Appendix 52 Baseline Surface and Groundwater Monitoring Report – Myara North and Holyoake

Baseline Surface and Groundwater Monitoring Report – Myara North and Holyoake

Pinjarra Alumina Refinery Revised Proposal

Alcoa of Australia Limited

14 January 2022

→ The Power of Commitment

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Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	1	MM, KH, AO	N Deeks		M Brook		14/2/22

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Abbreviations

Abbreviations	Definition
ADWG	Australian Drinking Water Guidelines
ANZG	Australia New Zealand Guidelines
BoM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CDFM	Cumulative Departure from Mean
DE	Development Envelope
DWER	Department of Water and Environmental Regulation
EC	Electrical Conductivity
EPA	Environmental Protection Authority Western Australia
EP Act	Environmental Protection Act 1986
EPBC Act	Environmental Protection and Biodiversity Conservation Act
GDE	Groundwater Dependent Ecosystem
km	Kilometres
LOR	Limit of reporting
MBAS	Methylene Blue Active Substances
mBGL	Metres Below Ground Level
µS/cm	Microsiemens Per Centimetre
mg/L	Milligrams Per Litre
ML	Megalitre
ML1SA	Mineral Lease 1SA
NATA	National Association of Testing Authorities
NTU	Nephelometric Turbidity Units
PAH	Polycyclic Aromatic Hydrocarbons
PFAS	Per- and Polyfluoroalkyl Substances
QA	Quality Assurance
QC	Quality Control
RPD	Relative Percentage Difference
SAQP	Sampling Analysis Quality Plan
TDS	Total Dissolved Solids
TRH	Total Recoverable Hydrocarbons
WIR	Water Information Reporting

1. Introduction

1.1 Proposal background

Alcoa of Australia Limited (Alcoa) is proposing to increase production at the Pinjarra Alumina Refinery (Refinery) by 5 per cent from 5.0 million tonnes per annum (Mtpa) to 5.25 Mtpa and transition the Huntly Bauxite mine to the proposed Myara North and Holyoake mine regions (the Proposal). The Proposal is located in the Peel region of Western Australia (WA), approximately 100 km south-east of Perth.

The Proposal will be subject to environmental impact assessment under Part IV of the WA *Environmental Protection Act 1986* (EP Act), and the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). The environmental impact assessment will be via a Public Environmental Review (PER).

Alcoa has engaged GHD to prepare the environmental approval documentation and supporting technical studies (the Project) for the Proposal under the EP Act and EPBC Act. The study area includes Myara North and Holyoake mine regions.

A desktop review of historical surface water and groundwater monitoring data was completed to provide a preliminary understanding of hydrological conditions within the Proposal area. A baseline monitoring program commenced in August 2020 to further characterise the baseline surface water and groundwater conditions within the Myara North and Holyoake regions.

1.2 Purpose of this report

This report serves to present a review of the historical surface water and groundwater monitoring data and the results and analysis of the baseline monitoring program. The report contains the following:

– Baseline monitoring program methodology
– Desktop assessment and summary of baseline monitoring program
– Baseline groundwater level data
– Baseline groundwater quality data
– Baseline surface water flow data
– Baseline surface water quality data

This report presents the results and analysis of the baseline monitoring program, including an overview of historical data for the Proposal mine regions of Myara North and Holyoake, referred together as the Mine Development Envelope (Mine DE).

The report is intended to be read in conjunction with the Hydrology and Water Quality Assessment report.

1.3 Scope and limitations

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2. Methodology

Baseline hydrological data relevant to the Mine DE comprise a combination of historical and published data collated as part of the desktop assessment, and project specific data collected as part of a baseline monitoring program of the Mine DE that commenced in August 2020.

2.1 Climate

Western Australia's south west region has a 'Mediterranean' type climate characterised by typically high winter rainfalls and an intense summer drought. A summary of the nearest Bureau of Meteorology (BoM) sites to the Mine DE is provided in Table 2-1. General climate data is drawn from the Karnet Station which is considered representative of both Myara North and Holyoake, while daily rainfall data is drawn from Jarrahdale or Dwellingup Stations where appropriate.

Table 2-1 Summary of nearest BoM climate stations

BoM Station	Station number	Distance from Mine DE	Data range
Serpentine Main Dam Station	009115	Within Myara North mine region	1963 to 2016 Rainfall
Jarrahdale	009023	Adjacent Myara North mine region	1907 to 2020 Rainfall
Karnet Station	009111	4 km south of Myara North mine region, 47 km north of Holyoake mine region	1963 to 2020 Rainfall, evaporation and solar radiation data
Dwellingup Station	009538	7 km from Holyoake mine region	1935 to 2020 Rainfall, evaporation and solar radiation data

2.2 Historical data sources

2.2.1 Groundwater levels and groundwater quality

Alcoa has been collating groundwater level and groundwater quality data within Mineral Lease 1SA (ML1SA) since the 1970's. Within the proposed Myara North and Holyoake mine regions this is the main source of available groundwater data, with public datasets not offering as complete a record for groundwater level and groundwater quality.

As further discussed and illustrated in Section 4, there is significantly more groundwater data available for Myara North mine region compared to Holyoake mine region. Within the Myara North mine region, historically available data tends to be concentrated within the eastern area of the mine region. Likewise for Holyoake mine region, where historical data is available, which is somewhat limited, this is also concentrated in the eastern area of the mine region. This tendency of monitoring bores in the eastern area is partly related to a focus of historical monitoring in areas east of the historic 1,100 mm isohyet. Whereas the overall time period of monitoring extends from the mid 1970's, data for specific locations tends to be limited, with monitoring bores often used for a specific project for a limited period of time. In general, groundwater level data is primarily recorded as manually dipped levels, with the monitoring frequencies ranging from weeks to months. Some locations only have spot depth measurements with no valid time series data available. Groundwater quality is predominately for field parameters with an emphasis on recording groundwater salinity. The groundwater quality records are less extensive than the groundwater level records.

2.2.2 Surface water level and flow

The Department of Water and Environmental Regulation (DWER) Water Information Reporting (WIR) database was reviewed to obtain surface water level and flow data relevant to the Myara North and Holyoake mine regions. The DWER WIR database identified that surface water level and flow were historically recorded at several gauging stations within, and in proximity to, the proposed mine regions. Details of the DWER WIR flow gauging stations are summarised in Table 2-2 for Myara North and Table 2-3 for Holyoake.

For the Myara North mine region there is one gauging station that is active and operated by DWER (Vardi Road, downstream of the mine region on Wungong Brook).

For the Holyoake mine region the Baden Powell gauging station located downstream of the mine region on the Murray River is active and operated by DWER, however this station is not representative of the Holyoake mine region with a largely agricultural upstream catchment, and is not considered further. Remaining gauging stations in proximity to Holyoake are inactive. The DWER WIR database identifies one additional gauging station for Holyoake mine region (South Dandalup River – Duncans Road Crossing) however this site has historical water level data for the period 1939 to 1941 only, and was not considered further in this assessment.

2.2.3 Surface water quality

Alcoa has been monitoring surface water quality data within ML1SA since the mid 1970's. Historical surface water quality data were also obtained from the DWER WIR database.

As with groundwater data there is significantly more surface water data available for the Myara North mine region and surrounds, compared to the Holyoake mine region.

Water quality data within the Myara North mine region predominantly comprises laboratory measurements of salinity (as total dissolved solids (TDS) and/or electrical conductivity (EC)), turbidity and pH), and within Holyoake mine region comprises EC, turbidity and pH.

Initial screening of historical surface water monitoring data was completed to remove sites with less than 5 data points. DWER salinity data was available as uncompensated EC, with the compensated EC data (at 25 ^{o}C) calculated using corresponding temperature data. Within the Holyoake mine region some sites reported turbidity values of <1 NTU, and for the purposes of this assessment these samples were assigned a value of 0.5 NTU to enable inclusion in the summary reporting.

Table 2-2 Gauging stations relevant to Myara North mine region

Site ID	Site name	Flow record	Catchment area	Coordinates	Status
Serpentine Catchment					
614035	River Road	1982 – 1998 2008 - 2019	243 km^2	428739 6409049	Inactive
614031	Jack Rocks	1981 – 1998 2006 - 2016	55 km^2	420689 6417649	Inactive
Wungong Brook Catchment					
616041	Wungong Brook – Vardi Rd	1981-2020	81 km^2	416390 6431738	Active
616124	Wungong Brook – Chandler Rd	2005-2013	18 km^2	418139 6426899	Inactive
616058	Wungong Brook – Cobiac Rd	1992-1997 2005-2016	4 km^2	424727 6423583	Inactive
Note: Alcoa have installed water level loggers at River Road and Jack Rocks in the Serpentine Catchment however data was not available at time of reporting					

Table 2-3 Gauging stations relevant to Holyoake mine region

Site ID	Site name	Flow record	Catchment area	Coordinates	Status
South Dandalup Tributary					
614043	Pindalup	1984-1998	7 km^2	427414 6377918	Inactive
614059	Skeleton Road	1988-1998	19 km^2	420539 6386749	Inactive
614060	Gordon Catchment	1988-2018	2 km^2	430139 6389249	Inactive
Murray River and Tributaries					
614045	Chadoora (Swamp Oak Tributary)	1984-1997	5 km^2	430119 6375398	Inactive
614047	Davis Brook – Murray Valley Plntn (Murray River Tributary)	1954-2002	66 km^2	415689 6375448	Inactive

2.3 Baseline monitoring program summary

A Baseline Hydrology Monitoring Program and Sampling Analysis and Quality Plan (SAQP) (GHD 2020a) was developed for the project. The SAQP documents the development of the baseline monitoring program; the sampling program; and analytical work for the collection and validation of field data, and should be read in conjunction with this report. The SAQP is supported by a Surface and Groundwater Installation Report (GHD 2020b).

The key aims of the program were to provide sufficient data on groundwater levels and quality, and surface water flows and quality to characterise the site-wide hydrological conditions. A summary of the monitoring program is provided in Appendix A and outlined in the sections below. The SAQP and Surface and Groundwater Installation Report are included as Appendix M and Appendix N, respectively.

2.3.1 Monitoring locations

Baseline monitoring locations were selected based on review of historical data and site characteristics:

– Groundwater monitoring locations were selected to provide spatial distribution across the Mine DE with new monitoring bores installed to infill gaps in the existing network where required.
– Surface water quality and logger installation locations were selected based on desktop review of historical monitoring data, proposed project activities at the time of monitoring program design, suitability for installation of monitoring equipment (where relevant), representative locations both upstream and downstream of the proposed mining operations.

An overview of the groundwater monitoring locations and surface water quality locations and logger installation locations is provided in Table 2-4. Tables and figures summarising the groundwater and surface water locations are provided in Appendix B.

Table 2-4 Groundwater and surface water monitoring locations

Mine DE	Groundwater monitoring*		Surface water monitoring	
	Existing bores	New bores	Surface water grab sample	Surface water logger^
Myara North	7 (25*)	18	20	6
Holyoake	4 (8*)	17	15	3
Note:	* Groundwater monitoring locations where groundwater quality samples were taken. Values in parentheses are total number of sites that groundwater levels were taken from			
	^ Surface water logger locations comprised water level logger, and turbidity and/or electrical conductivity logger			

2.3.2 Baseline groundwater monitoring program

As part of the Baseline Hydrology Monitoring Program a groundwater monitoring program was established to determine baseline groundwater conditions across the Mine Development Envelope. The following sections provide an overview of the groundwater monitoring program methods.

Hydraulic testing

Prior to the first groundwater monitoring round, slug test tests were undertaken on the monitoring bores. Slug tests provide indicative values for hydraulic conductivity. Because the test is influenced only by immediate surrounding of the test bore (and also the gravel-pack or other construction details) their value as indicator of aquifer permeability cannot be compared to data obtained from good quality pumping tests. In this context, the value of slug test data is used as a means of inter-site comparison and spatial variability in hydraulic conductivity.

Slug tests were completed using a rising head method whereby a ‘slug’ of water is quickly removed from the bore’s water column using a plastic one litre bailer, causing an initial drop in water levels and subsequent groundwater level recovery. During the tests groundwater levels were recorded using a data logger set to record levels every 1 second. A summary of the slug tests results is presented in Section 4.

2.3.2.1 Groundwater level

Groundwater levels were measured monthly in all new groundwater monitoring bores and selected existing bores between August 2020 to February 2021 (noting that Holyoake mine region bores were not completed and available for measuring until October 2020). Groundwater levels were measured using an electronic water level meter prior to collection of all groundwater samples during all groundwater monitoring events.

Groundwater level data loggers were installed at Myara North mine region monitoring bores B11S and B12D (shallow and deep bores). Continuous groundwater level data (hourly) was recorded between October 2020 and February 2021.

2.3.2.2 Groundwater quality

Groundwater field water quality parameters were recorded monthly in selected groundwater monitoring bores from August 2020 to February 2021. Field measurements were measured using a calibrated water quality meter.

Groundwater quality samples were collected for laboratory analysis during two groundwater monitoring events (GWME) completed in October 2020 and February 2021. The timing events was aligned to represent the seasonal periods of later winter annual groundwater level maximum, and the late summer groundwater level minimum.

Groundwater monitoring bores were purged prior to collection of groundwater samples to provide a representative sample *in-situ* groundwater. Purging of groundwater monitoring bores was based on AS/NZS 5667.11 – 1998 (Standards Australia 1998), with bores purged until stabilisation of field parameters. Groundwater samples were collected using low density polyethylene tubing coupled to an electric pumping system (high flow submersible pump) or using a bailer, with sampling method dependent on the bore type (i.e. diameter) and pump yield.

The groundwater field and laboratory program is summarised in Table 2-5 . The groundwater suite parameters were selected based on review existing activities within the Mine Development Envelope as well as activities that may occur under the Proposal, and identified potential contaminants of concern.

Table 2-5 Groundwater field and laboratory program

Suite	Field Parameters^	Laboratory parameters#
Groundwater suite	pH, EC, temperature	Physical parameters, major cations and anions, nutrients, dissolved metals (filtered metals), hydrocarbons, PFAS, explosives
Notes	^ Field parameters measured monthly	
	# Laboratory parameters measured in October 2020 and February 2021.	

2.3.3 Baseline surface water monitoring program

As part of the Baseline Hydrology Monitoring Program a surface water monitoring program was established in August 2020 to determine baseline surface water conditions across the Mine Development Envelope.

2.3.3.1 Surface water level and flow duration

Water level loggers were installed at five surface water locations within Myara North mine region and three surface water locations within Holyoake mine region to establish baseline surface water levels and flow duration for representative river reaches.

Surface water logger installation were delayed until mid to late September due to some equipment delays during 2020.

2.3.3.2 Surface water quality

Surface water grab samples were collected from selected surface water monitoring locations when flowing water was present during the monthly surface water monitoring events between August 2020 to January 2021.

The field and laboratory program included an extended field and laboratory parameter suite (SW extended suite) during the wetter months of August, September and October, with a shorter field and laboratory parameter suite collected during the drier months (SW short suite) as summarised in Table 2-6 and Appendix A. The SW extended

suite parameters were selected based on review existing activities within the Mine DE as well as activities that may occur under the Proposal, and identified potential contaminants of concern.

Field measurements for the SW extended suite were measured using a YSI Sonde multiparameter meter. During the SW short suite the field physico-chemical parameters did not include turbidity, with additional field samples collected for analysis immediately following sampling in the Alcoa laboratory.

Surface water quality monitoring data collected under the current baseline monitoring program were screened and interpreted in accordance with ANZG (2018).

