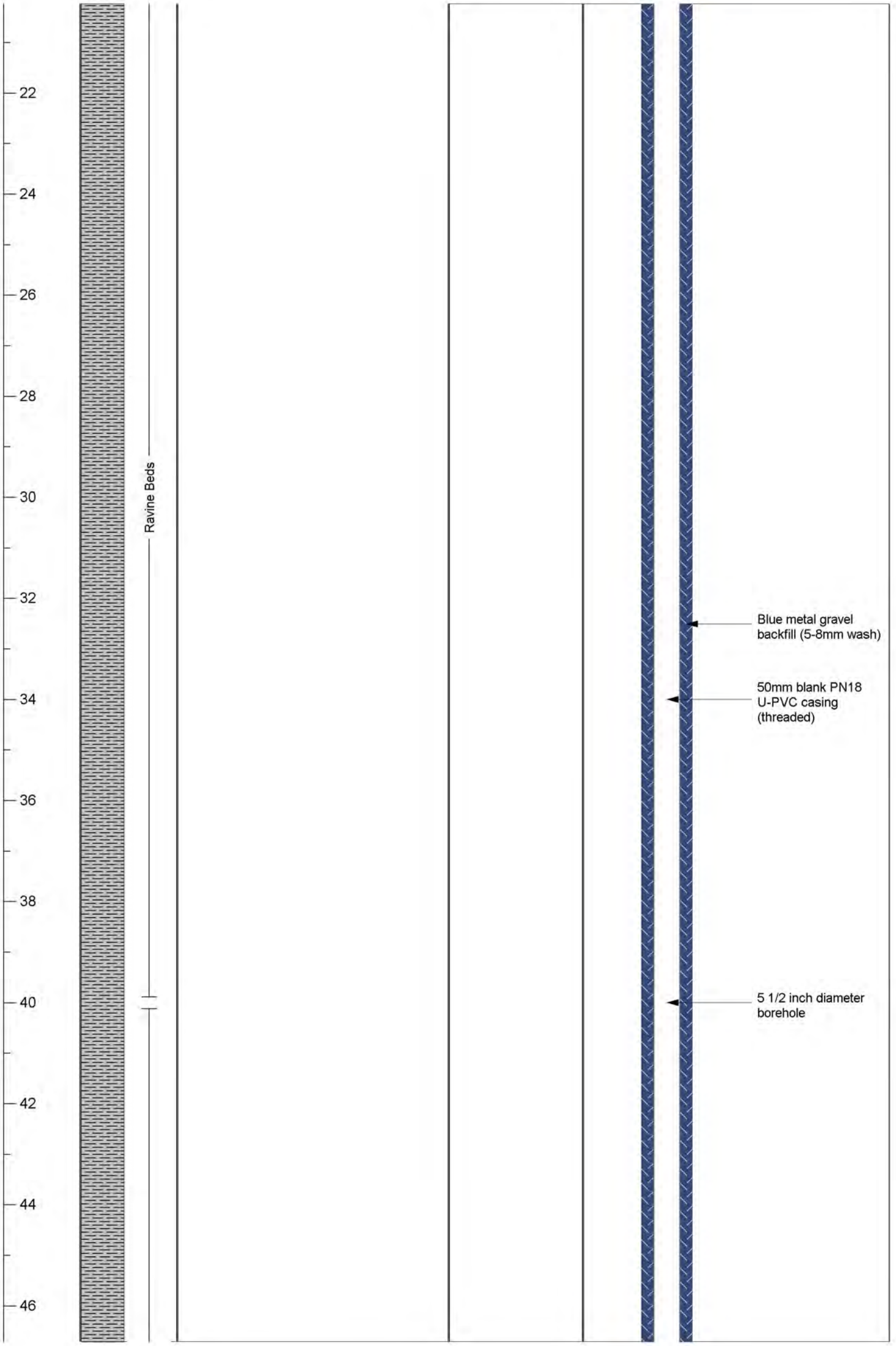
Client: Snowy Hydro **Project:** Snowy Hydro 2.0

Date completed:	14/03/18	**Project number:**	J17188
Drilling contractor:	Highland Drilling	**Elevation:**	601.7 mAHD
Drilling method:	Air rotary	**Easting:**	628370.7
Hydrogeologist:	K Maher	**Northing:**	6039896

Static Water Level: 3.2 mbgl **Screened Formation:** Ravine Beds **Date:**

Total depth: 77 mbgl **Screened depth:** 68 - 74 m **Casing:** 50 mm PVC

Depth (mbgl)	Lithology Graphic	Description	Water Quality	Bore Completion Diagram: Diagram	Bore Completion Diagram: Design notes
0		CORE LOSS	Cored hole. Water sampling not possible due to drilling method	Cement grout	
2		COLLUVIUM medium brown, weathered, broken, core loss throughout unit			
4		SILTSTONE grey, fresh			
6					
8					
10	Ravine Beds				
12					
14					
16					
18					
20					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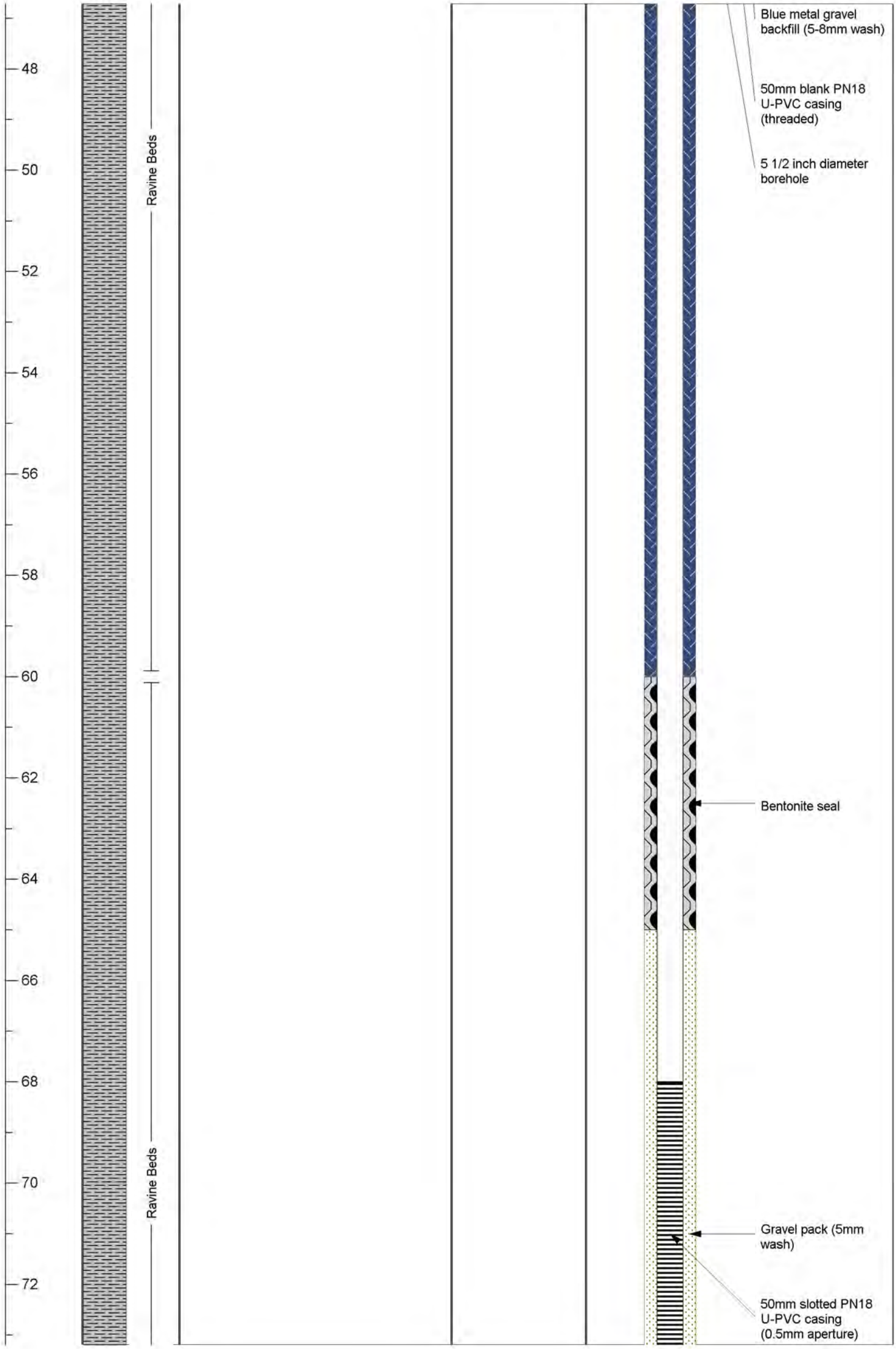
Ravine Beds
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole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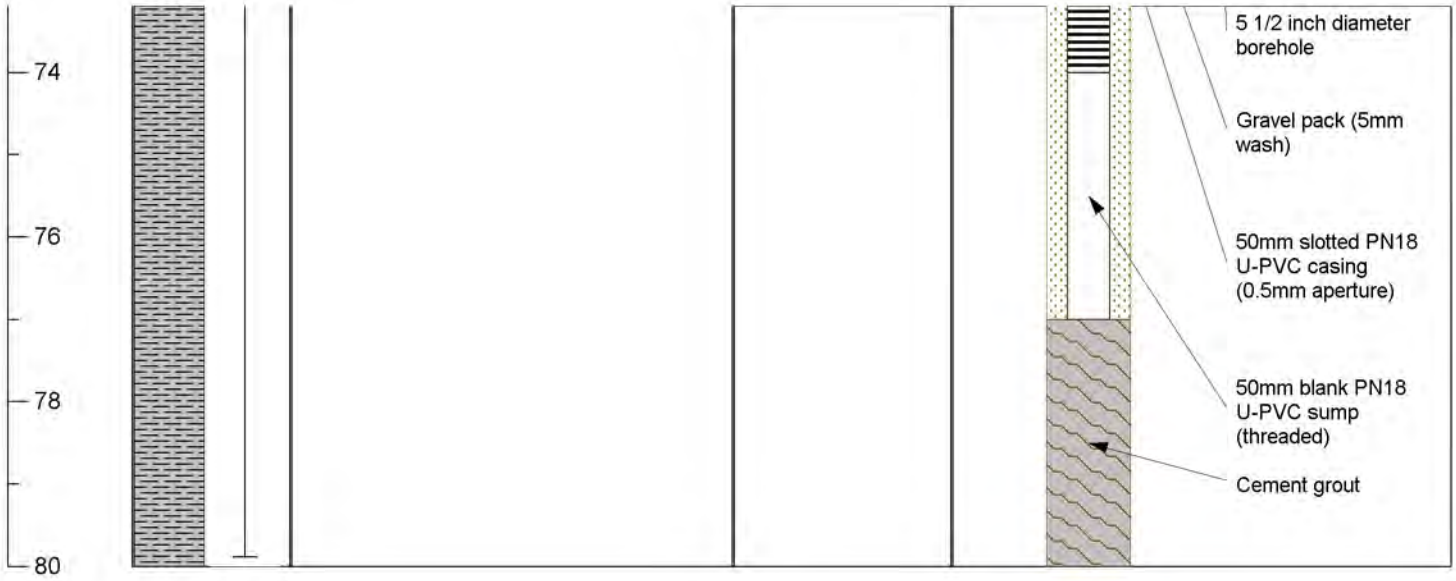
Ravine Beds
Ravine Beds
Blue metal gravel backfill (5-8mm wash)
50mm blank PN18 U-PVC casing (threaded)
5 1/2 inch diameter borehole
Bentonite seal
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)