Table 2-6 Surface water field and laboratory program

Suite	Timing	Field parameters	Laboratory parameters
Surface water extended suite	Wetter months (August, September, October 2020)	pH, EC, temperature, turbidity	Physical parameters, major cations and anions, nutrients, dissolved metals (filtered metals), microbiological, surfactants, hydrocarbons, PFAS, explosives
Surface water short suite	Drier months (November, December 2020, January 2021)	pH, EC, temperature	Physical parameters, major cations and anions

3. Quality assurance and quality control summary

3.1 Framework

3.1.1 Guidelines

The surface water and ground water sampling was undertaken with reference to the following guidelines:

– Australian Standard 5667 (1998 – reconfirmed 2016) Water quality – Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.
– ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.

3.1.2 Assessment criteria

The following assessment criteria were adopted for the baseline assessment:

– Australian Drinking Water Guidelines (ADWG) (NHMRC 2011, Version 3.5)
– PFAS National Environmental Management Plan Version 2.0 (HEPA, 2020)
– Ecological freshwater guidelines at 95% and 99% level of protection (ANZG 2018)
– Upland freshwater criteria for SW Australia (ANZECC 2000).

3.2 Field QA/QC

Field Quality Assurance and Quality Control (QA/QC) procedures and compliance during the investigation are summarised in Table 3-1 with exceptions detailed in the following subsections.

Table 3-1 Summary of field QA/QC compliance

QA/ QC element	Requirement	Adhered to?	Acceptable?
Record keeping	Detailed records of field activities maintained (e.g. standardised field sheets, etc.).	Yes	Yes
Chain of Custody documentation	Completed	Yes	
Equipment calibration	Equipment appropriately calibrated.	Yes. Calibration certificates provided in Appendix C	
Sample labelling	Samples properly labelled (sample ID, date and sample type, preservation techniques, etc.).	Yes	
Sample vessels	Samples collected in appropriate containers with appropriate preservation used.	Yes	
Sample storage and transport	Samples stored in a chilled container immediately after sampling and during transport to the laboratory under chain of custody documentation.	Yes	
Duplicate and split samples	Duplicate samples collected for analysis at a rate of one duplicate sample per 20 primary samples.	Yes 15 duplicate samples 10 rinsate samples	

QA/ QC element	Requirement	Adhered to?	Acceptable?
	Relative percent differences (RPD) between 0-30%.	Yes, with exceptions (see Appendix C)	

3.3 Laboratory QA/QC

Laboratory QA/ QC procedures and compliance during the investigation are summarised in Table 3-2. Analytical methods for all analyses performed are detailed in laboratory analytical certificates provided in Appendix C.

Table 3-2 Summary of laboratory QA/QC compliance

QA/ QC element	Requirement	Adhered to?	Acceptable?
National Association of Testing Authorities (NATA) accreditation	Analysis performed under NATA accreditation.	Yes	Yes
Analytical methodologies	To be relevant with regards to Schedule B(3) of the ASC NEPM.	Yes	
Laboratory limits of reporting (LOR)	Laboratory LORs to be below adopted assessment criteria.	Yes, with exceptions for some dissolved metals[1]	
Sample analysis and extraction holding times	Comply with holding times	Yes, with exceptions (see section 2.4.2)	
Acceptable laboratory QC results/ procedures	Laboratory duplicate sample analysis at the rate of one per ten samples.	Yes	
	Method blanks at the rate of one per 20 samples.	Yes	
	Laboratory control spike recovery analysis at the rate of one per 20 samples.	Yes	
	Matrix spike recovery analysis at the rate of one per 20 samples.	Yes	

3.3.1 General laboratory QA/QC

The following summarises general laboratory QA/QC results, with further detail including summary tables provided in Appendix C:

– Laboratory Control: No laboratory control outliers occur.

– Relative Percentage Difference (RPD): The RPD is a measure of the representativeness of duplicate samples, and may be used to identify issues with laboratory analysis or field sampling methods. The acceptable range of RPDs is between 0-50%. RPD exceedances for surface water samples and groundwater samples are summarised in Appendix C. Calculated RPD exceedances outside this range correspond with microbial parameters and turbidity for Myara North mine region, and low concentrations of total nitrogen parameters in Holyoake mine region surface water samples. In groundwater samples at both sites RPD exceedances typically correspond with organics and low concentrations of analytes. As a conservative measure, for the RPD exceedances the higher value between the primary and duplicate sample has been utilised in the assessment of results.

– Laboratory Limits of Reporting (LOR): No LOR values were noted to be above the adopted assessment criteria.

– Laboratory holding times: Holding times were breached consistently for some parameters due to travel time from Site to the laboratory for analysis (pH and methylene blue active substances (MBAS) surfactants). pH was measured in-situ during sample collection, with similar results giving confidence in laboratory results.

[1] ANZG 99% freshwater species protection criteria lower than the LOR for arsenic, boron cadmium, chromium, mercury, nickel, selenium, zinc.

MBAS was not detected in any surface water samples, which is considered consistent with the Site setting in State forest. Other breaches occurred due to delayed extraction outside of the holding time. The holding time breaches were considered when interpreting results. Holding time exceedances are summarised in Appendix C.

– Matrix spikes were carried out to test the potential for contamination of a sample (or samples) during sample collection. Matrix spike recovery was not determined for several analytes during the surface water and ground water sampling events. This is due to the sampled environment and is outside of GHD's and laboratory's control. The matrix spike outliers are outlined in Appendix C.

3.4 Assessment of data quality

A review of field and laboratory QA/QC data and procedures confirms an acceptable level of compliance with the general project requirements. While there are minor variations and anomalies the analytical results are considered of an acceptable quality for interpretive use, and considered suitable for the purposes of the baseline assessment.

4. Myara North monitoring results

4.1 Baseline monitoring program groundwater results

4.1.1 Hydraulic testing

The Aqtesolve outputs, showing the groundwater level recovery data for each monitoring bore, and the resulting calculated hydraulic conductivity are presented in Appendix F. All results were assessed using the Bouwer-Rice (1976) model for a slug test. The results are summarised in Figure 4-1. The following observations are made:

– Broadly, the slug test results showed a relatively close range of hydraulic conductivity values ranging from around 0.2 to 1 m/d (excluding outliers). This is consistent with values for a clayey sand/fine grained sand.
– The highest hydraulic conductivities align with those bores that had the greatest air lift yields. Bores such as B11, B12 and B17 are all screened in the basement saprock units where gravel rich basal saprock was present. Those sites with lower hydraulic conductivities align with screened units with less courser gravels and more clay dominant. There is no discernible spatial relationship between the bore's location and its hydraulic conductivity.

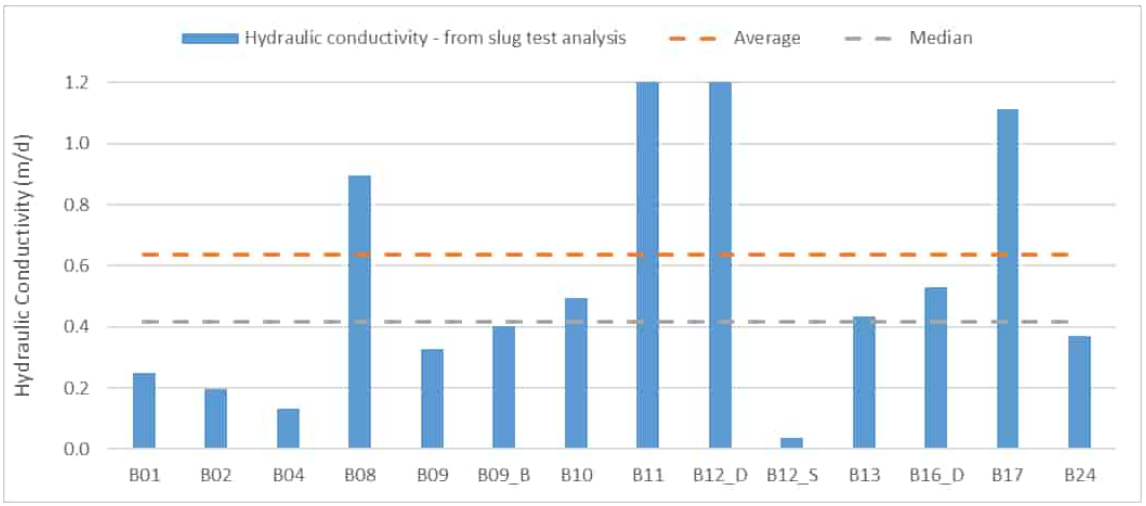

Figure 4-1 Myara North slug test results (hydraulic conductivity)

4.1.2 Groundwater levels – Long term monitoring

As noted in Section 2.2.1, groundwater levels have been recorded in the Myara North region for some monitoring bores since the 1970's. A spatially representative selection of historical monitoring bores were identified (i.e. they could be found in the field and were still useable) for existing monitoring. The location of these monitoring bores is shown on Figure B-7-1.

The distribution of long term monitoring bores has historically been focused on specific Alcoa project areas. These had a tendency to be in the east of the Myara North area. As such, the following observations generally apply to the eastern areas only. Groundwater level hydrographs for these bores are presented in Appendix J. The hydrographs include Rainfall data presented as 'Cumulative Departure from the Mean' (CDFM). This allows comparison of groundwater levels to changes in rainfall. The following provides a summary of the key observations from the Myara hydrographs:

– The bores presented for Myara North in Appendix J have sufficient frequency of historical monitoring data to assess seasonal variation. This shows that the majority of bores show a typical strong seasonal variation, with groundwater levels typically varying by 1 to 5 metres over an annual cycle.
– Monitoring bores that have a relatively greater depth to groundwater (i.e. more than 10 m) have a tendency to have a less significant seasonal variation.

– The majority of the bores show a significant reduction in groundwater levels over their monitoring period. Most of the bores presented have monitoring data over a period from the early 1990's. As shown on the graphs, this represents a period of relatively high rainfall, with rainfall then decreasing from this point forward. The reduction in rainfall is well mirrored by the trends in decreasing groundwater levels. This has resulted in levels recorded in 2020-2021 being up to 10 m lower than levels in the early 1990's.
– All bores with time series in the 1990's and the most recent monitoring have observed groundwater level declines. There does not appear to be a particular spatial relationship to the ranges of groundwater level decline, however the largest groundwater level declines are generally noted in bores where the 1990's depth to groundwater is 10 m or more. This is illustrated by the data presented in Figure 4-2 which plots the depths to groundwater in 2020 against the decline in groundwater levels over the period 1990 to 2020. The data shows that the greatest levels of groundwater decline are found in bores with the greatest depth to groundwater.
– Specific examples highlighting the groundwater level decline include the following (refer to the hydrographs in Appendix J for illustrations of these trends):
    - MK40191A recorded monthly to bi-monthly data between 1991 and 2009, showing a seasonal range of around 2 m and a general decline in levels from 0-2 metres in in the mid 1990's, to 2-6 mBGL in the early 2000's and then measuring around 8 mBGL during the monitoring completed for this program (2020-2021).
    - There is less data for MK40182A with comparison to MK40191A, but the data also shows levels reducing consistently from less than 5 mBGL in the late 1990's to over 15 mBGL for the last 6 round of monitoring in 2020-2021
– Bores MK37171A, MK40182A, MK40191A and MK40261A have limited data from the late 1970's. This coincides with a period of increasing rainfall (as demonstrated by the CDFM plots), and a rise in groundwater levels is generally seen to coincide with this increase in rainfall. All four of these sites recorded groundwater peaks in the late 1980's/early 1990's that have since reduced by several metres.

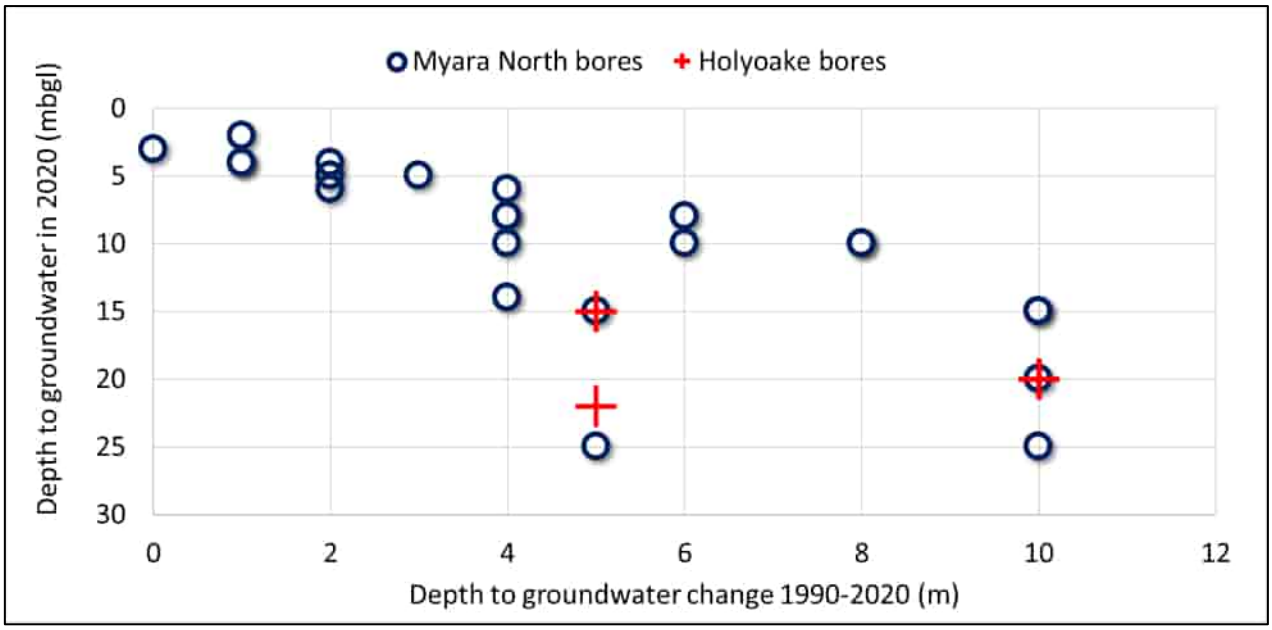

Figure 4-2 Groundwater level change and bore depth

4.1.3 Groundwater levels – New monitoring sites

New groundwater monitoring bores were installed at 16 locations, as detailed in the installation report (GHD, 2020b). The location of the monitoring bores (Figure B-7-1) was selected to provide site wide coverage of groundwater conditions, and as the eastern project area already had a significant groundwater monitoring network, the distribution of the new monitoring bores was generally more focused on the central and western areas of the Myara North project.

As noted in Section 2, groundwater levels for the new monitoring bores were recorded on a nominal monthly frequency between October 2020 and February 2021. Hydrographs for this monitoring period are presented as Appendix K, which also includes the field TDS data.

The groundwater level data for the new monitoring bores indicates the following:

– Groundwater is generally shallow (<10 mBGL) at the majority of monitoring sites. The only sites where groundwater is measured at depths of more than 10 m is in the far south (B02, B03 and B04), and B10 in the far east.
– Groundwater levels are generally seen to reduce over the monitoring period (September 2020 to February 2021), consistent with a seasonal change from late winter groundwater highs to summer groundwater lows. The reduction in groundwater levels resulted in the drying out of five of the monitoring bores. Of these, two (B12S and B16S) are shallow screened bores. These bores were installed to represent the perched or upper groundwater unit. At these locations the adjacent deep bore also records a reducing groundwater level but did not dry out. Bores B01, B09, B18 also dry out during the summer monitoring, however these bores are installed just about the basement rock, indicating the absence of a saturated profile in these areas during summer periods.
– The average seasonal groundwater level decline for all new bores is 1.9 m, with over 3.5 m range recorded in four bores (B12D, B13, B18 and B24). The least seasonal variation is seen in bores B02, B03 and B04 which are also the three bores with the deepest depth to groundwater.

4.1.4 Groundwater levels – Continuous data

Groundwater level data loggers installed at monitoring bores B11S and B12D (shallow and deep bores) highlight the reduction in groundwater levels between the end of the winter 2020 and the summer 2021 (see Figure 4-3). For the deep bore, screened from 18.5 m to 24.5 m below ground level, groundwater levels are seen to reduce by 3.5 m over the four months of monitoring. The groundwater level in the shallow bore (screened between 0.5 to 3.5 m below ground level) also recedes at the same rate as the deep bore. This results in the bore being recorded as dry from late December onwards i.e. groundwater levels have reduced below the base of the bore screen depths.

The logger data also indicates a slightly confined deeper aquifer with groundwater elevations being marginally higher in the deep bore with comparison to the shallow bore. Both bores show a similar response to rainfall events, with levels seen to rise by up to around 0.4 m after rainfall events of 20+ mm.

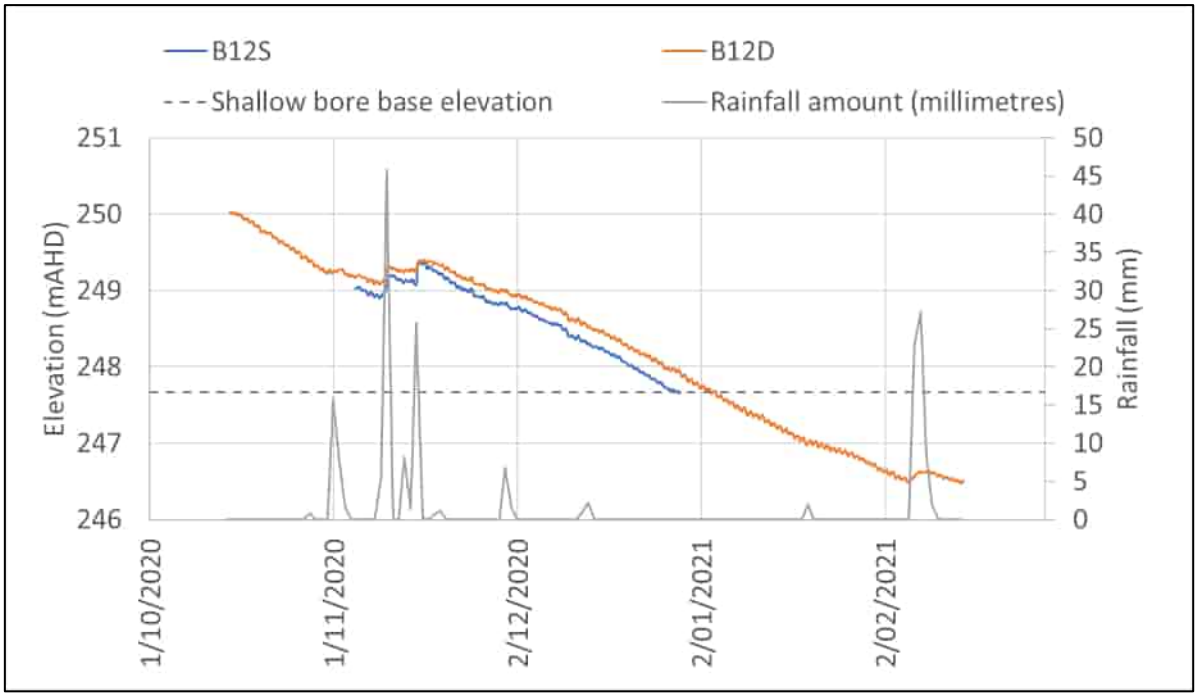

Figure 4-3 B12 groundwater levels (logger data) and rainfall

4.1.5 Groundwater quality - long term monitoring data

Groundwater quality, specifically salinity, is available for most of the historical bores that were monitored in 2020-2021. Review of this data allows some limited assessment of long term groundwater quality changes. The field salinity (as TDS) is presented on the hydrographs presented in Appendix J. The following observations are made from the historical range of salinity data:

– Long term salinity data is available for 17 of the bores within Myara North (i.e. data available from the 1990's and from recent data). As noted in previous sections, these bores are concentrated in the east of the project area. There is a relatively large range in salinities measured in the 1990's with TDS data in the range of 100 to 2000 mg/L (average of 450 mg/L). Within the limited spatial extent of the data, there does not appear to be a relationship between bore salinity and location with salinity ranges within each catchment being as variable as those between catchments.
– Where there is sufficient data to determine salinity trends between the historical data and contemporary data, the majority (10 out of 17) of bores show a generally stable salinity. Three bores show a defined increase in salinity, whereas four bores show a decrease in salinity albeit with more erratic and/or poor record of data.

4.1.6 Groundwater quality – 2020-2021 sampling data – field data

As detailed in Section 2, groundwater quality field data was collected at existing historical bores, and at the new monitoring bore sites on up to five sampling rounds between September 2020 and February 2021. Of these sampling events, two included more comprehensive monitoring rounds when a full groundwater laboratory suite was analysed. Data for field salinity (as TDS) is included on the hydrographs presented for the new bores in Appendix K. The following observations are made from the new bores field water quality data:

– Groundwater is consistently fresh (< 500 mg/L TDS) for the majority of bores and for the majority of sampling rounds. The average of the maximum salinity per bore is 420 mg/L, compared the average of the minimum salinity per bore of 260 mg/L. Bore B02 is an outlier for salinity, with a TDS of 1500 and 2000 mg/L.
– The graphed data does show some general variation for bore salinity over the monitoring period, however it should be noted that salinity for the October and February sampling rounds were taken after full purging of bore water, whereas the other sampling records only included limited bore purging.
– Groundwater pH in Myara North is relatively uniform, with an overall field average of 5.3. Recent data for the historical bore subset is consistent with an average pH variation for each bore of less than 0.5. For the new bores the variance is more pronounced, with an average range of 2 pH units. This larger range is possibly related to the influence of bore construction materials (alkaline grouts and cements) and the subsequent stabilisation of groundwater conditions.

4.1.7 Groundwater laboratory results

Groundwater quality analytical results for Myara North are presented in tabular format Appendix L. The tabulated data is presented for the two sampling rounds undertaken in October 2020 and February 2021. As summarised in Section 2, the sampling rounds included all of the new monitoring bores ("B" prefix) and a selection of existing Alcoa (historical) monitoring bores. The laboratory results are compared to various assessment criteria. The assessment criteria include Australian Drinking Water Guidelines (NHMRC, 2011) including PFAS for drinking water and recreational water and ANZG Freshwater species protection guidelines (ANZG, 2018).

The following observations are made for the two rounds of baseline groundwater data:

– Physical and major ion parameters
    - Laboratory results for pH and salinity/EC are in-line with the field data that has been discussed in the sections above. Groundwater pH is generally uniform with no discernible change between sampling rounds, with an average pH of 6.0. Groundwater EC is generally uniform within and between bores and less than 1000 µS/cm.
    - Two sites are significantly elevated with B02 having an EC of 2700-2900 µS/cm and J4012-1A having an EC of 3900 µS/cm (single value only, dry on follow up sampling round). Of note is that B01, within the same catchment as B02 does not show elevated EC/salinity data. J4012-1A is the only active monitoring bore within its catchment.

- The consistent EC and pH is reflected in the alkalinity and major ions, with sites B02 and J4012-1A being the outliers.

– Metals
  - Metal concentrations were below the LOR for all samples for arsenic, beryllium, mercury, selenium and vanadium.
  - Where metal concentrations were detected, they were generally above the ANZG 99% freshwater species protection assessment criteria. This includes metals boron, cadmium, chromium, copper, manganese, nickel and zinc. However, the freshwater assessment criteria is generally at concentrations below the LOR, and given the context only appropriate for a comparative assessment of groundwater conditions.
  - The drinking water assessment criteria for metals was exceeded at two monitoring bores. At B02, Manganese was detected between 1.0 mg/L and 1.3 mg/L, exceeding the 0.5 mg/L criteria. The single sample taken at K4106-1A (dry on subsequent monitoring round) recorded a lead concentration of 0.041 mg/L, exceeding the 0.01 mg/L criteria.
  - In general, the variable metal concentrations are typical of 'natural' conditions and representative of the geological setting.
  - The marginally elevated metal conditions seen at B02 is consistent with other parameters and possibly relates the concentration of metals in this more saline groundwater.
– Nutrients
  - Nutrient concentrations are low and consistent with the land-use type (i.e. lack of applied nutrients or sources). Where assessment criteria are available, all parameters are significantly below the criteria (i.e. an order of magnitude or more).
– PFAS –
  - PFAS compounds were below the laboratory limits of reporting (LOR) in all but four locations. In the October 2020 monitoring round PFAS was detected in B12_S (but not B12_D), K4106-1A and K4009-3A. In the February 2021 monitoring round, detections were only observed in K4009-3A and in K4104-1A (no detect in October).
  - All detections were significantly below the drinking water assessment criteria. The maximum Perfluorooctanoic acid (PFOA) concentration was 0.001 µg/L, compared to the assessment criteria of 0.56, and the maximum Sum of PFHxS and PFOS concentration detection was 0.0006 µg/L, compared to the assessment criteria of 0.07 µg/L.
– Hydrocarbons:
  - All samples analysed for BTEX compounds returned results less than LOR.
  - All samples analysed for pesticide returned results less than the LOR.
  - With the exception of two samples, all explosive analytes were below the LOR. Very low concentrations of PETN were detected (9 µg/L) in the first round at B07, with the follow up round recording levels less than LOR. Low levels (8 µg/L) were also detected in K4011-1A, but only one sampling round was completed on this bore (dry in the follow up round).
  - TRH was detected at low concentrations in B07, B09, B09B, B17, J3803-4A, K4011-1A, K4106-1A. The low levels, and detection in historical monitoring bores suggests possible low levels of cross contamination from sampling sources.
  - PAH was below LOR in all samples with six minor exceptions. Five of these were significantly below the PAH total ADWG Health criteria of 0.01 µg/L. The sixth sample, from B09_B in the October sampling round measured a concentration of 0.01 µg/L (i.e. at the assessment criteria value). The concentration in the subsequent monitoring round (February 2021) was 0.008 µg/L (i.e. below the assessment criteria value). The presence of very low levels of PAH, and their more numerous detections in the first round of monitoring possibly suggests they are related to the drilling activities, or alternatively could be related to sources from bush fires.

4.2 Baseline monitoring program surface water results

4.2.1 Surface water flows – Long term monitoring

The flow gauging stations with historical data relevant to Myara North are summarised in Table 2-2, with large areas of the Myara North mine region with no flow gauging data.

Appendix G presents annual flows and trends in monthly streamflow data over the period of record for these sites. Annual and monthly streamflow data are presented to account for observed step changes in streamflow (post 1975 and post 2000).

Flow seasonality at the River Road and Jack Rocks gauging stations of the Serpentine Catchment demonstrates flow is typically observed between June and November. Within the Wungong Brook catchment the smaller catchments in proximity to the Myara North area (Chandler Road and Cobiac Road – flow seasonality not shown) typically have flows between July and November, with the larger Vardi Road catchment downstream of the Myara North area typically experiencing a slightly longer flow period.

Baseflow is the portion of streamflow that is sustained between precipitation events but also forms part of the flow during rainfall events. Interflow represents lateral movement of water in the unsaturated zone. It is usually considered a component of baseflow, depending on the response time – and in this case in position with respect to the stream.

For the Serpentine catchment, Bari et al. (2010) used a model to estimate that interflow is the largest contributor to streamflow followed by groundwater connected baseflow and surface runoff. This is supported by Kitsios, et al. (2009), who also used a model to estimate that under the current climate, interflow represents 75% of the total Serpentine streamflow, before transmission and evaporation losses.

Barlow et al. (2014) describes a number of baseflow separation methods, including:

– The HYSEP-Slide method – this method uses a sliding interval of 5-days to draw connecting lines between low points of the streamflow hydrograph.
– The PART method – this method equates baseflow to streamflow on days that are designated as being unaffected by surface runoff or interflow (stormflow), and linearly interpolates between these days to determine baseflow for the remainder of the hydrograph.
– The digital filter method which partitions the streamflow data into 2-day intervals to identify and compared adjacent minimums to determine “turning points”. If 90% of a given minimum (the “turning point test factor”) is less than both adjacent minimums, then that minimum is a turning point.

Data analysis by GHD using methods described by Barlow et al. (2014) for the gauging stations located in the Myara North DE and study area indicates that baseflow represents between 45% and 67% of streamflow, depending on location and baseflow separation methodology (Appendix G). The baseflow analysis was undertaken for the full streamflow record, varying between sites, between 1982 and 2018.

For the O’Neil Road station (Big Brook, located to south of Myara North DE), representing the largest catchment of the Serpentine River and longest record, the baseflow proportion of runoff has a weak downward trend (Appendix G). This contrasts to the prediction by Kitsios, et al., (2009) that future climate change will significantly reduce the volume of baseflow but not the baseflow proportion.

4.2.2 Surface water flows – Baseline monitoring

The flow conditions at surface water sampling locations (Figure B-7-1) were recorded during monthly surface water sampling events. The observed surface water flow conditions across the Myara North area are summarised in Table 4-1.

Surface water level loggers were installed in mid to late September at selected Myara North surface water monitoring locations. A summary of surface water logger data is provided in

Table 4-2, with logged surface water levels presented in Figure 4-4.

The key trends in the surface water flow data include:

– The observed surface water flows varied across the Myara North area with site BF04 (minor tributary into upper Serpentine River) observed to be dry during all sampling events, while site SW05 (minor tributary into Pipehead Dam) with flow observed during all sampling events.
– The summary of observed surface water flow conditions during surface water monitoring events aligns with the observed flow duration at sites with water level loggers installed. Flowing water was present a in August preceding logger installation (site 6141125, downstream end of Goldmine Gully). Some logger installation sites that were dry in August prior to logger installation had upstream locations with flowing surface water, including 6141121 at downstream end of Banksia Gully (upstream site SN01 had flowing water present) and SW03 at downstream end of 39 Mile Brook (upstream sites TN14 and TN34 had flowing water present).
– Surface water was present at site SW05 (minor tributary to Serpentine Pipehead Dam) on all monitoring occasions between August 2020 and January 2021. Upwelling of water observed during the January 2021 sampling event inferred the presence of a local groundwater source.
– Varying water level response between Myara North sites following installation in mid to late September. Flows in the minor unnamed tributary (SW04) are rapid and flashy. Flows at other locations are more sustained with a general decline towards cease to flow ranging from early October in Banksia Gully (6141121) and late October in 39 Mile Brook (SW03).