74
76
78
80
5 1/2 inch diameter borehole
Gravel pack (5mm wash)
50mm slotted PN18 U-PVC casing (0.5mm aperture)
50mm blank PN18 U-PVC sump (threaded)
Cement grout

Appendix B

Monitoring bore licence

Contact Gerrod Webb
Phone 02 6953 9826
Fax 02 6953 9888
Date 22/12/20017

Snowy Hydro Limited
PO Box 332
Cooma NSW 2630

Our ref 40BL192707

Dear Sir/Madam

Subject: Monitoring Bore application

Please find enclosed Monitoring bore licence's for Parish of Pinbeyan, County of Buccleuch and a description of the works, terms, limitations and conditions under which the license is issued.

Condition (2) of the license applies whether the bore is successful or not and it is the Driller's responsibility to suppy the information. Two completed 'Form A's' must be returned to you. One copy is to be retained by you, and the original returned to the this office with details of any water analysis and pumping tests carried out.

The 'Form A' requests a sketch of the location of the bore site together with the lot number and boundaries.

The referenced license is for exploration only. Any bore which is to be converted to a production bore will require an application for an approval Prior to construction. Compliance with metering conditions and an appropriate access license together with the appropriate fees is required for any approval for irrigation/commercial purposes.

If you have any queries regarding the above, please contact me on (02) 6953 9888 or email gerrod.webb@waternsw.com.au.

Yours sincerely

Gerrod Webb

Water Regulation Officer
Water NSW

NSW Office of Water

Murrumbidgee Region
Po Box 156
2198 Irrigation Way East
Leeton NSW 2705
Phone: (02) 69512611

BORE LICENSE CERTIFICATE
UNDER SECTION 115 OF THE WATER ACT, 1912

40BL192701

Department of Primary Industries Office of Water

Snowy Hydro Limited
Po Box 332
Cooma NSW 2630

LICENSE NUMBER
40BL192701
DATE LICENSE VALID FROM
22-Dec-2017
DATE LICENSE VALID TO
PERPETUITY
FEE
$0.00

ABN 72189919072 GST NIL

LOCATION OF WORKS

Portion(s) or Lot/Section/DP	PARISH	COUNTY
Reserve - National Park.	Pinbeyan	Buccleuch

TYPE OF WORKS	PURPOSE(S) FOR WHICH WATER MAY BE USED
Bore - Monitoring	Monitoring Bore

CONDITIONS APPLYING TO THIS LICENSE ARE

As shown on the attached Condition Statement

ORIGINAL

NSW Office of Water

CONDITIONS STATEMENT REFERRED TO ON 40BL192701 ISSUED UNDER PART V OF THE WATER ACT, 1912 ON 22-Dec-2017

(1) THE LICENCE SHALL LAPSE IF THE WORK IS NOT COMMENCED AND COMPLETED WITHIN THREE YEARS OF THE DATE OF THE ISSUE OF THE LICENCE.

(2) THE LICENSEE SHALL WITHIN TWO MONTHS OF COMPLETION OR AFTER THE ISSUE OF THE LICENSE IF THE WORK IS EXISTING, FURNISH TO NSW OFFICE OF WATER:-

(A) DETAILS OF THE WORK SET OUT IN THE ATTACHED FORM "A" (MUST BE COMPLETED BY A DRILLER).

(B) A PLAN SHOWING ACCURATELY THE LOCATION OF THE WORK, IN RELATION TO PORTION AND PROPERTY BOUNDARIES.

(C) A ONE LITRE WATER SAMPLE FOR ALL LICENCES OTHER THAN THOSE FOR STOCK, DOMESTIC, TEST BORES AND FARMING PURPOSES.

(D) DETAILS OF ANY WATER ANALYSIS AND/OR PUMPING TESTS.

(3) THE LICENSEE SHALL ALLOW NSW OFFICE OF WATER OR ANY PERSON AUTHORISED BY IT, FULL AND FREE ACCESS TO THE WORKS, EITHER DURING OR AFTER CONSTRUCTION, FOR THE PURPOSE OF CARRYING OUT INSPECTION OR TEST OF THE WORKS AND ITS FITTINGS AND SHALL CARRY OUT ANY WORK OR ALTERATIONS DEEMED NECESSARY BY THE DEPARTMENT FOR THE PROTECTION AND PROPER MAINTENANCE OF THE WORKS, OR THE CONTROL OF THE WATER EXTRACTED AND FOR THE PROTECTION OF THE QUALITY AND THE PREVENTION FROM POLLUTION OR CONTAMINATION OF SUB-SURFACE WATER.

(4) IF A WORK IS ABANDONED AT ANY TIME THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER THAT THE WORK HAS BEEN ABANDONED AND SEAL OFF THE AQUIFER BY:-

(A) BACKFILLING THE WORK TO GROUND LEVEL WITH CLAY OR CEMENT AFTER WITHDRAWING THE CASING (LINING); OR

(B) SUCH METHODS AS AGREED TO OR DIRECTED BY NSW OFFICE OF WATER.

(5) IF THE BORE AUTHORISED BY THIS LICENSE IS LINED WITH STEEL OR PLASTIC CASING THE INSIDE DIAMETER OF THAT CASING SHALL NOT EXCEED 220 MM.

(6) WATER SHALL NOT BE PUMPED FROM THE BORE AUTHORISED BY THIS LICENSE FOR ANY PURPOSE OTHER THAN GROUNDWATER INVESTIGATION.

End Of Conditions

PROCEDURES – FORM A

1. The landholder must obtain an approval from the NSW Office of Water before a bore can be constructed

2. The department will forward the following to the landholder
   - Approval letter with the regional contact officer and regional address for return of the completed form A
   - The approval with the condition statement
   - Form A

3. The landholder makes arrangements with the driller to sink and construct the bore. (*A work plan and contractual agreement by both parties, prior to commencement of construction work is highly recommended. The agreement should include arrangements for obtaining the completed Form A)*

4. The driller must sight the approval before constructing the bore. (The approval number must be recorded on the Form A, and any subsequent enquiry or correspondence in relation to this bore with the Department should quote the approval number)

5. The driller is required to complete the Form A (during/after bore construction). The completed form needs to be co-signed by both the driller and landholder.

6. The landholder forwards the completed co-signed Form A to the departments regional office as nominated in the approval letter.

Notes:

(i) *The landholder is advised to make a copy of the completed/signed Form A before despatch to the department*

(ii) *The landholder must forward the completed Form A to the department, or else future actions relating to the licenced work such as renewal may not proceed.*

(iii) *Driller will not be forced to keep copies of Form A's for inclusion with applications for driller licence renewals. For future driller licence renewals, drillers will be asked to specify the bores they have constructed (by providing the bore licence number), and the department will review the recorded details against the bore from the corporate database.*

(iv) *If drillers require a copy of the completed Form A for their personal records, then they should make the appropriate arrangements to obtain a copy.*

7. Department staff will transfer the data contained in the Form A into the departments Ground Water System.
8. The original Form A should be placed in the bore licence file and retained by the regional office.

NSW GOVERNMENT | Department of Primary Industries Water

Form A Particulars of completed work

	1
Driller's Licence No:	
Class of Licence:	
Driller's Name:	
Assistant Driller:	
Contractor:	
New bore	Replacement bore
Deepened	Enlarged
Reconditioned	Other (specify)
Final Depth	m

	2
Work Licence No:	
Name of Licensee:	
Intended Use:	
Completion Date:	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method		D D L at end of test (m)	Duration		Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative	See Code 4			Hrs	min	Cond (µS/cm)	TDS (mg/L)

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5

Casing support method — See Code 5

Type of casing bottom — See Code 5

Centralisers installed (Yes/No) (indicate on sketch)

Sump installed (Yes/No) From m To m

Pressure cemented (Yes/No) From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General							Screen	Slot Details		
Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Aperture (mm)	Length (mm)	Width (mm)	Alignment See Code 6

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded							
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)									
Method of placement of Gravel Pack		See Code 7							

For Departmental use only: G W

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

Form A Particulars of completed work

Work Licence No:

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) ____ Name: ____

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	____ hrs	____ hrs	____ hrs	____ hrs	____ hrs	____ hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method ____ See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ____ m Is work partly backfilled: (Yes/No) ____

Is work abandoned: (Yes/No) ____ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work (Yes/No) ____ From ____ m To ____ m

Sealing / fill type See Code 11	From depth (m)	To depth (m)	Sealing / fill type See Code 11	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner ☐ Client ☐ Other ____ 12