Table 4-1 Myara North summary of surface water sampling event flow conditions

Site	August 2020	September 2020	October 2020	November 2020	December 2020	January 2021
Wungong Brook						
WG54	Dry	Flowing	Dry	Dry	Dry	Dry
WG42	Dry	Flowing	Flowing	Dry	Dry	Dry
Gooralong Brook						
GG03	Dry	Flowing	Not flowing	Dry	Dry	Dry
SW06+	Flowing	Flowing	Flowing	Flowing	Flowing	Dry
Pipehead Dam – minor tributary						
SW05	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing^
Serpentine Reservoir – minor tributary						
SW04	Dry	Flowing	Dry	Dry	Dry	Dry
39 Mile Brook						
TN34	Flowing	Flowing	Flowing	Dry	Dry	Dry
TN01	Dry	Flowing	Dry	Dry	Dry	Dry
TN14	Flowing	Flowing	Flowing	Flowing	Flowing	Dry
SW03	Dry	Flowing	Not flowing	Not flowing[#]	Dry	Dry
Banksia Gully						
SN01	Flowing	Flowing	Flowing	Dry	Dry	Dry
6141121	Dry	Flowing	Dry	Dry	Dry	Dry
Goldmine Gully						
SN02	Flowing	Flowing	Flowing	Not flowing[#]	Dry	Dry
6141125	Flowing	Flowing	Flowing	Dry	Dry	Dry
Serpentine River – eastern tributaries						
SW02	Flowing	Flowing	Flowing	Dry	Dry	Dry

Site	August 2020	September 2020	October 2020	November 2020	December 2020	January 2021
SN04	Dry	Flowing	Flowing	Flowing	Dry	Dry
SW01	Flowing	Flowing	Dry	Dry	Dry	Dry
BF04	Dry	Dry	Dry	Dry	Dry	Dry
SW07	Flowing	Flowing	Dry	Dry	Dry	Dry
Serpentine River						
SW08	N/A	Flowing	Flowing	Dry	Dry	Dry
Notes:	**Bold** sites indicate monitoring locations with logger installations					
	^ Upwelling water observed at the sampling site indicating a local groundwater source that was previously unobserved					
	# Indicates sites sampled when no flow was observed and sample was taken from a large pool extending upstream					
	+ Site within catchment of controlled burn commenced in late September 2020					

Table 4-2 Myara North surface water logger data summary

Site	Sub-catchment	Installation date	Cease to flow
GG03	Gooralong Brook	17/09/2020	13/10/2020
SW04	Unnamed minor tributary of Serpentine Main Dam	19/09/2020	23/09/2020
SW03	39 Mile Brook	17/09/2020	30/10/2020
6141121	Banksia Gully	21/09/2020	01/10/2020
6141125	Goldmine Gully	22/09/2020	21/10/2020
SW08	Serpentine River	22/09/2020	23/10/2020

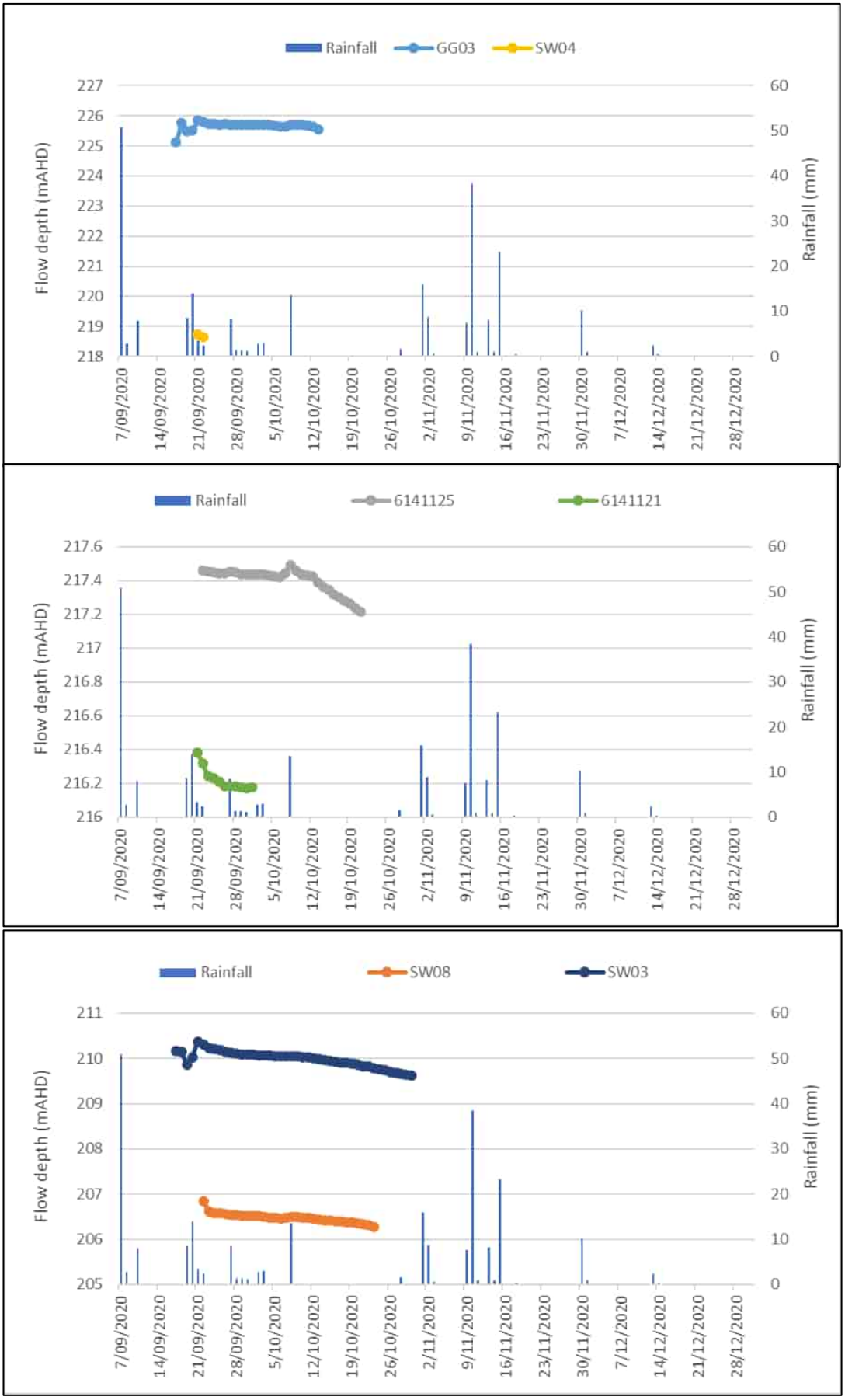

Figure 4-4 Myara North logged water levels (from date of installation)

4.2.3 Surface water quality – Long term monitoring

Historical surface water quality monitoring data from Alcoa and DWER were reviewed with summary statistics of key parameters provided in Appendix H. Historical data indicate the following key trends:

– pH data indicates a neutral to moderately acidic pH range.
– Surface water salinity is fresh (0-500 mg/L TDS) in the surface water tributaries west of the historic 1100 mm isohyet. Tributaries east of the 1100 mm isohyet are also typically fresh, however maximum TDS exceeds 500 mg/L.
– EC values identify a similar trend to TDS, with comparable median values across the Myara North area, however an increase in maximum EC values recorded for tributaries east of the 1100 mm isohyet.
– Turbidity data for the Myara North area indicate that median turbidity is typically below 1 NTU, with occasional values exceeding 25 NTU at some locations on Gooralong Brook, 39 Mile Brook and Banksia Gully.

4.2.4 Surface water quality

4.2.4.1 Surface water sampling events

Surface water sampling events were completed monthly between August 2020 and January 2021. Table 2-6 summarises the field and laboratory parameters across sampling events.

4.2.4.2 Surface water field physico-chemical parameters

The physico-chemical parameters measured for surface water are summarised as follows:

– pH: Moderately acidic conditions across all sites ranging from 4.4 (SW06, November 2020) and 6.78 (TN34, October 2020)
– EC: Typically ranged between 174 µS/cm (SW04, September 2020) and 587 µS/cm (SN02, October 2020) indicating fresh water. Outlier of 41 µS/cm (TN14) and 2790 µS/cm (SN02) were recorded during the November 2020 sampling event, with the sample from SN02 noted to have been collected from a standing pool.
– Turbidity: Relatively clear conditions across all sites ranging from -31 NTU (SW02, October 2020) and 10 NTU (SN01, October 2020). Maximum of 43 NTU recorded at site SW03 in October 2020.

4.2.4.3 Surface water laboratory results

A summary of the surface water laboratory results is provided in Appendix M. Key observations from the laboratory results from the baseline sampling program include:

– Physicochemical parameters (all sampling events):
  - pH: Moderately acidic to neutral conditions across all sites ranging from 5.99 (TN14, August 2020, and 7.09 (SN04 November 2020).
  - EC: Typically ranged between 162 µS/cm (SN04, September 2020) and 641 µS/cm (SN02, October 2020) indicating fresh water. An outlier of 2,800 µS/cm was measured from site SN02 in November 2020 with the sample collected from a standing pool which may indicate evapo-concentration.
  - Turbidity: Relatively clear conditions across all sites ranging from 0.2 NTU (multiple occurrences) to 5.5 NTU (SN02, November 2020). The observed results are within the observed range of historical turbidity monitoring across the Myara North area (Appendix I).
  - Total suspended solids: <5 mg/L across sites for all surface water monitoring events, with the exception of reported values of 6 mg/L (WG54, September 2020) and 8 mg/L (SW05, October 2020).

- Water hardness: Water hardness was consistently within the soft range (0-60 mg CaCO3, ANZG 2018). Marginally higher hardness was reported at site SN02 in October 2020 (76 mg/L CaCO3)2 and November 2020 (363 mg/L CaCO3)3.

– Metals (extended suite sampling events):
  - Metal concentrations were below the LOR for all samples for arsenic, beryllium, boron, cadmium, chromium, mercury, selenium, vanadium.
  - Where metal concentrations were detected, they were below drinking water guidelines.
  - The ANZG 99% freshwater species protection criteria for zinc was exceeded on two occasions at TN14 (August and October 2020). No other exceedances of the ANZG 95% or 99% freshwater species protection criteria were reported.
  - In general, the surface water metal concentrations are typical of 'natural' conditions and representative of the geological setting.
– Nutrients (extended suite sampling events):
  - Nutrient concentrations are typically low and consistent with national park land use (i.e. lack of applied nutrients or sources). At the majority of sample sites nutrient concentrations reported less than the LOR or below available criteria. All samples for nitrite-N and filterable reactive phosphorus returned results less than LOR.
  - Elevated nitrogen parameters (total oxidised nitrogen and total nitrogen) were detected at site GG03, which is the downstream extent of the Gooralong Brook at the MDE boundary. Gooralong Brook has some small landholdings within the upstream catchment.
  - One sample from site TN34 reported a total phosphorus concentration that marginally exceeded the ANZECC upland rivers default trigger value.
– Microbiological (extended suite sampling events):
  - Microbiological parameters enterococci and E. coli were detected at all sampling sites. Widespread detection of microbiological parameters is consistent with the presence of fauna species within the land use setting.
  - E. coli concentrations ranged from < 1 orgs/100mL to 97 orgs/100mL (site SN02, September).
  - Enterococci concentrations ranged from < 1 orgs/100mL to 51 orgs/100mL (site TN01, September).
– Other potential contaminants of concern (extended suite sampling events):
  - All samples analysed for surfactants returned results less than LOR.
  - All samples analysed for BTEX compounds returned results less than LOR.
  - All samples analysed for total recoverable hydrocarbons compounds returned results less than LOR.
  - All samples analysed for explosives returned results less than LOR.
  - PFAS compounds were below the laboratory limits of reporting (LOR) in all but four locations. In the August 2020 monitoring round PFAS was detected at 6141125 and TN34. In the September 2020 monitoring round PFAS was detected at WG42, 6141125 and SW08. All detections were significantly below the drinking water assessment criteria.
  - Samples analysed for pesticides were below the LOR in all but one location. Dieldrin was detected at SW01 (August 2020) with the sample concentration significantly lower than the drinking water assessment criteria.
  - Samples analysed for PAHs were below the LOR in all but one location. At SW06 (October 2020) the Sum of PAHs exceeded the drinking water guideline of 0.01 µg/L with a concentration of 0.039 µg/L comprising predominantly naphthalene. This site was in the catchment of a controlled burn in late September 2020, with the PAH detection possibly related to residual ash, with field notes from October 2020 sampling event note '*surrounding forest still smoking, smell of recent fire'*. Wildfire is a natural

[2] The moderate range hardness factor was applied for the purpose of calculating filtered metals hardness modified trigger values for SN02 samples for October monitoring round.
[3] Sample taken from standing pool, laboratory sample for SW short suite.

source of PAHs, with studies noting that burned soil and wildfire ash report concentrations of PAHs, particularly naphthalene[4].

4.2.4.4 Surface water logger quality data

Electrical conductivity logger data

EC loggers were installed in the lower reaches of two eastern tributaries, Banksia Gully and Goldmine Gully. The logger record at Banksia Gully (site 6141121) was limited to four days due to rapid decline in water levels at this site below the logger installation height. EC during the limited logger record was stable with an average EC of 167.1 µS/cm.

The logger record for Goldmine Gully (site 6141125) was four weeks with the logged EC steadily rising during this period, ranging between 236.2 and 377.6 µS/cm.

Turbidity logger data

Turbidity loggers were installed at two tributary inflows to the Serpentine Dam (lower reach of 39 Mile Brook (site SW03) representing a large tributary, and the lower reach of a minor unnamed tributary (site SW04)), on the Goolagong Brook just downstream of the Mine Development Envelope boundary (site GG03) and on the main branch of the Serpentine River downstream of the proposed conveyor crossing location (site SW08). The data from the minor unnamed tributary (site SW04) is not presented as data do not correspond with limited flashy flow data for this location and may represent errors due to dry site conditions.

At the remaining sites logged turbidity data is available for a week, with the median turbidity at these sites ranging between 0.4 NTU (GG03) and 1.9 NTU (SW03). Pulses of elevated turbidity were recorded at all sites (ranging from 86 NTU at GG03 to 138.7 NTU at SW03), corresponding with rainfall events during the available record. All pulses were isolated within the observed record, rapidly returning to background levels (loggers set to record at 15 minute intervals).

[4] Choi, S.-D (2014) Time trends in the levels and patterns of polycyclic aromatic hydrocarbons (PAHs) in pine bark, litter, and soil after a forest fire. Science of the Total Environment, 470-471, 1441−1449.