13

Lot No ____ DP No ____

Work Location Co ordinates Easting ____ Northing ____ Zone 54

GPS: (Yes/No) ____ >> AMG/AGD ☐ or MGA/GDA ☐ (See explanation)

Longitude ____ Latitude ____

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description See Code 15	WORK CONSTRUCTION SKETCH
0			

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

CODE TABLES

DRILLING METHOD 3

1	Auger - Hollow Flight	9	Rotary - Percussion - (Down Hole Hammer)
2	Auger - Solid Flight	10	Rotary - Percussion - Foam injection
3	Cable Tool - Drill and Drive Casing	11	Rotary - Reverse circulation - Air
4	Cable Tool - Mud stabilised	12	Rotary - Reverse circulation - Mud
5	Rotary Air	13	Rotary - Coring
6	Rotary - Air/foam	14	Jetted - Air
7	Rotary - Mud	15	Jetted - Water
8	Rotary - Water	16	Other - See page 2, N0 11

WATER BEARING ZONE 4

TEST METHOD				FLOW MEASURING DEVICE			
1	Airlift	6	Pump - Helical Roto	A	Container of known volum	F	Weir - Rectangular
2	Bailer	7	Pump - Jet	B	Flow meter	G	Weir - V Notch - 60°
3	Pump - Centrifugal	8	Pump - Turbine	C	Flume	H	Weir - V Notch - 90°
4	Pump - Cylinder	9	Freeflow	D	Orifice, plate & manomete	I	Other
5	Pump - Electric submersib			E	Ultra sonic meter		

CASING / LINER DETAILS 5

MATERIAL						METHOD OF FIXING			
1	A.B.S.	6	PVC - Class 12	11	Steel - Stainless	1	Glued	6	Welded - Butt
2	Aluminium	7	PVC - Class 15	12	Steel - Stainless 304	2	Kwik-lock	7	Welded - Colla
3	Concrete cylinder	8	PVC - Class 18	13	Steel - Stainless 316	3	Packer	8	Other
4	Fibre glass (FRP)	9	Steel - ERW	14	Other	4	Riveted		
5	PVC - Class 9	10	Steel - Galvanised			5	Screwed		

CASING SUPPORT METHOD				TYPE OF CASING BOTTOM			
1	Driven into small hole	5	Held in clamp	1	Open end	5	Casing shoe
2	Seated on bottom	6	Other	2	End cap	6	Wash down shoe
3	Seated on backfill			3	Plug - concrete	7	Cementing shoe
4	Cemented			4	Plug - wood	8	Other

WATER ENTRY DESIGN 6

OPENING TYPE				SLOT ALIGNMENT	
1	Casing - Bridge slot	7	Casing - Plasma-cut slot	D	Diagonal
2	Casing - Drilled holes	8	Casing - Perforated in hole	H	Horizontal
3	Casing - Hand sawn slot	9	Screen - gauze / mesh	V	Vertical
4	Casing - Louvre slot	10	Screen - round wire		
5	Casing - Machine slotted	11	Screen - wedge wire		
6	Casing - Oxy cut slot				

For MATERIAL and FIXING Codes Please refer to CASING DETAILS code table

GRAVEL PACK - METHOD OF PLACEMENT 7

1	Poured or shovelled into annul	2	Placed through tremie pipe	3	Reverse circulated

WORK PARTLY BACKFILLED OR ABANDONED - SEALING MATERIAL 11

1	Cement grout	3	Bentonite	5	Clay	7	Gravel
2	Concrete	4	Drilled cuttings	6	Sand	8	Coarse stone

DRILLER'S ROCK STRATA DESCRIPTION 15

Reporting sequence	1 Rock type	2 Colour	3 Grain size	4 Texture
Example	Sandstone	Dk Grey	mg	Fractured

To save confusion, write the *full name of colour and abbreviate th following:* light = lt, dark = dk, fine grained = fg, medium grained = mg, coarse grained = cg. *Texture can relate t* weathered, fractured, broken, hard, soft etc.

Appendix C

Form A's

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	150 m	

Work Licence No:	TMB03B	2
Name of Licensee:	Snowy Hydro 2.0 Project	
Intended Use:	Monitoring Bore	
Completion Date:	30-01-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	2	254	5
2	39	160	16
39	150	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
schedule	attached											

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	168	4.8	0	39	6
8	60.2	5	0	141	5
8	60.2	5	147	150	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	147	m	To	150	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN 6

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	141	147	5	5	0.4	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	135	150		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					132	135		
Method of placement of Gravel Pack (See Code 7)	1								

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: TMB03B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 6368507 Northing 6038507 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: TMB03B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Dark brown to black soil
1	2	medium olive brown clay
2	4	light to med brownish grey clay
4	6	medium to dark orange clay
6	8	light to medium orange clay
8	10	light greenish grey clay
10	12	medium orange brown basalt
12	20	greenish grey basalt
20	59	Light to med greenish grey greenschist altered
59	80	medium greenish grey basalt
80	113	medium to dark greenish grey basalt
113	114	medium to dark grey basalt
114	125	medium to dark grey basalt
125	148	medium to dark grey basalt, siliceous
148	150	medium to dark grey black basalt

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	34 m	

Work Licence No:	TMB03A	2
Name of Licensee:	Snowy Hydro 2.0 Project	
Intended Use:	Monitoring Bore	
Completion Date:	31-01-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	34	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
33	34		11.9	0.1	0.1	1	A			15	37.7	

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	29.5	5
8	60.2	5	32.5	34	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	32.5	m	To	34	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	29.5	32.5	5	5	0.4	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	26.5	34		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					23.5	26.5		

Method of placement of Gravel Pack — See Code 7: 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: TMB03A

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 636224 Northing 6038505 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: TMB03A

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	12	Medium orange/brown clay
12	13	Medium reddish orange clay
13	15	medium orange brown clay
15	19	light greenish grey clay, basalt 30%
19	23	dark greenish grey basalt, clay 30%
23	24	white quartz, light to medium grey basalt 10%
24	29	light greenish grey FG possibly altered
29	34	light greenish grey FG possibly altered, siliceous

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	201 m	

Work Licence No:	TMB02B	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	01-03-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	1.3	254	2
1.3	41	200	9
41	201	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
see		attached										

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	219.1	4.8	0	1.3	8
9	168	4.8	0	41	6
8	60.2	5	0	191	5
8	60.2	5	197	201	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	197	m	To	201	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	191	197	5	5	1	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	188	200		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					185	188		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: TMB02B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	1 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type	From depth (m)	To depth (m)	Sealing / fill type	From depth (m)	To depth (m)
See Code 11			See Code 11		

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 634541 Northing 6038599 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ----------

Date: ----------

Licensee: ----------

Date: ----------

Work Licence No: TMB02B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Dark Brown Soil
1	24	Light to medium caly thinly bedded weathered
24	200	medium green/grey metasediments

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	15 m	

Work Licence No:	TMB02A	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	26-02-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	15	160	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
12	13	1	5.6	0.3	0.3	1	A			15	20.3	

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	60.2	5	0	10.7	5
5	60.2	5	13.7	15	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}: No (indicate on sketch)

Sump installed {Yes/No}: Yes — From 13.7 m To 15 m

Pressure cemented {Yes/No}: No — From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
5	60.2	5	10.7	13.7	5	5	1	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	7.7	15		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					4.7	7.7		

Method of placement of Gravel Pack — See Code 7: 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: TMB02A

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.25 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type See Code 11	From depth (m)	To depth (m)	Sealing / fill type See Code 11	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 633550 Northing 6038604 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: TMB02A

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Dark Brown Soil
1	3	Light Yellow-Brown Clay
3	8	Medium Orange Clay
8	15	Medium Yellow-Brown Clay

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	60.5 m	

Work Licence No:	MB07B	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	23-02-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	23	200	9
23	60.5	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
22	23	1	9	0.2	0.2	1	A			15	2534	
36	37	1		0.1	0.3	1	A			15	2151	
48	49	1		0.1	0.4	1	A			15	989	

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	160.25	6.7	0	23	1
8	60.2	5	0	51	5
8	60.2	5	57	60	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}: No (indicate on sketch)

Sump installed {Yes/No}: Yes From 57 m To 60 m

Pressure cemented {Yes/No}: No From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	51	57	5	5	1	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	48	60		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					45	48		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

Form A Particulars of completed work

NSW GOVERNMENT Office of Water

Work Licence No: MB07B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	0.5	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type See Code 11	From depth (m)	To depth (m)	Sealing / fill type See Code 11	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 641039 Northing 6042296 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB07B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Soil
1	6	Clay weathered
6	13	shale weathered
13	15	shale sandstone
15	16	sandstone oxidised
16	22	siltsone
22	36	sandstone
36	60	shale

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	14 m	

Work Licence No:	MB07A	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	23-02-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	14	160	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
11	12	1	8.85	0.3	0.3	1	A			15	101	
13	14	1		0.5	0.8	1	A			15	60.3	

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	10	5
8	60.2	5	13	14	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	13	m	To	14	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	10	13	5	5	1	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	7	14		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					4	7		

Method of placement of Gravel Pack — See Code 7: 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: MB07A

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 641050 Northing 6042295 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB07A

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Soil
1	5	Reddish Brown Clay
5	6	Chert (?)
6	12	Weatheredv silt stone
12	14	Siltstone

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	101 m	

Work Licence No:	MB03	2
Name of Licensee:	Snowy Hydro 2.0 Project	
Intended Use:	Monitoring Bore	
Completion Date:	24-01-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	16	200	9
16	101	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
see		attached		schedule								

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	160.25	6.7	0	18	1
8	60.2	5	0	92	5
8	60.2	5	98	101	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}: No (indicate on sketch)

Sump installed {Yes/No}: Yes From 98 m To 101 m

Pressure cemented {Yes/No}: No From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	92	98	5	5	0.4	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	89	101		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					86	89		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: MB03

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 637490 Northing 6043212 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB03

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	5	Sandy Clay Regolith
5	17	Sandstone conglomerate, MG angular quartz
17	49	Basalt
49	50	Quartz
50	55	Greenshist
55	86	Basalt
86	89	Greenschist
89	100	Basalt

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	53 m	

Work Licence No:	MB01C	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	16-01-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	11	200	9
11	53	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
attached	schedule											

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	45	5
8	60.2	5	51	52	5
9	168	4.8	0	10.3	6

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	51	m	To	52	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	45	51	5	5	0.4	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	41	52		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					36	41		

Method of placement of Gravel Pack — See Code 7: 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: MB01C

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 637069 Northing 6040249 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB01C

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	2	Regolith orange brown gravels, sand
2	10	Extremely unconsolidated basalt, gravels
10	30	Fractured Metamorphosed basalt, FG, pale grey/blue
30	36	Clayey metamorphosed shale, grey/black
36	53	green schist, FG, darg grey/green

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 11.5 m

Work Licence No:	MB01B	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	18-01-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	11.5	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
4	5	1	3.5	0.8	0.8	1	A			15	122.1	

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	5.3	5
8	60.2	5	6.8	7	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}: No (indicate on sketch)

Sump installed {Yes/No}: Yes From 6.8 m To 7 m

Pressure cemented {Yes/No}: No From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	5.3	6.8	5	5	0.4	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	4.2	7		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					2.5	4.2		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: MB01B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: 11 m Is work partly backfilled: (Yes/No) Yes

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)
4	7	11			

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

13

Lot No DP No

Work Location Co ordinates Easting 637055 Northing 6040240 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB01B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	2	Regolith, brown/orange clay
2	11.5	Extremely unconsolidated basalt, gravels

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL 1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 200 m

Work Licence No:	TMB04	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	19-02-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	30	200	9
30	200	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
ee		attached										

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	160.25	6.7	0	30	1
8	60.2	5	0	191	5
8	60.2	5	197	200	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	197	m	To	200	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	191	197	5	5	1	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	188	200		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					185	188		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: TMB04

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	1 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 634541 Northing 6038599 Zone 55

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA X (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: TMB04

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1.00	SOIL orange, fill/spoil
1.00	8.00	CLAY medium orangey brown, extremely weathered
8.00	27.00	CLAY medium to dark reddish brown, extremely weathered
27.00	200.00	BASALT light bluish grey, extremely weathered

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL 1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 72 m

Work Licence No:	MB06B	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	04-04-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	25	200	9
30	72	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
see		attached										

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	160.25	6.7	0	25	1
8	60.2	5	0	64	5
8	60.2	5	70	72	5

Casing support method See Code 5: 2

Type of casing bottom See Code 5: 2

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	70	m	To	72	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN 6

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details: Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	64	70	5	5	1	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	60	72		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					56	60		

Method of placement of Gravel Pack: See Code 7: 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: MB06B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	1	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 628719 Northing 6048397 Zone 55

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA X (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB06B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0.00	1.00	SOIL dark brown
1.00	19.00	VOLCANIC ROCK, UNDIFFERENTIATED dark reddish orange, extremely weathered, CLAY, 30% dark reddish orange
19.00	32.00	VOLCANIC ROCK, UNDIFFERENTIATED orangey brown, highly weathered
32.00	72.00	VOLCANIC ROCK, UNDIFFERENTIATED dark blackish grey, fresh

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL 1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 14 m

Work Licence No:	MB06A	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	05-04-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	14	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
10	11	1	4.51	0.2	0.2	1	A			15	88.2	

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	9	5
8	60.2	5	12	14	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	12	m	To	14	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	9	12	5	5	1	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	6	14		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					3	6		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: MB06A

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	1	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 628723 Northing 6048391 Zone 55

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA X (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB06A

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0.00	1.00	SOIL dark brown
1.00	14.00	VOLCANIC ROCK, dark reddish orange,

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	102 m	

Work Licence No:	MB04B	2
Name of Licensee:	Snowy Hudro 2.0 Project	
Intended Use:	Monitoring Bore	
Completion Date:	05-02-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	10	200	9
10	102	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
53	54		48.8	0.05	0.05	1	A		0.5		147.4	

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	93.5	5
8	60.2	5	99.5	102.5	5
5	160.25	6.7	0	18	1

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	99.5	m	To	103	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	93.5	99.5	5	5	1	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	90.5	102.5		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					87.5	90.5		
Method of placement of Gravel Pack (See Code 7)	1								

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: MB04B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 640023 Northing 6047820 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB04B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Soil
1	2	Weathered Basalt
2	3	Moderately Weathered Basalt
3	78	Basalt
78	102.5	Fine Sandstone/Siltstone

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	30.5 m	

Work Licence No:	MB04A	2
Name of Licensee:	Snowy Hudro 2.0 Project	
Intended Use:	Monitoring Bore	
Completion Date:	07-02-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	5	200	9
5	30.5	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
Nil												

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.2	5	0	23	5
8	60.2	5	29	30	5
5	160.25	6.7	0	5	1

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	29	m	To	30	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	23	29	5	5	1	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	18	30		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					17	18		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

Form A Particulars of completed work

Work Licence No: MB04A

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
			X			
Duration	hrs	hrs	0.5 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 640025 Northing 6047813 Zone

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: MB04A

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	1	Soil
1	30.5	Basalt

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No)	Laboratory analysis of water Sample	(Yes/No)	Pumping test(s)	(Yes/No)
Geophysical log	(Yes/No)	Sieve analysis of aquifer material	(Yes/No)	Installed Pump details	(Yes/No)

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 150.5 m

Work Licence No:	MB02	2
Name of Licensee:	Snowy Hydro 2.0 Project	
Intended Use:	Monitoring Bore	
Completion Date:		

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	12	200	9
12	150.5	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	160.25	6.7	0	12	1
8	60.2	5	0	141	5
8	60.2	5	147	150	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	147	m	To	150	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN (6)

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details: Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	141	147	5	5	0.4	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	138	150	151	0.151
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					135	138		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: MB02

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	0.5	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 634310 Northing 6033303 Zone 55

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA X (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: MB02

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	0.5	Soil
0.5	7	Red orange clay soft
7	9	Red brown clay, breakable, weathered basalt
9	11	Red brown clay & greenish grey basalt
11	55	Greenschist
55	75	Basalt
75	86	Greenschist
86	99	Basalt
99	117	Greenschist
117	150.5	Basalt

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL 1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 251 m

Work Licence No:	TMB03C	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	15-03-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	37	219.1	16
37	251	190.5	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	219.1	6.35	0	37	6
9	139.7	5	0	238.8	6
9	139.7	5	250.8	251	6

Casing support method (See Code 5): 3

Type of casing bottom (See Code 5): 1

Centralisers installed {Yes/No}	No	(indicate on sketch)						
Sump installed {Yes/No}	Yes	From	250.8	m	To	251	m	
Pressure cemented {Yes/No}	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
9	139.7	5	238.8	250.8	7	6	1	100	200	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	231	251		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	No					226	231		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: TMB03C

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	0.5	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 636237 Northing 6038498 Zone 55

GPS: (Yes/No) >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: TMB03C

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	0.5	Soil
0.5	16	Clay (decomposed basalt/metabasalt)
16	111	Metabasalt
111	112	Greenschist
112	220	Metabasalt
220	225	Greenschist
225	251	Metabasalt

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 72 m

Work Licence No:	TMB01B	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	22-03-18	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	9.5	168	16
9.5	72	140	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	168	4.8	0	9.5	6
8	60.2	5	0	63	5
8	60.2	5	69	72	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	69	m	To	72	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	63	69	5	5	0.4	20	10	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	60	72		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					57	60		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Work Licence No: TMB01B

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	0.5	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist X Geologist Driller Diviner Client Other 12

Lot No DP No 13

Work Location Co ordinates Easting 627690 Northing 6038072 Zone 55

GPS: (Yes/No) >> AMG/AGD or MGA/GDA X (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: TMB01B

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	0.5	SOIL reddish brown
0.5	4	COLLUVIUM pebbly to cobbly, purplish red, rounded, CLAY 5%, reddish purple
4	5	COLLUVIUM pebbly to cobbly, purplish red, rounded, IGNIMBRITE 40%, purplish grey
5	12	IGNIMBRITE purplish red, CLAY 5%, fine grained, light yellowish green
12	13	TUFF very fine grained , light yellowish green
13	14	TUFF medium green, siliceous, IGNIMBRITE 2%, purplish red
14	15	IGNIMBRITE purplish red, TUFF 5%, medium green, siliceous
15	16	TUFF light yellowish green, SILTSTONE 5%, medium to dark greenish grey, rare quartz
16	19	IGNIMBRITE purplish red
19	30	IGNIMBRITE purplish red, TUFF 5%, medium green, siliceous
30	32	SILTSTONE medium grey, SILTSTONE 30%, light grey, IGNIMBRITE 10%, reddish purple, SILTSTONE 2%, creamy grey
32	45	SILTSTONE medium greenish grey
45	46	SILTSTONE medium greenish grey, minor quartz, abundant sulphides (chalcopyrite)
46	72	SILTSTONE medium grey

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

Form A Particulars of completed work

NSW GOVERNMENT Office of Water

Driller's Licence No:	DL1913	1
Class of Licence:	Class 4	
Driller's Name:	Ian Palk	
Assistant Driller:	Ashley Wills	
Contractor:	Highland Drilling PL	
New bore	X	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	15 m	

Work Licence No:	TMB01A	2
Name of Licensee:	Snowy Mountains Hydro	
Intended Use:	Monitoring Bore	
Completion Date:	22-03-18	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	4	168	16
4	15	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
12	13	1	5.07	0.1	0.1	1	A			15	642	
14	15	1		0.1	0.2	1	A			15	650	

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	168	4.8	0	4	6
8	60.2	5	0	11	5
8	60.2	5	14	15	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 2

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	14	m	To	15	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	60.2	5	11	14	5	5	0.4	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	3	5	6	15		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					3	6		

Method of placement of Gravel Pack (See Code 7): 1

For Departmental use only: G W

AQUIFER SCHEDULE

CLIENT; Snowy Hydro 2.0

SITE; MB01C

WATER BEARING ZONES

From	To	SWL	Yield Each Aquifer	Yield Cumulative LPS	Test method	Test duration	Cond OR	TDS
30	31		0.1	0.1	Air	15 mins	12780	
42	43		0.3	0.4	Air	15 mins	103.8	
48	49		0.1	0.5	Air	15 mins	96	
66	67		.2	0.7	Air	15 mins	70.3	
72	73		.3	1	Air	15 mins	66	
84	85		.2	1.2	Air	15 mins	53.8	
90	91		.3	1.5	Air	15 mins	54.5	
114	115		.5	2	Air	15 mins	52.2	