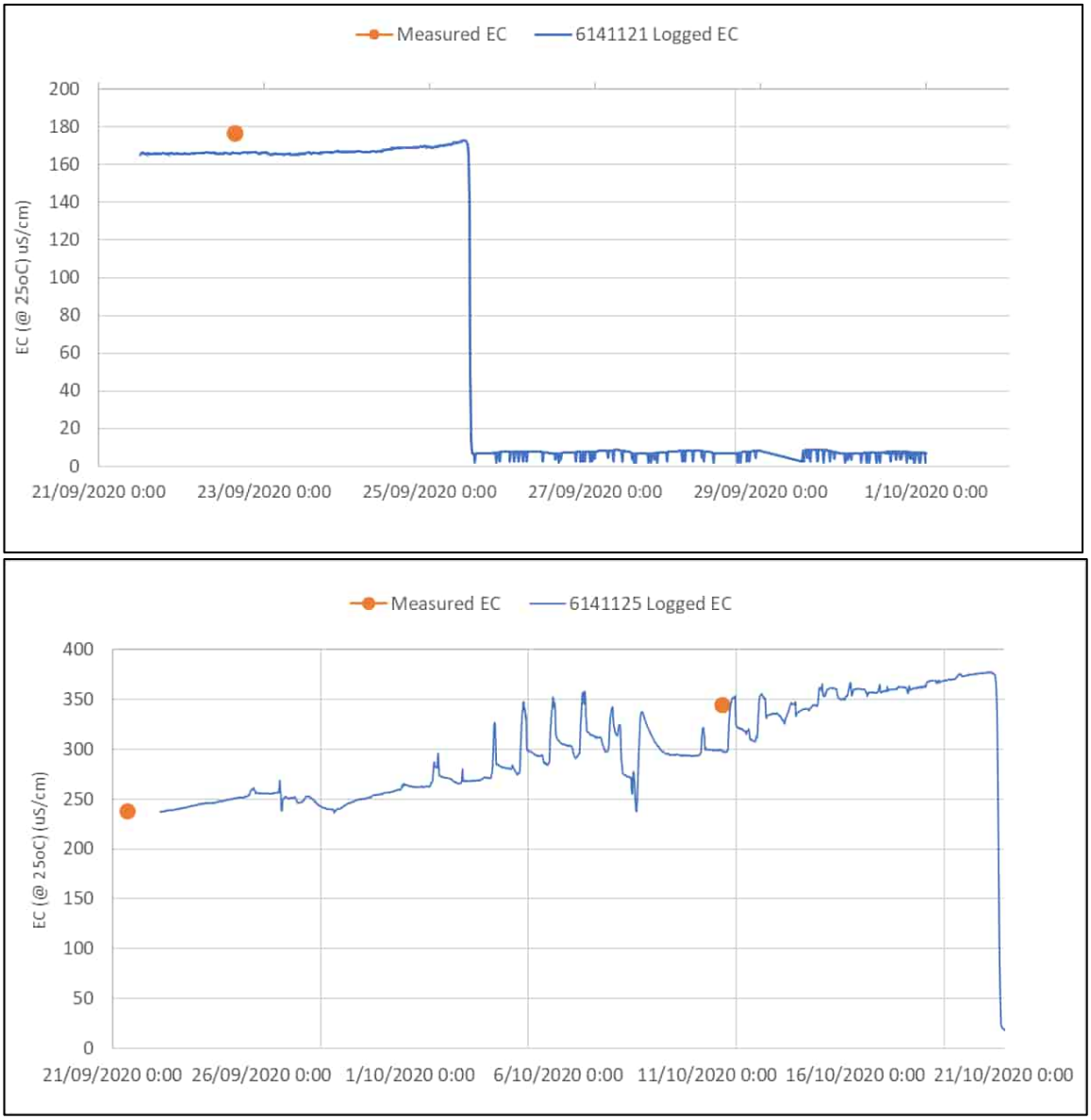

Figure 4-5 Myara North logged EC data

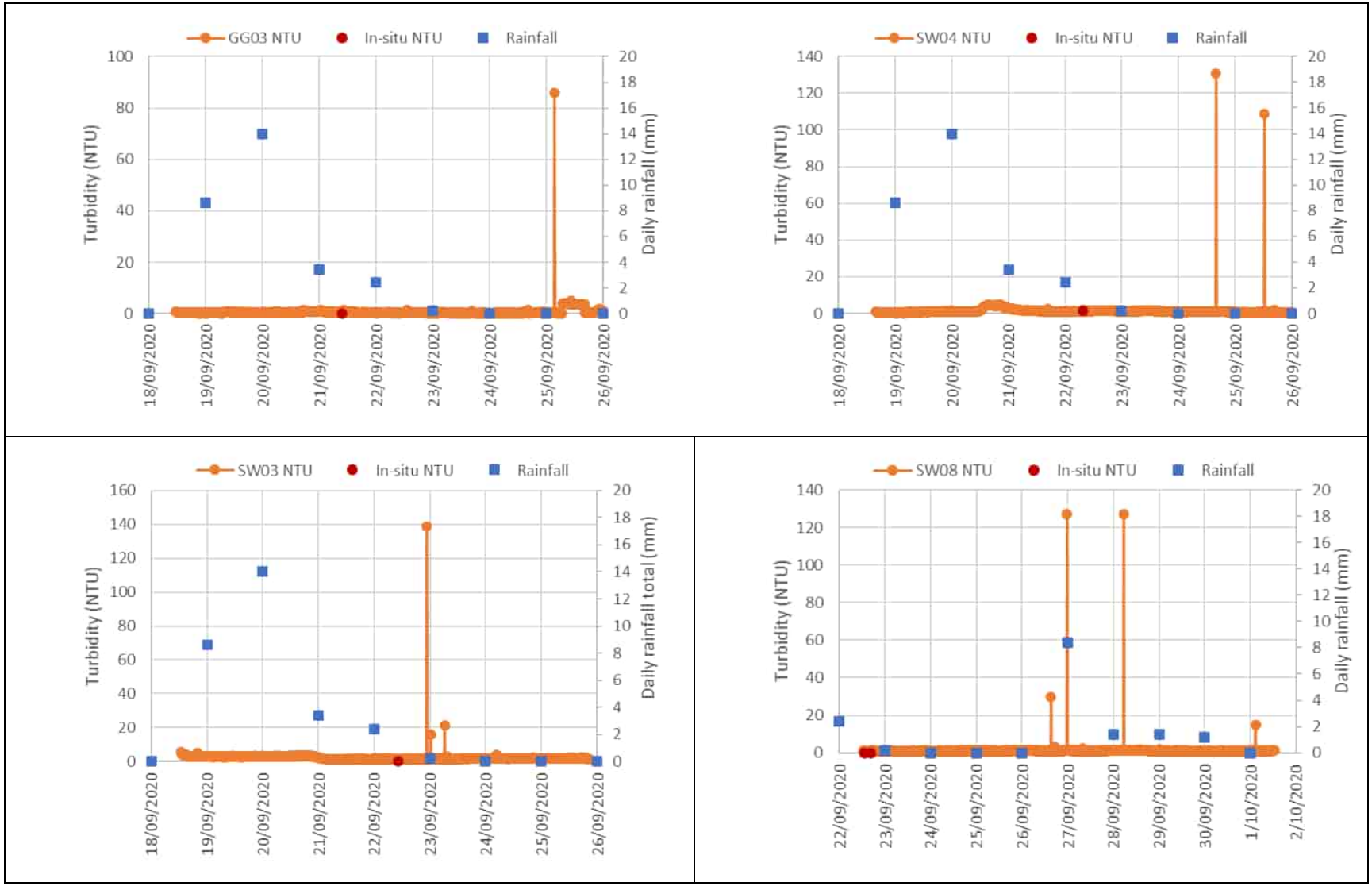

Figure 4-6 ***Myara North turbidity logger data***

5. Holyoake monitoring results

5.1 Baseline monitoring program groundwater results

5.1.1 Hydraulic testing

The slug test data was analysed using Aqtesolve software. The Aqtesolve outputs, showing the groundwater level recovery data for each bore, and the resulting calculated hydraulic conductivity are presented in Appendix F. All results were assessed using the Bouwer-Rice (1976) model for a slug test. The results are summarised in Figure 5-1 below. The following observations are made:

– Bores with the highest hydraulic conductivity such as BH03 and BH14 are screened in the basement saprock/highly weathered granite. The higher hydraulic conductivity values here likely relate to discrete higher permeable zones within this unit.
– The average hydraulic conductivity for Holyoake mine region is 0.3 m/d compared to 0.6 m/d for Myara North mine region. The lower average hydraulic conductivity at Holyoake mine region than Myara North mine region is consistent with the described lithology and drilling, where higher groundwater flows, associated with the basement/saprock profile were more common.

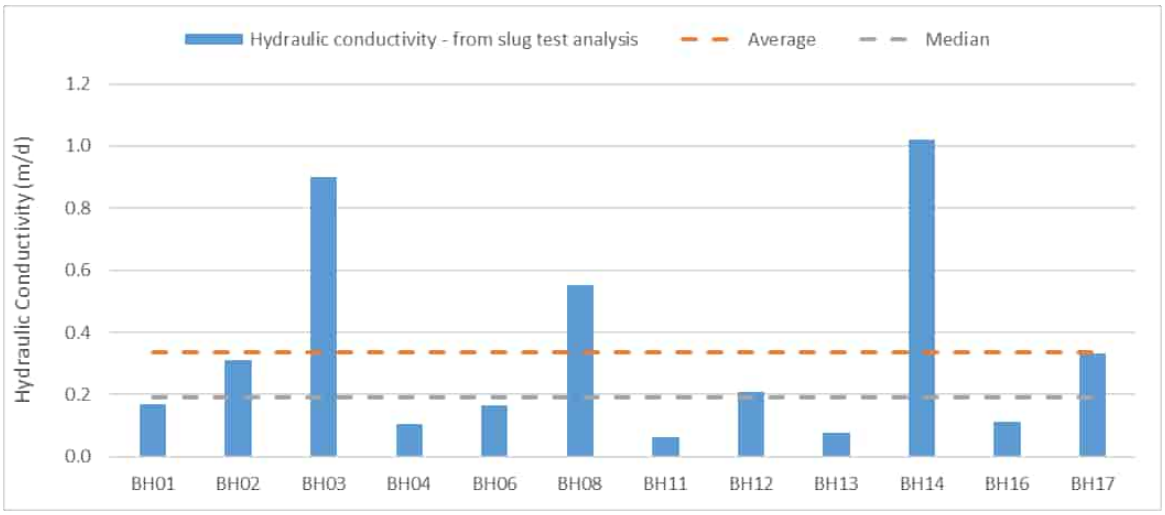

Figure 5-1 Holyoake slug test results (hydraulic conductivity)

5.1.2 Groundwater levels – Long term monitoring

As noted in Section 2, whereas groundwater monitoring data for Myara North mine region has been ongoing since the 1970's (), data for Holyoake mine region is less available. A review of the historical data and site reconnaissance was able to locate a total of 6 monitoring bores that had both historical data and were suitable for further testing. A further two existing bores were identified but did not have historical data available (H4821-2.4 and J4908-4.9). The location of these monitoring bores is shown in Figure B-7-2. Those bores with historical monitoring data are located marginally outside of the project boundary but are still suitable for developing baseline conditions for the area.

Groundwater level hydrographs for the long term Holyoake mine region bores are presented in Appendix J. The hydrographs include rainfall data presented as 'Cumulative Departure from the Mean'. This allows comparison of groundwater levels to changes in rainfall. The following provides a summary of the key observations from the Holyoake mine region hydrographs:

– Of the six bores presented for Holyoake in Appendix J, four have sufficient frequency of historical monitoring data to assess seasonal variation. These bores show a seasonal variation of around 1 to 2 m.

– The Holyoake mine region historic bores generally have a greater depth to groundwater than Myara North mine region bores. All bores recorded groundwater of between10 to 15 mBGL during the 1990's monitoring, with all bores then showing a significant reduction in groundwater levels for more recent data. The reduction in groundwater levels is shown on Figure 4-2 (in Myara North Section 4.1.2). The reduction in levels is greater than 5 m in all bores over the completed monitoring record, and broadly aligns with the reduction in rainfall seen over this period.
– The most complete monitoring record is available for MK46101A which has groundwater level data from the mid 1990's until present and shows a near linear reduction from 10 mBGL to 25 mBGL for the latest reading.

5.1.3 Groundwater levels – New monitoring sites

New groundwater monitoring bores were installed at 17 locations, as detailed in the installation report (GHD, 2020b). The location of the monitoring bores (Figure B-7-2) was selected to provide site wide coverage of groundwater conditions. Due to the change in project area, bores BH15, BH16 and BH17 are now located south of the project boundary.

As noted in Section 2, groundwater levels for the new monitoring bores were recorded on a nominal monthly frequency between October 2020 and February 2021 (up to four monitoring rounds). Hydrographs for this monitoring period are presented as Appendix K, which also includes the field TDS data.

The groundwater level data for the new monitoring bores indicates the following:

– Groundwater is generally not as shallow with comparison the Myara North mine region. The average depth to water is 14.5 mBGL. BH12 is the only bore recording a consistently shallow depth to water of less than 5 m, whereas the other bores recorded depth to water of 9 m to 25 m. BH12 is also the shallowest bore, installed to 6.1 m with fresh basement rock (quartzite/granite) from 4 m.
– Groundwater levels reduce over the monitoring period (October 2020 to February 2021), consistent with a seasonal change from late winter groundwater highs to summer groundwater lows. The reduction in groundwater levels results the drying out of BH15 with groundwater level reducing beyond the base of bore at 8 m, indicating the absence of a saturated profile at this location during summer.
– The average seasonal groundwater level decline for all new bores is 0.7 m, significantly less than Myara mine region (1.9 m for Myara mine region bores). The lesser range in seasonal variation is consistent with deeper bores (i.e. shallower bores tend to have a greater seasonal range in groundwater levels).

5.1.4 Groundwater quality - long term monitoring data

Groundwater quality, specifically salinity, is available for four of the six historical bores that were monitored in 2020-2021. Review of this data allows some limited assessment of long term groundwater quality changes. The field salinity (as TDS) is presented on the hydrographs presented as Appendix J. The following observations are made from the historical range of salinity data:

– There is a relatively large range in salinities measured in the 1990's with TDS data in the range of 150 mg/L to 2000 mg/L (average of 850 mg/L). The spatial extent of the bores is limited, but the two bores with high salinities (MK49162A and ML49131A) are located 400 m apart just outside of the south east of the project area.
– Of the four bores with salinity data, three show a marginally increasing trend, with the fourth being stable.

5.1.5 Groundwater quality – 2020-2021 sampling data – field data

As detailed in Section 2, groundwater quality field data was collected at existing historical bores, and at the new monitoring bore sites on up to four sampling rounds between October 2020 and February 2021. Of these sampling events, two included more comprehensive monitoring rounds when a full groundwater laboratory suite was analysed. Data for field salinity (as TDS) is included on the hydrographs presented for the new bores in Appendix K. The following observations are made from the new bores field water quality data:

– Groundwater is consistently fresh for the majority of bores and for the majority of sampling rounds. Of the 16 new monitoring bores, excluding the 3 highest salinity bores, the average TDS is around 400 mg/L. Three bores have a relatively high TDS of between 1000-1500 mg/L (BH03, BH05 and BH12). Two of these sites

(BH03 and BH05) are located relatively close together (1.8 km) along the same drainage line in the far north east of the project area.

– Groundwater pH in Holyoake is relatively uniform, with an overall average field pH of 6.3. Recent data for the historical bore subset is consistent with an average pH variation for each bore of less than 0.5. For the new bores the variance is more pronounced, with an average range of 1.2 pH units. This larger range is possibly related to the influence of bore construction materials (alkaline grouts and cements) and the subsequent stabilisation of groundwater conditions.

5.1.6 Groundwater laboratory results

Groundwater quality analytical results for Holyoake are presented in tabular format in Appendix L. The tabulated data is presented for the two sampling rounds undertaken in October 2020 and February 2021. As summarised in Section 2, the sampling rounds included all of the new monitoring bores (prefix “BH”) and a selection of existing Alcoa (historical) monitoring bores. The laboratory results are compared to various assessment criteria. The assessment criteria include Australian Drinking Water Guidelines including PFAS for drinking water and recreational water and ANZG Freshwater species protection guidelines.

The following observations are made for the two rounds of baseline groundwater data:

– Physical and major ion parameters:
  - Laboratory results for pH and salinity/EC are in-line with the field data that has been discussed in the sections above. Groundwater pH is generally uniform with an average of 6.8. Some bores show a higher pH for the first round, possibly showing the influence of bore construction materials (cements and grouts).
  - Groundwater EC is generally uniform with an average of 1100 µS/cm. Five sites (BH03, BH05, BH06, BH12 and K4916-2A) have EC above 1000 µS/cm and up to 3000 µS/cm (K4916-2A). The spatial distribution of these sites does not indicate a particular area where more elevated EC is prevalent.
– Metals:
  - Metal concentrations were below the LOR for all samples for beryllium and selenium. Minor above LOR detects (less than three results) were recorded for arsenic, cadmium, lead, mercury and vanadium.
  - Where metal concentrations were detected, they were generally above the ANZG 99% freshwater species protection assessment criteria. This includes metals arsenic, cadmium, chromium, copper, lead, manganese, nickel and zinc. However, the freshwater assessment criteria are generally at concentrations below the LOR, and given the context, only appropriate for a comparative assessment of groundwater conditions.
  - The drinking water assessment criteria for metals was exceeded only for manganese with six detects above the 0.5 mg/L criteria. This was at locations BH01, BH05. BH12 and BH16 which show a widespread spatial distribution (i.e. no locally impacted groundwater).
  - In general, the variable metal concentrations are typical of ‘natural’ conditions and representative of the geological setting.
– Nutrients:
  - Nutrient concentrations are low and consistent with the land-use type (i.e. lack of applied nutrients or sources). Nutrient concentrations are generally higher in the first round of monitoring, however the reason for this is unclear. Nitrogen species concentrations at BH10 are elevated with comparison to other monitoring bores, with Total Nitrogen of 11.8 mg/L. However, where assessment criteria are available, all parameters are significantly below the criteria.
– PFAS:
  - PFAS compounds were below the laboratory LOR in all but five locations. In the October 2020 monitoring round PFAS was detected in BH09, BH10, BH12, BH17 and K4916-2A. In the February 2021 monitoring round, detections were only observed BH12.
  - All detections were significantly below the drinking water assessment criteria with maximum Perfluorooctanoic acid (PFOA) concentration detection of 0.021 µg/L, compared to the assessment

criteria of 0.56, and a maximum Sum of PFHxS and PFOS concentration detection of 0.0046 µg/L, compared to the assessment criteria of 0.07 µg/L.