AQUIFER SCHEDULE

CLIENT; Snowy Mountains Hydro 2.0 Project - 40BL192701

SITE; TMB03B

WATER BEARING ZONES

From	To	SWL	Yield Each Aquifer	Yield Cumulative LPS	Test method	Test duration	Cond OR	TDS
38	39	17.70	1.5	1.5	Air	15 mins	72.7	
41	42		1	2.5	Air	15 mins	73.9	
71	72		.35	2.85	Air	15 mins	64.6	
83	84		0.48	3.33	Air	15 mins	64.5	
135	136		0.67	4	Air	15 mins	120.2	

AQUIFER SCHEDULE

CLIENT; EMM – Snowy Hydro

SITE; TMB02B

WATER BEARING ZONES

From	To	SWL	Yield Each Aquifer	Yield Cumulative LPS	Test method	Test duration	Cond OR	TDS
11	12	7	.2	.2	Air	15 mins		
18	19		.1	.3	Air	15 mins	18.4	
24	25		.2	.5	Air	15 mins	12.4	
36	37		.5	1	Air	15 mins	16.4	
48	49		1	2	Air	15 mins	22.8	
108	109		.2	2.2	Air	15 mins	66.9	
114	115		.3	2.5	Air	15 mins	72.1	
120	121		.7	3	Air	15 mins	76.5	

Aquifer Schedule

Client: Snowy Hydro 2.0 Project

Site: TMB03C

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method		D D L at end of test (m)	Duration		Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative	See Code 4			Hrs	min	Cond (µS/cm)	TDS (mg/L)
36	37	1		0.2	0.2	1	A			15	92	
41	42	1		0.1	0.3	1	A			15	52.3	
65	66	1		0.7	1	1	A			15	70.7	
83	84	1		0.5	1.5	1	A			15	59.8	
113	114	1		0.1	1.6	1	A			15	76.8	
119	120	1		0.4	2	1	A			15	110.7	
167	168	1		1	3	1	A			15	105.1	
173	174	1		1	4	1	A			15	98.1	
179	180	1		1	5	1	A			15	94.5	

Aquifer Schedule

Client: Snowy Hydro 2.0 Project

Site: TMB01B

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method		D D L at end of test (m)	Duration		Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative	See Code 4			Hrs	min	Cond (µS/cm)	TDS (mg/L)
18	19	1	6.08	0.1	0.1	1	A			15	1004	
30	31	1		0.2	0.3	1	A			15	962	
36	37	1		1.7	2	1	A			15	936	
42	43	1		0.5	2.5	1	A			15	918	
60	61	1		0.5	3	1	A			15	1278	

Aquifer Schedule

Client: Snowy Hydro 2.0 Project

Site: MB06B

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method		D D L at end of test (m)	Duration		Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative	See Code 4			Hrs	min	Cond (µS/cm)	TDS (mg/L)
17	18	1	4.51	0.2	0.2	1	A			15	28.5	
41	42	1		0.3	0.5	1	A			15	228.5	
47	48	1		0.3	0.8	1	A			15	191.2	
53	54	1		0.2	1	1	A			15	171.2	
65	66	1		0.2	1.2	1	A			15	176.6	

AQUIFER SCHEDULE

CLIENT; EMM – Snowy Hydro

SITE; MB03

WATER BEARING ZONES

From	To	SWL	Yield Each Aquifer	Yield Cumulative LPS	Test method	Test duration	Cond OR	TDS
5	6		.5	.5	Air	15 mins	116.1	
35	36		.3	.8	Air	15 mins	80.3	
54	55		1.2	2	Air	15 mins	76.6	
60	61		.5	2.5	Air	15 mins	94.3	
					Air	15 mins		

AQUIFER SCHEDULE

CLIENT; EMM – Snowy Hydro

SITE; MB02

WATER BEARING ZONES

From	To	SWL	Yield Each Aquifer	Yield Cumulative LPS	Test method	Test duration	Cond OR	TDS
12	13	6.05	0.3	0.3	Air	15 mins	170	
18	19		.5	0.8	Air	15 mins	132.10	
54	55		.2	1	Air	15 mins	206.9	
66	67		.1	1.1	Air	15 mins	182.1	
72	73		.4	1.5	Air	15 mins	105.1	
90	91		.5	2	Air	15 mins	101.5	

AQUIFER SCHEDULE

CLIENT; Snowy Hydro 2.0 Project

SITE; MB01C

WATER BEARING ZONES

From	To	SWL	Yield Each Aquifer	Yield Cumulative LPS	Test method	Test duration	Cond OR	TDS
12	13	21.5	0.5	0.5	Air	15 mins	160.7	
40	41		0.5	1.0	Air	15 mins	101.2	
47	48		1	2.0	Air	15 mins	137.3	
49	50		2	4	Air	15 mins	121.5	

Appendix D

Water quality laboratory certificates

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1805343**	Page	: 1 of 14
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR SEAN CASSIDY	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 9493 9500	Telephone	: +61-2-8784 8555
Project	: J17188 Snowy Hydro 2.0	Date Samples Received	: 20-Feb-2018 09:00
Order number	: ----	Date Analysis Commenced	: 20-Feb-2018
C-O-C number	: ----	Issue Date	: 26-Feb-2018 17:36
Sampler	: IMOGEN FRAWLEY, SEAN CASSIDY		
Site	: ----		
Quote number	: SY/068/18		
No. of samples received	: 16		
No. of samples analysed	: 16		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Sanjeshni Jyoti	Senior Chemist Volatiles	Sydney Organics, Smithfield, NSW

General Comments

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

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK057G: LOR raised for Nitrite on sample 1 due to sample matrix.
- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- TDS by method EA-015 may bias high for sample 4 due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MB04B	MB04A	MB03	MB01B	SW08
			Client sampling date / time	14-Feb-2018 14:15	14-Feb-2018 00:00	13-Feb-2018 16:10	13-Feb-2018 00:00	14-Feb-2018 14:20
Compound	CAS Number	LOR	Unit	ES1805343-001	ES1805343-002	ES1805343-003	ES1805343-004	ES1805343-005
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	----	----	136	----	----
Total Dissolved Solids @180°C	----	10	mg/L	1090	176	----	274	103
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	----	----	----	----	<5
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	130	57	81	67	86
Total Alkalinity as CaCO3	----	1	mg/L	130	57	81	67	86
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	84	43	12	5	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	53	6	7	1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	12	26	17	11	25
Magnesium	7439-95-4	1	mg/L	1	2	5	6	2
Sodium	7440-23-5	1	mg/L	114	14	7	5	3
Potassium	7440-09-7	1	mg/L	2	1	9	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	0.002	0.007	0.004	0.006	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L	0.006	<0.005	0.020	<0.005	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	----	----	----	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L	----	----	----	----	<0.0001
Chromium	7440-47-3	0.001	mg/L	----	----	----	----	<0.001
Copper	7440-50-8	0.001	mg/L	----	----	----	----	<0.001
Nickel	7440-02-0	0.001	mg/L	----	----	----	----	<0.001
Lead	7439-92-1	0.001	mg/L	----	----	----	----	<0.001
Zinc	7440-66-6	0.005	mg/L	----	----	----	----	<0.005

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB04B	MB04A	MB03	MB01B	SW08
				Client sampling date / time	14-Feb-2018 14:15	14-Feb-2018 00:00	13-Feb-2018 16:10	13-Feb-2018 00:00	14-Feb-2018 14:20
Compound	CAS Number	LOR	Unit		ES1805343-001	ES1805343-002	ES1805343-003	ES1805343-004	ES1805343-005
					Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	**0.0011**	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	**0.4**	<0.1	<0.1	<0.1
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.02**	<0.01	**0.03**	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.10	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.66**	**0.38**	**0.26**	**0.05**	**0.04**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.66**	**0.38**	**0.26**	**0.05**	**0.04**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.9**	**0.5**	**0.2**	**0.8**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.6**	**0.9**	**0.5**	**0.8**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.19**	**0.29**	**1.02**	**31.9**	**0.02**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**5.84**	**2.20**	**2.06**	**1.47**	**1.72**
Total Cations	----	0.01	meq/L		**5.69**	**2.10**	**1.79**	**1.26**	**1.54**
Ionic Balance	----	0.01	%		**1.30**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW07	SW05	SW04	SW06	TMB03A
			Client sampling date / time	14-Feb-2018 16:00	14-Feb-2018 14:50	14-Feb-2018 10:20	13-Feb-2018 17:00	15-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	ES1805343-006	ES1805343-007	ES1805343-008	ES1805343-009	ES1805343-010
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	----	----	----	51	----
Total Dissolved Solids @180°C	----	10	mg/L	71	21	25	----	84
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	----	----	----	<5	----
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	68	15	17	29	43
Total Alkalinity as CaCO3	----	1	mg/L	68	15	17	29	43
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	<1	<1	<1	6
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	<1	6
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	20	1	3	5	8
Magnesium	7439-95-4	1	mg/L	3	<1	1	1	3
Sodium	7440-23-5	1	mg/L	4	1	2	4	6
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	1
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	----	----	----	----	0.001
Cadmium	7440-43-9	0.0001	mg/L	----	----	----	----	<0.0001
Chromium	7440-47-3	0.001	mg/L	----	----	----	----	<0.001
Copper	7440-50-8	0.001	mg/L	----	----	----	----	0.006
Nickel	7440-02-0	0.001	mg/L	----	----	----	----	0.001
Lead	7439-92-1	0.001	mg/L	----	----	----	----	<0.001
Zinc	7440-66-6	0.005	mg/L	----	----	----	----	0.025
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW07	SW05	SW04	SW06	TMB03A
				Client sampling date / time	14-Feb-2018 16:00	14-Feb-2018 14:50	14-Feb-2018 10:20	13-Feb-2018 17:00	15-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		ES1805343-006	ES1805343-007	ES1805343-008	ES1805343-009	ES1805343-010
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	<0.1	<0.1	<0.1	**0.1**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.02**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**1.92**	**0.02**	**0.31**	**0.03**	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**1.92**	**0.02**	**0.31**	**0.03**	**0.01**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	**0.1**	<0.1	<0.1	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.9**	**0.1**	**0.3**	<0.1	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.09**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**1.44**	**0.30**	**0.34**	**0.58**	**1.15**
Total Cations	----	0.01	meq/L		**1.42**	**0.09**	**0.32**	**0.50**	**0.93**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TMB03B	MB02	SW02	SW01	QA1
				Client sampling date / time	15-Feb-2018 00:00	15-Feb-2018 00:00	15-Feb-2018 00:00	16-Feb-2018 00:00	16-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		ES1805343-011	ES1805343-012	ES1805343-013	ES1805343-014	ES1805343-015
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		97	68	40	54	43
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		----	----	16	7	<5
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		75	45	26	31	33
Total Alkalinity as CaCO3	----	1	mg/L		75	45	26	31	33
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		11	14	<1	<1	<1
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		4	<1	1	<1	<1
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		20	17	5	5	5
Magnesium	7439-95-4	1	mg/L		2	2	3	3	3
Sodium	7440-23-5	1	mg/L		8	2	<1	11	2
Potassium	7440-09-7	1	mg/L		4	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.015	<0.001	----	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	<0.001
Copper	7440-50-8	0.001	mg/L		0.006	0.002	----	----	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	----	----	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	<0.001
Zinc	7440-66-6	0.005	mg/L		0.015	0.049	----	----	<0.005
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		----	----	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		----	----	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		----	----	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		----	----	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L		----	----	0.002	<0.001	----
Lead	7439-92-1	0.001	mg/L		----	----	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		----	----	<0.005	0.005	----
EG035F: Dissolved Mercury by FIMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TMB03B	MB02	SW02	SW01	QA1
			Client sampling date / time	15-Feb-2018 00:00	15-Feb-2018 00:00	15-Feb-2018 00:00	16-Feb-2018 00:00	16-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	ES1805343-011	ES1805343-012	ES1805343-013	ES1805343-014	ES1805343-015
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	----	----	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.6**	<0.1	<0.1	<0.1	<0.1
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	<0.01	**0.01**	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.03**	**0.08**	**0.03**	**0.04**	**0.05**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.03**	**0.08**	**0.03**	**0.04**	**0.05**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**0.2**	**0.3**	**0.1**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**0.3**	**0.3**	**0.1**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.10**	**0.05**	**0.05**	**0.01**	**0.01**
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**1.84**	**1.19**	**0.55**	**0.62**	**0.66**
Total Cations	----	0.01	meq/L	**1.61**	**1.10**	**0.50**	**0.97**	**0.58**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	----	----	----	----	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	----	----	----	----	<1.0
Acenaphthene	83-32-9	1.0	µg/L	----	----	----	----	<1.0
Fluorene	86-73-7	1.0	µg/L	----	----	----	----	<1.0
Phenanthrene	85-01-8	1.0	µg/L	----	----	----	----	<1.0
Anthracene	120-12-7	1.0	µg/L	----	----	----	----	<1.0
Fluoranthene	206-44-0	1.0	µg/L	----	----	----	----	<1.0
Pyrene	129-00-0	1.0	µg/L	----	----	----	----	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	----	----	----	----	<1.0
Chrysene	218-01-9	1.0	µg/L	----	----	----	----	<1.0

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TMB03B	MB02	SW02	SW01	QA1
				Client sampling date / time	15-Feb-2018 00:00	15-Feb-2018 00:00	15-Feb-2018 00:00	16-Feb-2018 00:00	16-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		ES1805343-011	ES1805343-012	ES1805343-013	ES1805343-014	ES1805343-015
					Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		----	----	----	----	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		----	----	----	----	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		----	----	----	----	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		----	----	----	----	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		----	----	----	----	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		----	----	----	----	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		----	----	----	----	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		----	----	----	----	<0.5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		----	----	----	----	<20
C10 - C14 Fraction	----	50	µg/L		----	----	----	----	<50
C15 - C28 Fraction	----	100	µg/L		----	----	----	----	<100
C29 - C36 Fraction	----	50	µg/L		----	----	----	----	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		----	----	----	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		----	----	----	----	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		----	----	----	----	<20
>C10 - C16 Fraction	----	100	µg/L		----	----	----	----	<100
>C16 - C34 Fraction	----	100	µg/L		----	----	----	----	<100
>C34 - C40 Fraction	----	100	µg/L		----	----	----	----	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		----	----	----	----	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		----	----	----	----	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		----	----	----	----	<1
Toluene	108-88-3	2	µg/L		----	----	----	----	<2
Ethylbenzene	100-41-4	2	µg/L		----	----	----	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	----	----	----	<2
ortho-Xylene	95-47-6	2	µg/L		----	----	----	----	<2
^ Total Xylenes	----	2	µg/L		----	----	----	----	<2
^ Sum of BTEX	----	1	µg/L		----	----	----	----	<1
Naphthalene	91-20-3	5	µg/L		----	----	----	----	<5
EP075(SIM)S: Phenolic Compound Surrogates									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TMB03B	MB02	SW02	SW01	QA1
				Client sampling date / time	15-Feb-2018 00:00	15-Feb-2018 00:00	15-Feb-2018 00:00	16-Feb-2018 00:00	16-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		ES1805343-011	ES1805343-012	ES1805343-013	ES1805343-014	ES1805343-015
					Result	Result	Result	Result	Result
EP075(SIM)S: Phenolic Compound Surrogates - Continued									
Phenol-d6	13127-88-3	1.0	%		----	----	----	----	**31.1**
2-Chlorophenol-D4	93951-73-6	1.0	%		----	----	----	----	**68.0**
2.4.6-Tribromophenol	118-79-6	1.0	%		----	----	----	----	**59.6**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		----	----	----	----	**82.4**
Anthracene-d10	1719-06-8	1.0	%		----	----	----	----	**102**
4-Terphenyl-d14	1718-51-0	1.0	%		----	----	----	----	**99.0**
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		----	----	----	----	**107**
Toluene-D8	2037-26-5	2	%		----	----	----	----	**109**
4-Bromofluorobenzene	460-00-4	2	%		----	----	----	----	**105**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA2	----	----	----	----
			Client sampling date / time	16-Feb-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1805343-016	--------	--------	--------	--------
				Result	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**53**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**33**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**33**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**5**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**3**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**2**	----	----	----	----
Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QA2	----	----	----	----
				Client sampling date / time	16-Feb-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1805343-016	--------	--------	--------	--------
					Result	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.1**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.1**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**0.66**	----	----	----	----
Total Cations	----	0.01	meq/L		**0.58**	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	----	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	----	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	----	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	----	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QA2	----	----	----	----
				Client sampling date / time	16-Feb-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1805343-016	--------	--------	--------	--------
					Result	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons - Continued									
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	----	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ Total Xylenes	----	2	µg/L		<2	----	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**29.7**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**64.1**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**58.6**	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**79.2**	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**102**	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**101**	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**99.9**	----	----	----	----
Toluene-D8	2037-26-5	2	%		**81.8**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**86.8**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1805147**	Page	: 1 of 12
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: MR SEAN CASSIDY	Contact	: Customer Services EM
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Telephone	: +61 02 9493 9500	Telephone	: +61-3-8549 9600
Project	: EMM # - J17188	Date Samples Received	: 23-Mar-2018 16:30
Order number	:	Date Analysis Commenced	: 23-Mar-2018
C-O-C number	: ----	Issue Date	: 04-Apr-2018 18:51
Sampler	: DANIEL CONDON (HT)		
Site	: Snowy Mountains		
Quote number	: EN/222/17		
No. of samples received	: 16		
No. of samples analysed	: 15		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

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

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA015H: EM1805147 #1, #6-7 and #9 TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- EK057G: Results for EM1805147-008 have been confirmed by re-preparation and re-analysis.
- ED093F:EM1805147_006 has been confirmed for major cations by re-preparation and re-analysis.
- TDS by method EA-015 may bias high for EM1805147 #11 and 12 due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Ionic Balance out of acceptable limits for sample #6 due to analytes not quantified in this report. Major anions and major cations have been confirmed by re-preparation and re-analysis.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EK040-P: EM1805146 #13 Poor matrix spike recovery for fluoride due to sample matrix. Confirmed by re-extraction and re-analysis.

Analytical Results

Sub-Matrix: TRIP BLANK (Matrix: WATER)				Client sample ID	TRIP BLANK	----	----	----	----
				Client sampling date / time	22-Mar-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1805147-015	--------	--------	--------	--------
					Result	----	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
Styrene	100-42-5	5	µg/L		<5	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
Isopropylbenzene	98-82-8	5	µg/L		<5	----	----	----	----
n-Propylbenzene	103-65-1	5	µg/L		<5	----	----	----	----
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	----	----	----	----
sec-Butylbenzene	135-98-8	5	µg/L		<5	----	----	----	----
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	----	----	----	----
tert-Butylbenzene	98-06-6	5	µg/L		<5	----	----	----	----
p-Isopropyltoluene	99-87-6	5	µg/L		<5	----	----	----	----
n-Butylbenzene	104-51-8	5	µg/L		<5	----	----	----	----
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	----	----	----	----
2-Butanone (MEK)	78-93-3	50	µg/L		<50	----	----	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	----	----	----	----
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	----	----	----	----
EP074C: Sulfonated Compounds									
Carbon disulfide	75-15-0	5	µg/L		<5	----	----	----	----
EP074D: Fumigants									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	----	----	----	----
1.2-Dichloropropane	78-87-5	5	µg/L		<5	----	----	----	----
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	----	----	----	----
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	----	----	----	----
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	----	----	----	----
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	----	----	----	----
Chloromethane	74-87-3	50	µg/L		<50	----	----	----	----
Vinyl chloride	75-01-4	50	µg/L		<50	----	----	----	----
Bromomethane	74-83-9	50	µg/L		<50	----	----	----	----
Chloroethane	75-00-3	50	µg/L		<50	----	----	----	----
Trichlorofluoromethane	75-69-4	50	µg/L		<50	----	----	----	----