– Hydrocarbons:
  - All samples analysed for BTEX compounds returned results less than LOR.
  - All samples analysed for explosive compounds returned results less than LOR.
  - TRH was detected at low concentrations in BH02, BH05, BH10, BH12 and K4916-2A. The low levels, and detection in historical monitoring bores suggests possible low levels of cross contamination from sampling sources.
  - PAH was detected in more than half of the samples analysed. The most prevalent detection was pyrene, with 21 detects of the 34 samples analysed. The ADWG Health criteria of 0.01 µg/L was exceeded on 10 occasions from locations BH01, BH04, BH05, BH11, BH12, BH16, BH17, J4904-4.25 and K4916-2A. Where detected during both sampling rounds, the concentrations in the first round are significantly higher. This possibly suggests that the detections are related to the drilling activities, with some subsequent cross contamination of the two historical bores. Alternatively, the widespread detection could relate to a source from bush fires, however reason for the varying concentrations between rounds remains uncertain.

5.2 Baseline monitoring program surface water results

5.2.1 Surface water flows – Long term monitoring

The flow gauging stations with historical data relevant to Holyoake mine region are summarised in Table 2-2. The majority of flow gauging stations relevant to Holyoake mine region hold around 15 years of data from mid 1980s through to late 1990s. The Gordon Rd site is the exception, with a 30 year record available from 1988 to 2018. As with Myara North mine region, large areas of the Holyoake mine region have no flow gauging data.

Appendix G presents annual flows and trends in monthly streamflow data over the period of record for these sites. Annual and monthly streamflow data are presented to account for observed step changes in streamflow (post 2000).

Flow seasonality is typically observed between July and September within the smaller eastern sub-catchments (Gordon and Pindalup). The larger western sub-catchments (Skeleton Rd upstream and Davis Brook downstream of the Holyoake mine region) observe longer flow periods between June and November.

Data analysis by GHD for the gauging stations located in the study area indicates that baseflow and interflow represents between 37% and 80% of streamflow, depending on location and baseflow separation methodology (Appendix G).

The analysis was undertaken for the full streamflow record, varying between sites, between 1980 and 2018. These gauging stations are for much smaller catchments than those used for Serpentine Catchment Appendix G) and represent a wider range or results.

5.2.2 Surface water flows – Baseline monitoring

The flow conditions at surface water sampling locations were recorded during monthly surface water sampling events. The observed flow conditions across the Holyoake area are summarised in Table 5-1.

Surface water level loggers were installed in late September at selected Holyoake surface water monitoring locations. A summary of surface water logger data is provided in Table 5-2, with logged surface water levels presented in Figure 5-2.

The key trends in the surface water flow data include:

– The observed surface water flows varied across the Holyoake mine region with multiple sites observed to be dry during all sampling events (including logger location HSW03, a minor eastern tributary at site 6141470 and a minor tributary inflow to the South Dandalup Dam at site 6141325). The most downstream site of the central tributary through the Holyoake mine region (site 6141340) was also dry during all sampling events,

while its upstream location at site SD31 was observed to be flowing on one sampling event (September 2020).

– Flowing water was present in August preceding logger installation at sites 6141005 and HSW05. Some sites upstream of the site HSW05 had observed surface water flows in late October surface water sampling (site HSW01 and site 6141349), as well as November (site HSW01), extending beyond the cease to flow at HSW05 in mid-October.

– Varying water level response to seasonal rainfall events was observed in the limited logger record. Rainfall totalling 18.4 mm over 4 days (27 to 30/09/2020) was insufficient to prevent water level decline to cease to flow at site HSW05, with water levels also declining at site 6141005. A 30.8 mm rainfall event on the 8/10/2020 results in a brief return of flows at site HSW05, and maintains flows at site 6141005 until cease to flow in mid-October.

Table 5-1 Holyoake mine region summary of surface water sampling event flow conditions

Site	August 2020	September 2020	October 2020	November 2020	December 2020	January 2021
Unnamed northern tributary						
6141333	Flowing	Flowing	Dry	Not flowing #	Dry	Dry
HSW05	Flowing	Flowing	Dry	Dry	Dry	Dry
South Dandalup River and tributaries						
HSW01	Flowing	Flowing	Not flowing #	Not flowing #	Dry	Dry
BF20	Flowing	Not flowing #	Dry	Dry	Dry	Dry
6141352	Flowing	Dry	Dry	Dry	Dry	Dry
6141349	Flowing	Flowing	Not flowing #	Dry	Dry	Dry
HSW04	Flowing	Flowing	Dry	Dry	Dry	Dry
6141005	Flowing	Flowing	Dry	Dry	Dry	Dry
Central Sth Dandalup – Pindalup tributary						
SD31	Dry	Flowing	Dry	Dry	Dry	Dry
6141340	Dry	Dry	Dry	Dry	Dry	Dry
Minor tributary of South Dandalup Dam						
6141325	Dry	Dry	Dry	Dry	Dry	Dry
Davis Brook						
DV04	Dry	Flowing	Dry	Dry	Dry	Dry
Swamp Oak Brook						
HSW02	Flowing	Flowing	Dry	Dry	Dry	Dry
6141470	Dry	Dry	Dry	Dry	Dry	Dry
HSW03	Dry	Dry	Dry	Dry	Dry	Dry
Notes:	**Bold** indicates monitoring locations with logger installations					
	# Indicates site sampled from disconnected pool					

Table 5-2 Holyoake mine region surface water logger data summary

Site	Sub-catchment	Installation date	Cease to flow
6141005	South Dandalup River	24/09/2020	14/10/2020
HSW05	Unnamed northern tributary of South Dandalup River	15/09/2020	9/10/2020
HSW03	Swamp Oak Brook	24/09/2020	No flow recorded

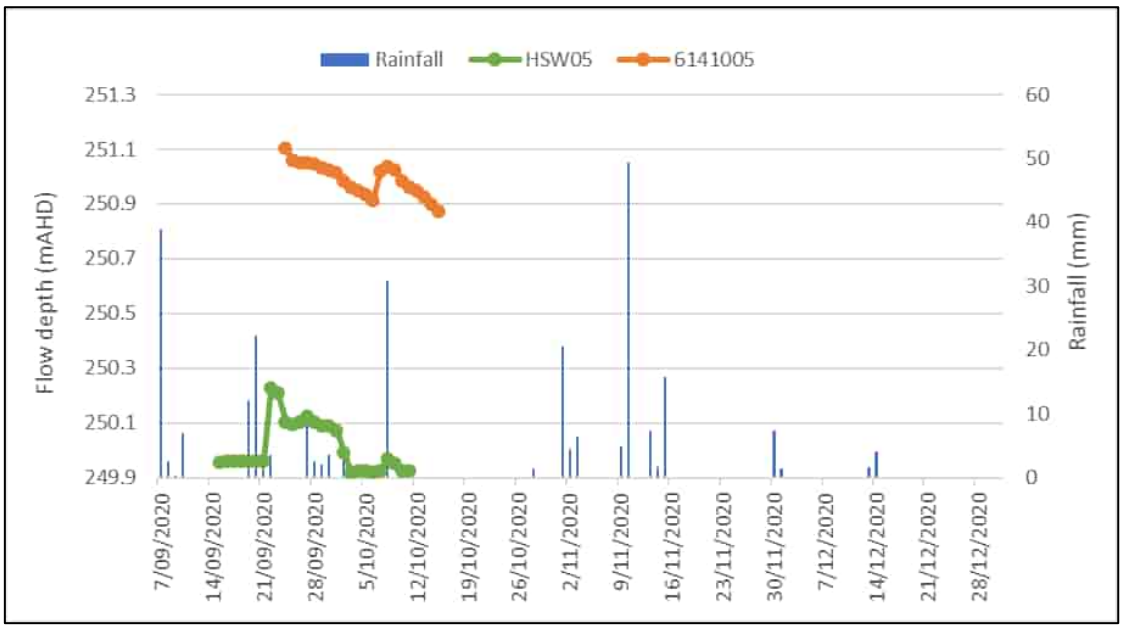

Figure 5-2 Holyoake logged water levels (from date of installation)

5.2.3 Surface water quality – Long term monitoring

Historical surface water quality monitoring within the proposed Holyoake mine region has primarily been undertaken by DWER, with Alcoa monitoring in this region limited to one site on Davis Brook (DV04) with sufficient data for review. Summary statistics of key parameters are provided in Appendix H, with historical data indicating the following key trends:

– Limited pH data for the South Dandalup indicates average pH was neutral.
– EC values are predominantly available for sites on the main and minor tributaries of the South Dandalup River, with median EC ranging from 169 µS/cm (site 614060) to 699 µS/cm (site 6141005, limited data from 1972 and 1975). The limited EC for tributaries of the Murray River indicate higher historical median EC concentrations (Swamp Oak Brook, 763 µS/cm; Davis Brook, 646 µS/cm).
– Turbidity data for sites on the main and minor tributaries of the South Dandalup River indicate that median turbidity ranged from 0.9 NTU (site 6141340) to 7.3 NTU (site 6141344). Occasional discrete samples exceeded 25 NTU.

5.2.4 Surface water quality

5.2.4.1 Surface water sampling events

Surface water sampling events were completed monthly between August 2020 and January 2021. Table 2-6 summarises the field and laboratory parameters across sampling events.

5.2.4.2 Surface water field physico-chemical parameters

The physico-chemical parameters measured for surface water are summarised as follows:

– pH: Mildly acidic conditions across all sites ranging between 5.51 (6141333, November 2020) and 7.5 (6141005, August 2020).
– EC: Typically ranged between 122 µS/cm (BF20, August 2020) and 384 µS/cm (DV04, September 2020) indicating fresh water.

– Turbidity: Relatively clear conditions across all sites with values typically ranging from -27 NTU[5] (HSW01, October 2020) and 4.7 NTU (6141005, September 2020). Slightly higher values reported from site 6141349 in September (14.2 NTU) and October (15 NTU) with conditions at this site reported as cloudy. Maximum of 40 NTU was recorded at HSW04 (September 2020).

5.2.4.3 Surface water laboratory results

A summary of the surface water laboratory results is provided in Appendix M. Key observations from the laboratory results from the baseline sampling program include:

– Physicochemical parameters (all sampling events):
  - pH: Neutral conditions across all sites ranging from 6.5 (BF20, September 2020), and 7.28 (6141349, September 2020).
  - EC: Typically ranged between 109 µS/cm (BF20, August 2020) and 368 µS/cm (DV04, September 2020) indicating fresh water.
  - Turbidity: Relatively clear conditions across all sites ranging from 0.2 NTU (HSW02, September 2020) to 23 NTU (6141349, October 2020).
  - Total suspended solids: <5 mg/L across sites during all sampling events, with exception of site 6141349 in September 2020 (21 mg/L) and October 2020 (25 mg/L).
  - Water hardness: Water hardness was consistently within the soft range (0-60 mg CaCO3, ANZG 2018).
– Metals (extended suite sampling events):
  - Metal concentrations were below the LOR for all samples for arsenic, beryllium, boron, cadmium, chromium, mercury, selenium, vanadium.
  - Where metal concentrations were detected, they were below drinking water guidelines.
  - The ANZG 95% freshwater species protection assessment criteria was exceeded for zinc at site 6141349 (October 2020), and for copper at site HSW02 (September 2020). There were two exceedances of the ANZG 99% freshwater species protection assessment criteria for zinc (site 6141349, October 2020; site BF20, September 2020), and one for copper (site HSW02, September 2020). No other exceedances of the ANZG 95% or 99% freshwater species protection criteria were reported.
  - In general, the variable metal concentrations are typical of ‘natural’ conditions and representative of the geological setting.
– Nutrients (extended suite sampling events):
  - Nutrient concentrations are typically low and consistent with national park land use (i.e. lack of applied nutrients or sources). At the majority of sample sites nutrient concentrations reported less than the LOR or below available criteria. All samples for ammonia-N, nitrite-N and filterable reactive phosphorus returned results less than LOR.
  - Several samples were marginally elevated (0.5 to 0.7 mg/L) above the ANZECC South-western Australia default guideline values for total nitrogen and total Kjeldahl nitrogen, with one sample at site HSW05 (September 2020) reporting a total nitrogen concentration of 1.2 mg/L.
  - Three samples reported total phosphorus concentrations above the ANZECC South-western Australia default guideline values, with two very high sample concentrations reported at site HSW01 (0.68 mg/L, September 2020) and DV04 (3.4 mg/L, September 2020).
– Microbiological (extended suite sampling events):
  - Microbiological parameters enterococci and E. coli were detected at all sampling sites. Widespread detection of microbiological parameters is consistent with the presence of fauna species within the land use setting.
  - E. coli concentrations ranged from < 1 orgs/100mL to 200 orgs/100mL (site 6141349, September).
  - Enterococci concentrations ranged from 2 orgs/100mL (site HSW02, August 2020) to 90 orgs/100mL (site BF20, August).

[5] Negative turbidity values measured under field conditions considered a result of low turbidity conditions.

– Other potential contaminants of concern (extended suite sampling events):
  - All samples analysed for surfactants returned results less than LOR.
  - All samples analysed for BTEX compounds returned results less than LOR.
  - All samples analysed for total recoverable hydrocarbons compounds returned results less than LOR.
  - All samples analysed for PAHs returned results less than LOR.
  - All samples analysed for explosives returned results less than LOR.
  - All samples analysed for OC Pesticides returned results less than LOR.
  - PFAS compounds were below the laboratory limits of reporting (LOR) in all but five locations. In the August 2020 monitoring round PFAS was detected at HSW05. In the September 2020 monitoring round PFAS was detected at 6141005, 6141439, HSW02 and HSW04. All detections were significantly below the drinking water assessment criteria.

5.2.4.4 Surface water logger quality data

Electrical conductivity logger data

EC loggers were installed in the lower reaches of the South Dandalup River (site 6141005) and an unnamed northern tributary of South Dandalup River (site HSW05), and at the outflow of the MDE to the Swamp Oak Tributary of the Murray River (site HSW03).

No data was collected from site HSW03 due to dry conditions at this location.

The EC logger record for the few weeks representing end of season flow reported similar median values for sites 6141005 (197.7 µS/cm) and HSW05 (186.7 µS/cm). The EC record at site 6141005 steadily rose prior to cease to flow periods, and reported a marginally higher maximum EC (244.6 µS/cm) than the more stable EC record at site HSW05 (201.5 µS/cm).

Turbidity logger data

Turbidity loggers were installed at the same locations as the EC loggers in the Holyoake mine region. No data was collected from site HSW03, with this site dry for the duration of logger installation.

The logged turbidity data at sites is available for a week, with median turbidity of 4 NTU at site 6141005 and 6 NTU at site HSW05. Average turbidity at site 6141005 over the week of 25.9 NTU, primarily due to some long duration turbidity events, and a logged maximum of 130 NTU. Site HSW05 had shorter duration events with elevated turbidity, and a maximum of 129.2 NTU. Unlike the short pulses measured at Myara North mine region, these longer pulses are representative of a real turbidity spike. The pulses correspond to storm events. The source of the turbidity is unknown but may be a relic of prescribed burns in the catchment conducted in late 2018.