Analytical Results

Sub-Matrix: TRIP BLANK (Matrix: WATER)				Client sample ID	TRIP BLANK	----	----	----	----
				Client sampling date / time	22-Mar-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1805147-015	--------	--------	--------	--------
					Result	----	----	----	----
EP074E: Halogenated Aliphatic Compounds - Continued									
1.1-Dichloroethene	75-35-4	5	µg/L		<5	----	----	----	----
Iodomethane	74-88-4	5	µg/L		<5	----	----	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	----	----	----	----
1.1-Dichloroethane	75-34-3	5	µg/L		<5	----	----	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	----	----	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	----	----	----	----
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	----	----	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	----	----	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	----	----	----	----
Trichloroethene	79-01-6	5	µg/L		<5	----	----	----	----
Dibromomethane	74-95-3	5	µg/L		<5	----	----	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	----	----	----	----
1.3-Dichloropropane	142-28-9	5	µg/L		<5	----	----	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	----	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	----	----	----	----
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	----	----	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	----	----	----	----
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	----	----	----	----
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	----	----	----	----
Pentachloroethane	76-01-7	5	µg/L		<5	----	----	----	----
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	----	----	----	----
Hexachlorobutadiene	87-68-3	5	µg/L		<5	----	----	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	----	----	----	----
Bromobenzene	108-86-1	5	µg/L		<5	----	----	----	----
2-Chlorotoluene	95-49-8	5	µg/L		<5	----	----	----	----
4-Chlorotoluene	106-43-4	5	µg/L		<5	----	----	----	----
1.3-Dichlorobenzene	541-73-1	5	µg/L		<5	----	----	----	----
1.4-Dichlorobenzene	106-46-7	5	µg/L		<5	----	----	----	----
1.2-Dichlorobenzene	95-50-1	5	µg/L		<5	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		<5	----	----	----	----
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	----	----	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	----	----	----	----

Analytical Results

Sub-Matrix: TRIP BLANK (Matrix: WATER)				Client sample ID	TRIP BLANK	----	----	----	----
				Client sampling date / time	22-Mar-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1805147-015	--------	--------	--------	--------
					Result	----	----	----	----
EP074G: Trihalomethanes - Continued									
Bromodichloromethane	75-27-4	5	µg/L		<5	----	----	----	----
Dibromochloromethane	124-48-1	5	µg/L		<5	----	----	----	----
Bromoform	75-25-2	5	µg/L		<5	----	----	----	----
EP074H: Naphthalene									
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		**107**	----	----	----	----
Toluene-D8	2037-26-5	5	%		**107**	----	----	----	----
4-Bromofluorobenzene	460-00-4	5	%		**112**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB01B	MB01C	MB02	MB03	MB04A
				Client sampling date / time	22-Mar-2018 00:00	22-Mar-2018 00:00	20-Mar-2018 00:00	21-Mar-2018 00:00	21-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1805147-001	EM1805147-002	EM1805147-003	EM1805147-004	EM1805147-005
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		264	127	90	107	210
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		39	81	46	53	61
Total Alkalinity as CaCO3	----	1	mg/L		39	81	46	53	61
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	13	14	3	78
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		1	1	3	1	5
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		6	14	15	9	33
Magnesium	7439-95-4	1	mg/L		3	6	2	4	3
Sodium	7440-23-5	1	mg/L		6	9	4	4	15
Potassium	7440-09-7	1	mg/L		<1	1	<1	<1	2
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.009	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		0.001	<0.001	0.001	0.002	0.002
Copper	7440-50-8	0.001	mg/L		0.126	<0.001	0.007	0.104	0.088
Nickel	7440-02-0	0.001	mg/L		0.007	<0.001	0.002	0.003	0.003
Lead	7439-92-1	0.001	mg/L		0.007	<0.001	0.001	0.005	0.004
Zinc	7440-66-6	0.005	mg/L		0.148	<0.005	0.029	0.121	0.116
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	0.1	<0.1	0.4
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.36	0.06	0.16	0.14	0.13
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.02	<0.01	<0.01	0.25	0.66

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB01B	MB01C	MB02	MB03	MB04A
				Client sampling date / time	22-Mar-2018 00:00	22-Mar-2018 00:00	20-Mar-2018 00:00	21-Mar-2018 00:00	21-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1805147-001	EM1805147-002	EM1805147-003	EM1805147-004	EM1805147-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	<0.01	<0.01	**0.25**	**0.67**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	**0.4**	**0.2**	**0.3**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.4**	**0.4**	**0.2**	**0.6**	**0.9**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**1.93**	**0.11**	**0.05**	**0.07**	**0.08**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**0.81**	**1.92**	**1.30**	**1.15**	**2.98**
Total Cations	----	0.01	meq/L		**0.81**	**1.61**	**1.09**	**0.95**	**2.60**
Ionic Balance	----	0.01	%		<0.01	**----**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	MB04B	MB07A	MB07B	TMB02A	TMB02B
				Client sampling date / time	21-Mar-2018 00:00	22-Mar-2018 00:00	22-Mar-2018 00:00	20-Mar-2018 00:00	20-Mar-2018 00:00
					EM1805147-006	EM1805147-007	EM1805147-008	EM1805147-009	EM1805147-010
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**----**	**----**	**----**	**98**	**80**
Total Dissolved Solids @180°C	----	10	mg/L		**940**	**94**	**312**	**----**	**----**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		**5**	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**126**	**18**	**22**	**12**	**56**
Total Alkalinity as CaCO3	----	1	mg/L		**131**	**18**	**22**	**12**	**56**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**88**	**9**	**158**	**6**	**8**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**37**	**1**	**5**	<1	<1
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**5**	**4**	**55**	**4**	**13**
Magnesium	7439-95-4	1	mg/L		**1**	**2**	**4**	<1	**2**
Sodium	7440-23-5	1	mg/L		**103**	**3**	**13**	**1**	**7**
Potassium	7440-09-7	1	mg/L		**2**	<1	**3**	<1	<1
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		**0.002**	<0.001	**0.002**	<0.001	**0.004**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.002**	**0.001**	<0.001
Copper	7440-50-8	0.001	mg/L		**0.010**	**0.007**	**0.098**	**0.009**	**0.007**
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.002**	**0.002**	**0.002**	**0.001**
Lead	7439-92-1	0.001	mg/L		**0.002**	**0.001**	**0.005**	**0.002**	**0.001**
Zinc	7440-66-6	0.005	mg/L		**0.030**	**0.027**	**0.105**	**0.037**	**0.015**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	<0.1	**0.5**	<0.1	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.16**	**0.06**	**0.06**	**0.05**	**0.06**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.06**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB04B	MB07A	MB07B	TMB02A	TMB02B
				Client sampling date / time	21-Mar-2018 00:00	22-Mar-2018 00:00	22-Mar-2018 00:00	20-Mar-2018 00:00	20-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1805147-006	EM1805147-007	EM1805147-008	EM1805147-009	EM1805147-010
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser - Continued									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.17**	<0.01	<0.01	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.17**	**0.06**	<0.01	**0.01**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**1.0**	**0.7**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.4**	**1.1**	**0.7**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**1.14**	**0.18**	**1.66**	**0.09**	**0.07**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**5.49**	**0.58**	**3.87**	**0.36**	**1.28**
Total Cations	----	0.01	meq/L		**4.86**	**0.49**	**3.72**	**0.24**	**1.12**
Ionic Balance	----	0.01	%		**6.08**	**----**	**2.03**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TMB03A	TMB03B	TMB04	QA01	----
				Client sampling date / time	20-Mar-2018 00:00	20-Mar-2018 00:00	21-Mar-2018 00:00	22-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit		EM1805147-011	EM1805147-012	EM1805147-013	EM1805147-014	--------
					Result	Result	Result	Result	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		136	179	56	124	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		34	73	33	80	----
Total Alkalinity as CaCO3	----	1	mg/L		34	73	33	80	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		6	26	5	13	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		5	4	<1	1	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		5	16	9	14	----
Magnesium	7439-95-4	1	mg/L		3	3	<1	6	----
Sodium	7440-23-5	1	mg/L		6	14	3	9	----
Potassium	7440-09-7	1	mg/L		1	2	<1	1	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.014	<0.001	0.008	----
Cadmium	7440-43-9	0.0001	mg/L		0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	0.002	<0.001	----
Copper	7440-50-8	0.001	mg/L		0.008	0.090	0.101	<0.001	----
Nickel	7440-02-0	0.001	mg/L		0.004	0.003	0.002	0.002	----
Lead	7439-92-1	0.001	mg/L		0.001	0.005	0.006	0.001	----
Zinc	7440-66-6	0.005	mg/L		0.056	0.116	0.119	<0.005	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		0.1	0.3	<0.1	<0.1	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.05	0.04	0.05	0.06	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	0.04	<0.01	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TMB03A	TMB03B	TMB04	QA01	----
				Client sampling date / time	20-Mar-2018 00:00	20-Mar-2018 00:00	21-Mar-2018 00:00	22-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit		EM1805147-011	EM1805147-012	EM1805147-013	EM1805147-014	--------
					Result	Result	Result	Result	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.04**	<0.01	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.5**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.5**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.11**	**0.05**	**0.13**	**0.09**	**----**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**0.94**	**2.11**	**0.76**	**1.90**	**----**
Total Cations	----	0.01	meq/L		**0.78**	**1.70**	**0.58**	**1.61**	**----**

Surrogate Control Limits

Sub-Matrix: **TRIP BLANK**

Compound	CAS Number	Recovery Limits (%) Low	High
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131

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Appendix B

Peer review modelling report

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INDEPENDENT REVIEW STATEMENT

ATTENTION:	Dr Doug Weatherill, Associate Groundwater Modeller, EMM Consulting	
FROM:	Hugh Middlemis, Principal Groundwater Engineer, Hydrogeologic Pty Ltd	
REFERENCES:	18 May 2018	EMM ref: Snowy 2.0 (J17188)
	HGL job#: 61.065	
SUBJECT:	Peer Review of Snowy 2.0 Early Works Groundwater Model - Calibration stage	

1. SUMMARY

This brief statement summarises the outcomes of an independent review of the calibration of the Snowy 2.0 Early Works numerical groundwater model that was developed by EMM Consulting to support environmental assessments for the Snowy 2.0 feasibility study.