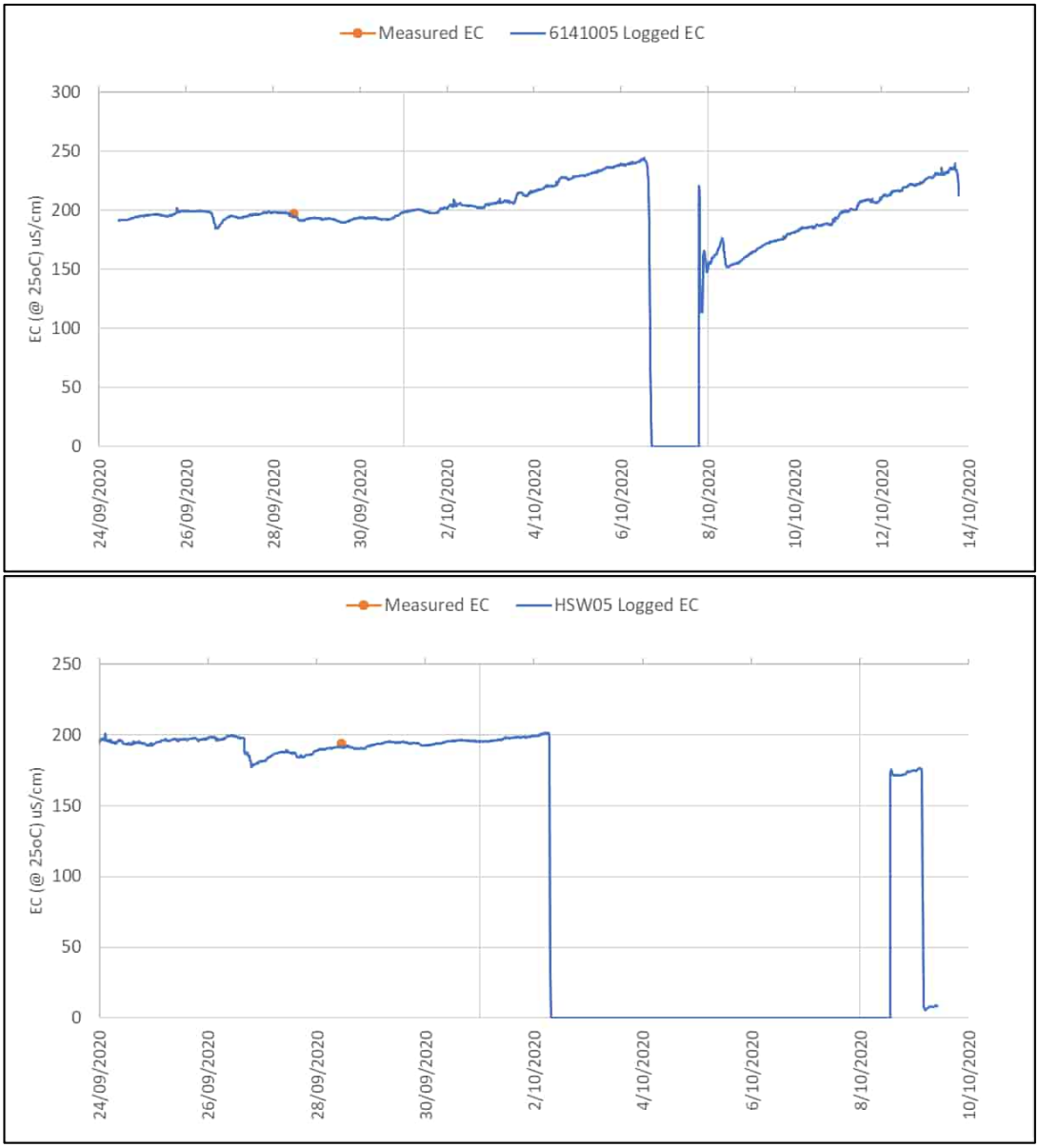

Figure 5-3 Holyoake logged EC data

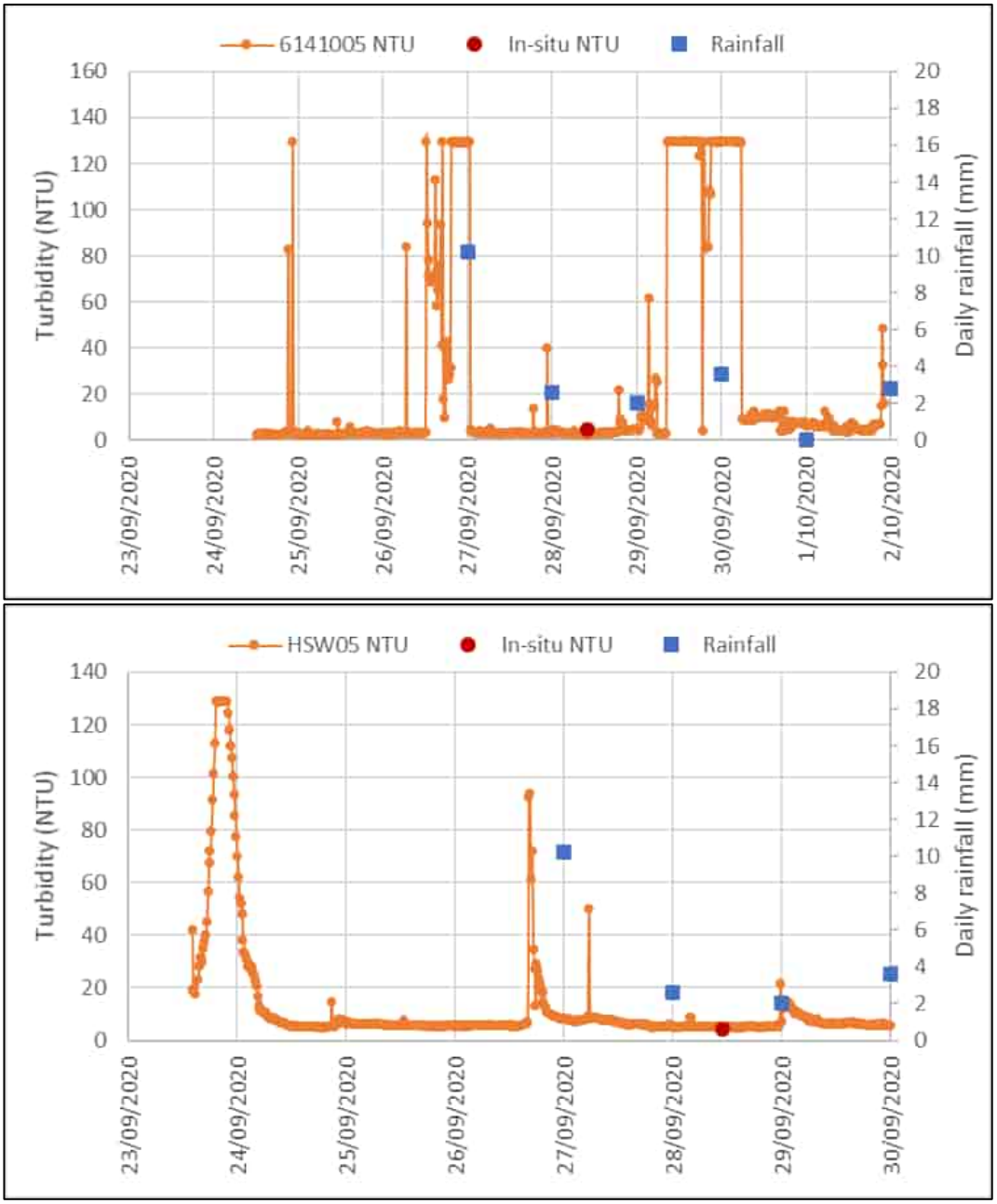

Figure 5-4 Holyoake logged turbidity data

6. Baseline assessment summary

6.1 Myara North

6.1.1 Groundwater

6.1.1.1 Groundwater levels

Groundwater levels within the Myara North mine region are broadly related to topography, with greatest depth to groundwater generally found higher up in the slope profile. Groundwater levels show a strong seasonal variation, with the variation being the greatest for those bores lower in the slope profile where groundwater tends to be shallower. Depending on location, groundwater levels are seen to vary by 1 to 5 m over an annual cycle.

The strong seasonal variation observed during the monitoring undertaken for this program, identified locations where at paired sites (deep and shallow bores) the shallow bores dried out (groundwater level reducing below bottom of screened unit). Additionally, some fully penetrating bores (screened just above the basement rock) were observed to dry out, indicating a seasonal unsaturated profile, generally observed where basement rock is relatively shallow.

A review of the historical groundwater levels with comparison to the latest levels indicated that from around the early 1990's until present groundwater levels show an overall declining trend, i.e. depth to groundwater is now greater than it was in the 1990's. The groundwater level decline aligns with a period of reduced rainfall. The reduction in groundwater levels is most significant in those bores with a deeper depth to water, where groundwater levels have reduced by up to 10 m over the 30 year period.

6.1.1.2 Groundwater quality

Groundwater quality within the Myara North mine region is typically fresh, unimpacted by anthropogenic activities and consistent with the current site setting within the state forest. The majority of the monitoring data for the area, available for some sites since the 1970's, indicates generally fresh conditions with an average salinity of around 450 mg/L. However, there is some variability within the salinity dataset with isolated bore locations having salinities around 2000 mg/L.

Within the limited spatial extent of the data, there does not appear to be a relationship between bore salinity and location with salinity ranges within each catchment being as variable as those between catchments. Whereas there has been a definite reduction in site wide groundwater levels, the groundwater quality data, albeit less comprehensive, does not show any widespread long-term trends.

The groundwater quality sampling rounds undertaken for this assessment included the laboratory assessment for a wide range of water quality parameters. Sampling was undertaken in later winter 2020 and summer 2021. The data indicated no discernible seasonal change in groundwater quality, however some effects of sampling soon after drilling of the bores was noted.

The results showed very low nutrient levels, typical for the land-use, suggesting lack of applied nutrients. Metal concentrations were typical of 'natural' conditions and representative of the geological setting. Very low concentrations of PFAS were detected in four of the sampled bores, however all detections were significantly below the drinking water assessment criteria. Minor detection of TRH and PAH was noted, with concentrations reducing in the second sampling round, possibly indicating that the drilling was the source or the low levels are associated with bush fire affects.

6.1.2 Surface water

6.1.2.1 Surface water flow duration

Surface water flow data across the majority of the Myara North mine region show a strong seasonality of stream flow. Short periods of flow were observed at some sites, with other sites sustaining flows over longer periods. The

observed periods of flow during the baseline monitoring program align with historical seasonality of flow observed across the proposed Myara North mine region, and more recent observations from monitoring of the current Myara mine region of the Huntly Mine.

One site (SW05) sustained flows during the surface water sampling round in January 2021, with upwelling water observed in addition to surface flow at this site which may indicate a local groundwater source. Sustained flows were also observed at site SW06 (cease to flow in November 2020) within the upper Gooralong Brook catchment. This site was located in the catchment of a controlled burn completed in late September 2020.

6.1.2.2 Surface water quality

The baseline surface water quality is generally similar across the Myara North mine region, reflecting the uniform hydrological and hydrogeological conditions across the area. As with groundwater quality data the surface water quality is typically fresh, unimpacted by anthropogenic activities and typical of the site setting within state forest.

The field and laboratory surface water physico-chemical data collected during the baseline monitoring program are similar to historical observations across the Myara North mine region. Surface water is non-saline and moderately acidic, with marginally elevated surface water salinity observed in some samples during late season monitoring or when sampling occurred from pools. Surface water samples typically had low turbidity and low total suspended solids. The low background turbidity was also observed in a short continuous turbidity logger record at four sites, with short pulses of elevated turbidity rapidly returning to background levels. The turbidity data observed during the baseline monitoring period is consistent with the historical data record for the various sub-catchments of the Myara North mine region (Appendix I).

An extended suite of surface water quality parameters were also sampled during the first three months of sampling in August, September and October 2020. As with groundwater within the Myara North area the surface water results had low nutrient levels, and metal concentrations representative of the geological setting. Microbiological parameters were detected at all sampling sites, with widespread detection consistent with the presence of fauna species within the national park setting.

Very low concentrations of PFAS were detected at four sites, however all detections were significantly below the drinking water assessment criteria.

Detection of PAHs elevated above the drinking water guideline was reported at site SW06 in October 2020, with the PAH concentration dominated by naphthalene and attributed to natural introduction of PAHs from a controlled burn in the catchment in late September. Dieldrin was detected in a single sample at a concentration significantly lower than the drinking water assessment criteria.

For other contaminants of potential concern, including surfactants, BTEX compounds, TRH and explosives, all samples analysed returned results less than LOR.

6.2 Holyoake

6.2.1 Groundwater

6.2.1.1 Groundwater levels

Groundwater levels within the Holyoake mine region are broadly related to topography, consistent with Myara North mine region. However, within the Holyoake mine region there is a tendency of depth to groundwater being somewhat greater than Myara North mine region. The greater depth to groundwater is typical of the generally thicker weathered profile found within Holyoake i.e. the depth to basement rock is also deeper in Holyoake mine region compared to Myara North mine region.

The greater depth to groundwater also relates to a more muted seasonal variation at Holyoake. Typical seasonal variations are around 1 to 2 m. However, good time-series historical groundwater data is lacking in Holyoake mine region, with only a very limited number of historical monitoring bores, most of which are marginally outside of the of the study area. Where data is available, the trend of significantly reducing groundwater levels over the last 30 years is strongly apparent, consistent with the Myara North mine region data.

6.2.1.2 Groundwater quality

Groundwater quality within the Holyoake region is typically fresh, unimpacted by anthropogenic activities and reflects the current site setting within State forest. The data is broadly uniform with Myara North mine region data, with a slightly higher average salinity. Unlike Myara North mine region, there is a lack of good historical monitoring data, but where data is available there is no discernible long-term trend in water quality. Similarly to Myara North mine region, there does not appear to be a relationship between bore salinity and location with salinity ranges within catchments being as variable as those between catchments.

Data from the two comprehensive monitoring rounds undertaken for this study indicated no discernible seasonal change in groundwater quality, however some effects of sampling soon after drilling of the bores was noted. The results showed low nutrient levels, albeit marginally higher than Myara North mine region. Metal concentrations were also marginally higher than Myara North mine region but still typical of 'natural' conditions and representative of the geological setting. Very low concentrations of PFAS were detected in five of the sampled bores, however all detections were significantly below the drinking water assessment criteria. Low level detection of PAH (pyrene) was noted in the majority of bores in the first minoring round, with concentrations reducing in the second sampling round, possibly indicating that the drilling was the source, or that the PAHS source was related to bush fires.

6.2.2 Surface water

6.2.2.1 Surface water flow duration

Surface water flow occurrence varied across the Holyoake area with dry conditions observed during all sampling events at several sites. Where flow was observed the strong seasonal flow periods aligned with available historical data.

6.2.2.2 Surface water quality

The baseline surface water quality is generally uniform across the Holyoake mine region. As with groundwater quality data the surface water quality is typically fresh, unimpacted by anthropogenic activities and reflects the site setting within state forest.

The in-situ field and laboratory surface water physico-chemical data collected during the baseline monitoring program are similar to historical observations for the Holyoake mine region. Surface water is non-saline with neutral pH. Surface water samples typically had low to moderate turbidity and low total suspended solids. A short continuous turbidity logger record at two sites identified pulses of elevated turbidity that were sustained for up to several hours before returning to background levels.