This review was conducted in accordance with the best practice principles of the Australian Groundwater Modelling Guideline (Barnett et al. 2012), which suggests a compliance checklist to summarise review outcomes; this is presented as Table 1.

The review was conducted progressively (i.e. consistent with the guidelines) through a series of consultations with the EMM Consulting hydrogeology and modelling teams at the conceptualisation and model design stages (including a site visit on 13th February 2018), and at the model calibration and early works prediction stage. While the model report documentation is not yet available, the model data set and results were inspected in detail on 17th May 2018 at the EMM offices in Adelaide.

It is my professional opinion that the Snowy 2.0 Early Works groundwater model has been developed consistent with best practice, including careful model design and acceptable calibration to the available groundwater levels and with consideration of river baseflow estimates. The Snowy 2.0 model is suitable for early works scenario modelling and assessment of drawdown and catchment water balance impacts.

The Modflow-USG package was used to design a detailed variable grid, with minimum cell sizes of 12.5 m near mapped streams and the tunnel alignment, with 8 additional sub-layers either side of the tunnel, and with pinching out of unnecessary layers and/or cells remote from such features.

The boundary conditions, recharge, surface-groundwater interactions and parameters applied are reasonable, with a bias towards conservative assumptions where warranted (e.g. adopting a storage depletion setup rather than regional groundwater throughflow, in cognisance of the limited data set).

The model performance across the 16 monitoring bore sites meets statistical criteria (mainly due to the large range in elevations), with residual values of less than 4 metres in 4 of the 16 bores, but 11-17 metres in 6 other bores, and a slight bias to over-predict levels. The steady state (long term average) predictions are robustly benchmarked by the steady state calibration, but the results of the transient predictions of progressive early works tunnelling are subject to more uncertainty as there is no time series groundwater level data for transient calibration. Model sensitivity/uncertainty scenarios have been run, again with conservative parameter settings.

The ongoing hydrogeological investigations will provide additional data for future model refinements and improvements in performance (e.g. to reduce residuals and improve river baseflow calibration) and for more extensive uncertainty analysis.

Table 1 - Groundwater Model Compliance Checklist: 10-point essential summary - Snowy 2.0 model

Question	Y/N	Comments re Snowy 2.0 Early Works groundwater model
1. Are the model objectives and model confidence level classification clearly stated?	Yes	Class 2 model confidence level is justifiable (see Table 2 below)
2. Are the objectives satisfied?	Yes	Competent model design and calibration to groundwater levels at 16 bores, and estimated Yarrangobilly River baseflow, demonstrating fitness for purpose of early works impact assessment scenarios (drawdowns & catchment water balances).
3. Is the conceptual model consistent with objectives and confidence level?	Yes	Conceptualisation is sound, consistent with data on fractured rock aquifer system and weathered shallow regolith, and with early works investigations objectives and Class 2 confidence level. Information available from existing Snowy Hydro scheme was used to guide investigations and benchmark model results.
4. Is the conceptual model based on all available data, presented clearly and reviewed by an appropriate reviewer?	Yes	Report is not yet available, but available information has been considered carefully. Additional monitoring bores have been drilled and tested and there has been detailed consultation with Snowy Hydro and geotechnical experts. Experienced hydrogeologists and modellers have reviewed available data and new investigations, conceptualisation, model design and outcomes.
5. Does the model design conform to best practice?	Yes	The model software, design, extent, grid and parameters are a good example of best practice design and execution. The limited data set is acknowledged, and a conservative approach has been applied such that potential impacts would be over-estimated.
6. Is the model calibration satisfactory?	Yes	Steady state model calibration statistical performance is good (1.1% SRMS error), mainly due to large range in elevations. Residual values are less than 4 metres in 4 of the 16 bores, but 11-17 metres in 6 other bores, and there is a slight bias to over-predict levels. Transient calibration or verification not possible with the limited data set and time available.
7. Are the calibrated parameter values and estimated fluxes plausible?	Yes	Model parameter values are consistent with drilling and testing information, and fluxes were benchmarked to baseflow estimates and existing tunnel drainage estimates. Model recharge flux inputs considered several analytical methods, plus estimates from BoM AWRA and regional modelling in Victoria that involved extensions into NSW (Ensym project). Evapo-transpiration flux estimates based on BoM data, with spatial variations for plateau (eastern) or ravine (western) conditions.
8. Do the model predictions conform to best practice?	Yes	Predicted drawdown at water table shown to be limited except where there is shallow cover over tunnel (e.g. <100m), and steady state predicted tunnel max. inflow ~3.5 L/s (~1 L/s/km); all consistent with observations in existing Snowy Hydro scheme.
9. Is the uncertainty associated with the simulations/predictions reported?	Yes	The hydrogeological conceptualisation, model design and review process considered conceptual and measurement uncertainties, such as geology, faulting, rainfall recharge, surface drainage network, baseflow and differences between the plateau (eastern) and ravine (western) areas). Report not yet available.
10. Is the model fit for purpose?	Yes	My professional opinion is that the Snowy 2.0 model is a sound example of best practice in design and execution. The Snowy 2.0 model is suitable for early works scenario modelling of drawdown effects due to tunnel construction and effects on catchment water balances (for licensing purposes).

2. Model Confidence Level Classification

The Snowy 2.0 groundwater model report was not available when this review report was written, so the "model confidence level" criteria (Barnett et al. 2012, Section 2 and Table 2-1) is not yet documented. However, the modelling team indicated the aim is for a Class 2 model (suitable for impact assessment).

This review conducted an independent assessment (Table 2) based on a method recommended in the draft NCGRT report on groundwater modelling uncertainty (Middlemis and Peeters, 2018, in review). Some of the attributes cannot be scored definitively in this case (at this stage) as only the early works calibration and predictions have been run, and the report is not yet available. Table 2 indicates that the Snowy 2.0 model exhibits a few Class 1 attributes, but more Class 2 attributes, and a roughly equal number of Class 3 attributes. An overall Class 2 model confidence level has been achieved, confirming the Snowy 2.0 model as suitable for impact assessment scenario modelling.

Table 2 - Snowy 2.0 early works groundwater model (calibration) confidence level

Class	Data		Calibration		Prediction		Quantitative Indicators	
1 (simple)	~	Not much.	√	Transient not possible. S/state ok		Timeframe >> Calibration	?	Timeframe >10x
	~	Sparse coverage.		Large error statistic.		Long stress periods.	?	Stresses >5x
	√	No metered usage.	~	Inadequate data spread.	√	Poor/no validation.		Mass balance > 1% (or one-off 5%)
		Low resolution topo DEM.		Targets incompatible with model purpose.	~	Transient prediction but steady-state calibration.		Properties <> field values.
		Poor aquifer geometry.						No review by Hydro/Modeller.
2 (impact assessment)	~	Some.		Partial performance.	√	Timeframe > Calibration	?	Timeframe = 3-10x
		OK coverage.		Some long term trends wrong.		Long stress periods.	?	Stresses = 2-5x
		Some usage data/low volumes.	√	Short time record.		OK validation.		Mass balance < 1%
	~ ~	Baseflow estimates Some K & S measurements.	√	Weak seasonal match. Or no seasonal trends.	X √	Transient calib. & pred'n (or S/state cal/pred).		Some properties <> field values. Review by Hydrogeologist.
	√ ~	Some high res. topo DEM &/or some aquifer geometry.		No use of targets compatible with model purpose (heads & fluxes).	√	New stresses not in calibration.		Some coarse discretisation in key areas of grid or at key times.
3 (complex simulator)		Lots, with good coverage.	√	Good performance stats.		Timeframe ~ Calibration		Timeframe < 3x
		Good metered usage info.		Most long term trends matched.	√	Similar stress periods.		Stresses < 2x
	√	Local climate data (or SILO)		Most seasonal matches OK.		Good validation.	√	Mass balance < 0.5%
		Kh, Kv & Sy measurements from range of tests.	√	Present day data targets.	√ ~	Calib. & prediction consistent (transient or steady-state).	√	Properties ~ field measurements.
	√	High resolution DEM all areas.	√	Head & Flux targets used to constrain calibration.	~	Similar stresses to those in calibration. (climate)	√	No coarse discretisation in key areas (grid or time).
		Good aquifer geometry.					√	Review by experienced Modeller.
(after Table 2-1 of Barnett et al (2012) Australian Groundwater Modelling Guideline)								

3. Conclusion

This review finds that the Snowy 2.0 groundwater model is fit for the purpose of early works scenario modelling of drawdown effects due to tunnel construction and effects on catchment water balances.

Yours sincerely, Hydrogeologic Pty Ltd

Hugh

Hugh Middlemis (Principal Groundwater Engineer)

Declaration: For the record, the reviewer (Hugh Middlemis) is an engineer, hydrogeologist and independent modelling specialist with more than 37 years' experience. Hugh was principal author of the first Australian groundwater modelling guidelines (Middlemis et al, 2001) that formed the basis for the latest guidelines (Barnett et al. 2012) and was awarded a Churchill Fellowship in 2004 to benchmark groundwater modelling best practice. No potential conflict of interest is identified.

4. References

Barnett B, Townley L, Post V, Evans R, Hunt R, Peeters L, Richardson S, Werner A, Knapton A and Boronkay A. (2012). Australian Groundwater Modelling Guidelines. Waterlines report 82, National Water Commission, Canberra. http://webarchive.nla.gov.au/gov/20160615064846/http://archive.nwc.gov.au/library/waterlines/82.

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Middlemis H, Merrick N, Ross J, and Rozlapa K. (2001). Groundwater Flow Modelling Guideline. Prepared for Murray-Darling Basin Commission by Aquaterra, January 2001. URL: www.mdba.gov.au/sites/default/files/archived/mdbc-GW-reports/2175_GW_flow_modelling_guideline.pdf

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