An extended suite of surface water quality parameters were sampled during the first three months of sampling in August, September and October 2020. Total nutrient levels in surface water of the Holyoake mine region were higher in Holyoake mine region compared to Myara North mine region. Metals concentrations were representative of the similar geological setting, with ANZECC guideline exceedances reported for zinc and copper in limited samples. Similar to Myara North mine region microbiological parameters were detected at all sampling sites, with higher maximum detections reported at Holyoake mine region.

Very low concentrations of PFAS were detected at five sites, however all detections were significantly below the drinking water assessment criteria.

For other contaminants of potential concern, including surfactants, BTEX compounds, TRH, PAH, OC Pesticides and explosives, all samples analysed returned results less than LOR.

7. References

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Appendices

Appendix A

Monitoring Summary

Table A-1 Monitoring summary

Parameters	Analytes	Monitoring locations	Schedule
Surface water			
Surface water extended suite	Field – temperature, pH, dissolved oxygen, redox potential (ORP) and turbidity. Lab - Physical parameters, major cations and anions, nutrients, dissolved metals (filtered metals), microbiological, surfactants, hydrocarbons, PFAS, explosives	Myara North All 20 SW sites Holyoake All 15 SW sites	Wetter months (Aug, Sept, Oct 2020)
Surface water short suite	Field – EC Lab – Physical parameters, Major cations and anions	Myara North All 20 SW sites Holyoake All 15 SW sites	Drier months (Nov, Dec 2020, Jan 2021)
Groundwater			
Groundwater field	Water level, EC or TDS, and temperature	Myara North 25 existing bores 18 new bores Holyoake 8 existing bores 17 new bores	Monthly until January 2021
Groundwater lab	Physical parameters, major cations and anions, nutrients, dissolved metals (filtered metals), hydrocarbons, PFAS, explosives	Myara North 7 potential existing bores 18 new bores Holyoake 4 potential existing bores 17 new bores	Two events (October 2020 and February 2021)
Surface water instrumentation			
Suspended solids and turbidity	Greenspan TS1000 turbidity logger	Myara North GG03 SW04 SW03 SW08 Holyoake HSW05 6141005 HSW03	Continuous logging (Sept – Dec 2020)
Salinity	Hobo U24 EC logger	Myara North 6141121 6141125 Holyoake HSW05 6141005 HSW03	Continuous logging (Sept – Dec 2020)
Water level	Diver water level logger	All logger locations	Continuous logging (Sept – Dec 2020)

Appendix B

Surface water and groundwater locations

Table B-1 Groundwater monitoring locations

Type	ID	Sampling type	Easting (MGA50)	Northing (MGA50)	RL (mAHD)	Top of screen	Base of screen
						mBGL	
Myara North							
GHD	B01	Water quality and levels	427,687	6,410,644	225.7	4.4	7.7
GHD	B02	Water quality and levels	428,166	6,411,595	246.3	22.5	28.5
GHD	B03	Water quality and levels	429,882	6,412,459	285.5	17.9	23.9
GHD	B04	Water quality and levels	430,634	6,413,444	295.8	29.2	35.2
GHD	B07	Water quality and levels	417,322	6,419,415	260.5	5	8
GHD	B08	Water quality and levels	415,948	6,417,938	242.7	7.1	13.1
GHD	B09	Water quality and levels	420,091	6,418,115	251.7	0.7	3.2
GHD	B09_B	Water quality and levels	419,195	6,418,601	236.5	5.9	8.9
GHD	B10	Water quality and levels	426,297	6,419,709	295.4	15.2	21.2
GHD	B11	Water quality and levels	414,752	6,416,768	258.6	11	14
GHD	B12D	Water quality and levels	421,659	6,418,965	251.8	18.5	24.5
GHD	B12S	Water quality and levels	421,659	6,418,965	251.7	0.5	3.5
GHD	B13	Water quality and levels	413,156	6,421,906	226.9	9.4	18.4
GHD	B16D	Water quality and levels	420,801	6,421,111	266.5	11.5	17.5
GHD	B16S	Water quality and levels	420,800	6,421,111	266.4	1	4
GHD	B17	Water quality and levels	422,519	6,421,795	284.8	4.7	10.7
GHD	B18	Water quality and levels	426,132	6,425,478	348.0	1.8	7.8
GHD	B24	Water quality and levels	423,557	6,418,440	264.0	12.3	24.3
ALCOA	J3803-4A	Water quality and levels	423,857	6,425,953	298.0	9.9	12.9
ALCOA	J4012-1A	Water quality and levels	424,314	6,416,012	265.0	1.8	7.3
ALCOA	K3917-1A	Water quality and levels	425,580	6,419,008	283.0	4.93	29.93
ALCOA	K4011-1A	Water quality and levels	427,345	6,416,326	290.1	9.9	16.5
ALCOA	K4104-1A	Water quality and levels	428,407	6,413,122	270.0	1.98	13.98
ALCOA	K4106-1A	Water quality and levels	425,980	6,412,606	239.6	19	22
ALCOA	L4009-3A	Water quality and levels	428,915	6,416,135	320.6	5.5	8.5
ALCOA	J3803-3A	Water levels	423,445	6,425,994	283.5	2.8	5.8
ALCOA	J3922-2A	Water levels	422,468	6,418,491	278.3	4.33	26.23
ALCOA	J4108-1A	Water levels	424,370	6,412,792	240.6	3.7	6.7
ALCOA	K3825-11A	Water levels	425,729	6,421,999	307.0	2.9	5.9
ALCOA	K3918-1A	Water levels	426,264	6,419,167	293.6	9	12
ALCOA	K3919-1A	Water levels	426,866	6,418,916	299.6	9.25	15.25
ALCOA	K4010-2A	Water levels	426,364	6,416,172	297.0	15.62	24.62
ALCOA	K4018-1A	Water levels	426,371	6,414,800	270.0	2.53	12.23
ALCOA	K4018-2A	Water levels	426,145	6,415,171	278.6	5.2	20.2
ALCOA	K4019-1A	Water levels	427,280	6,414,986	278.3	3.64	10.64
ALCOA	K4025-1A	Water levels	424,925	6,413,867	250.0	5	14.5
ALCOA	K4025-2A	Water levels	425,664	6,413,655	260.6	21.8	24.8

Type	ID	Sampling type	Easting (MGA50)	Northing (MGA50)	RL (mAHD)	Top of screen	Base of screen
						mBGL	
ALCOA	K4026-1A	Water levels	425,841	6,413,802	250.0	2.2	6.2
ALCOA	L4009-2A	Water levels	429,079	6,416,547	330.4	5.85	9.85
ALCOA	L4013-1A	Water levels	428,936	6,415,647	310.5	23	29
ALCOA	L4019-1A	Water levels	430,845	6,415,054	340.6	NA	10.78
ALCOA	L4027-1A	Water levels	430,770	6,413,886	319.3	NA	29.22
ALCOA	L4101-1A	Water levels	429,036	6,413,478	280.0	3.57	21.57
Holyoake							
GHD	BH01	Water quality and levels	424,054	6,390,718	278.9	20.5	29.5
GHD	BH02	Water quality and levels	424,192	6,388,696	270.0	12.5	17.5
GHD	BH03	Water quality and levels	426,806	6,387,108	274.7	28.2	40.2
GHD	BH04	Water quality and levels	424,015	6,386,978	257.7	23.7	29.7
GHD	BH05	Water quality and levels	428,234	6,386,651	264.1	12.2	14.2
GHD	BH06	Water quality and levels	425,573	6,384,809	272.2	34.3	40.3
GHD	BH07	Water quality and levels	424,805	6,383,732	256.5	12	18
GHD	BH08	Water quality and levels	422,941	6,381,445	259.0	13	19
GHD	BH09	Water quality and levels	429,106	6,381,269	273.7	22.2	28.2
GHD	BH10	Water quality and levels	426,113	6,381,245	293.4	11.5	18.2
GHD	BH11	Water quality and levels	419,714	6,379,933	232.0	13.5	22.5
GHD	BH12	Water quality and levels	424,142	6,379,814	272.8	3.1	6.1
GHD	BH13	Water quality and levels	426,917	6,377,918	296.4	28	34
GHD	BH14	Water quality and levels	419,640	6,377,768	228.3	26.6	38.6
GHD	BH15	Water quality and levels	420,847	6,376,506	230.6	4.2	8.2
GHD	BH16	Water quality and levels	422,958	6,375,535	248.2	28	34
GHD	BH17	Water quality and levels	422,522	6,372,129	209.0	19.2	25.2
ALCOA	K4916-2A	Water quality and levels	428,489	6,377,903	303.0	NA	24.33
ALCOA	J4904-4.25	Water quality and levels	424,091	6,379,273	NA	NA	9.68
ALCOA	H4821-2.4	Water levels	418,441	6,380,573	255.1	NA	15.77
ALCOA	J4607-1A	Water levels	423,285	6,391,928	316.2	16	22
ALCOA	J4607-1B	Water levels	423,287	6,391,930	315.1	15.95	18.95
ALCOA	J4908-4.9	Water levels	424,357	6,378,864	298.5	NA	23.55
ALCOA	K4605-1A	Water levels	425,037	6,391,511	300.5	17.9	21.9
ALCOA	K4610-1A	Water levels	425,967	6,391,100	290.6	23.2	26.2
ALCOA	L4913-1A	Water levels	428,774	6,378,098	308.0	20	32

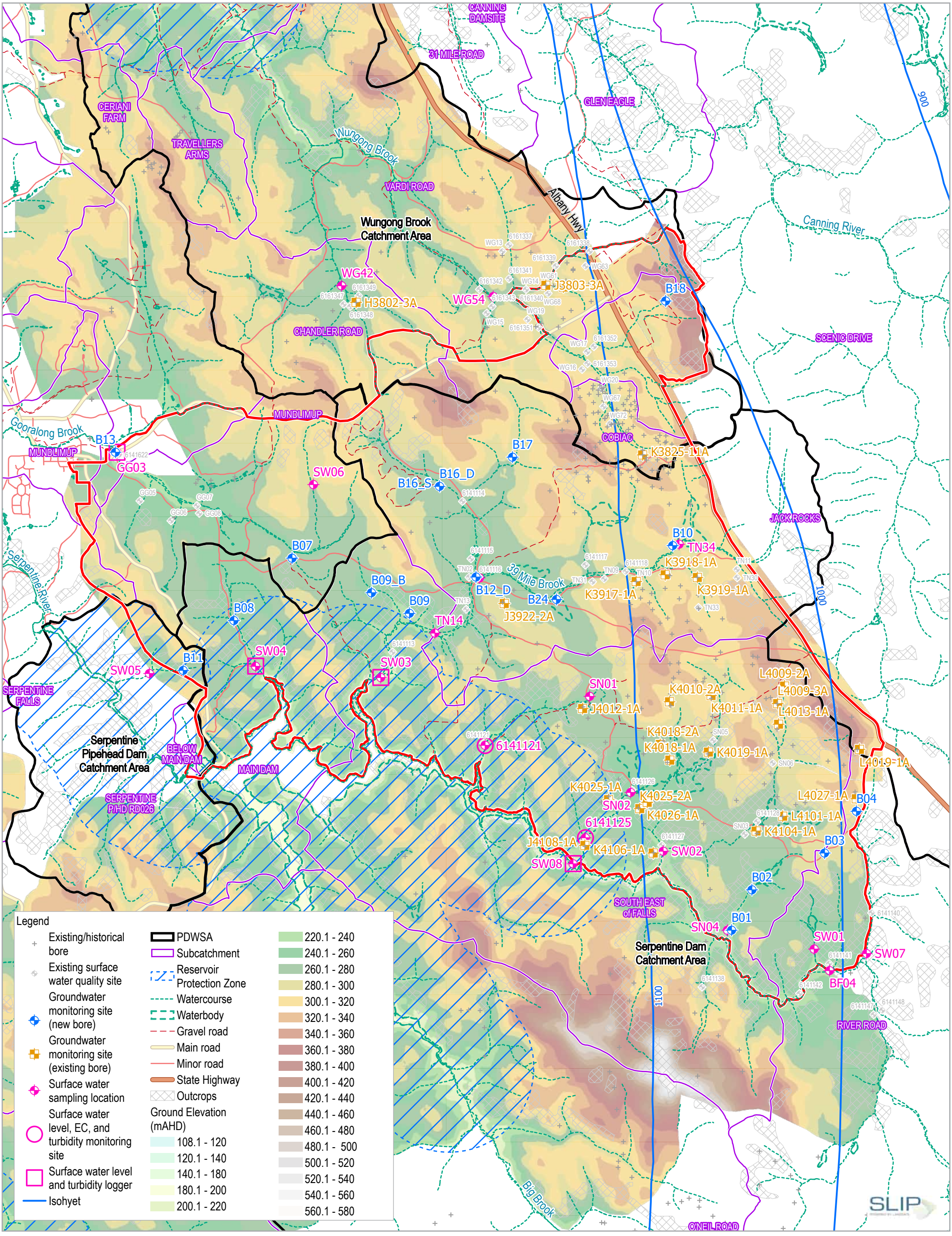
Table B-2 Surface water monitoring locations

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
Myara North					
WG54	SW grab	Existing Alcoa	Wungong/Cobiac subcatchment Downstream of confluence of tributaries that have proposed mining	422,064	6,425,587
WG42	SW grab	Existing Alcoa	Wungong/Chandler Rd subcatchment Downstream of confluence of tributaries that have proposed mining	418,488	6,425,833
GG03	SW grab Turbidity WQ logger Diver WL logger	Existing Alcoa	Downstream extent of Gooralong Brook near study boundary (DWER site Gooralong Brook 12) Site located in proximity to Jarrahdale Rd	413,191	6,421,910
SW06	SW grab	New	Upstream tributary of Gooralong Brook Possible no upstream mining	417,826	6,421,144
SW05	SW grab	New	Minor tributary along western mining margin Direct flow into lower reach of Serpentine River Pipehead Dam	413,955	6,416,689
SW04	SW grab Turbidity WQ logger Diver WL logger	New	Minor tributary Direct flow into Serpentine River Pipehead Dam	416,461	6,416,868
TN34	SW grab	Existing Alcoa	39 Mile Brook upper catchment Background/control monitoring location Monitoring at suspected groundwater dependent ecosystem (GDE) location	426,450	6,419,745
TN01	SW grab	Existing DWER	39 Mile Brook - mid catchment Monitoring at suspected GDE location	421,739	6,418,949
TN14	SW grab	Existing Alcoa Existing DWER	39 Mile Brook Jack Rocks stream gauging Equipment installed by Alcoa	420,689	6,417,649

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
SW03	SW grab Turbidity WQ logger Diver WL logger	New	Downstream extent of 39 Mile Brook catchment	419,652	6,416,696
SN01	SW grab	Existing Alcoa	Upstream Banksia Gully Monitoring at suspected GDE location	424,339	6,416,149
6141121	SW grab EC WQ logger Diver WL logger	Existing DWER	Banksia Gully (DWER site Serpentine 22) Mining in upper extent of catchment extends into 1100mm isohyet	421,839	6,415,049
SN02	SW grab	Existing Alcoa	Goldmine Gully - mid catchment Monitoring at suspected GDE location	425,306	6,413,889
6141125	SW grab EC WQ logger Diver WL logger	Existing DWER	Central tributary Goldmine Gully (DWER site Serpentine 26) Subcatchment crosses 1100 mm isohyet Mining proposed in lower and upper sections of catchment	424,189	6,412,849
SW02	SW grab	New	Eastern tributary with limited mining activity identified	426,078	6,412,502
SN04	SW grab	Existing Alcoa	Minor tributary with no mining identified in catchment Proposed background location	427,589	6,410,640
SW01	SW grab	New	Minor eastern tributary with limited mining activity identified	429,636	6,410,191
BF04	SW grab	Existing Alcoa	Minor eastern tributary with limited mining activity identified	430,000	6,409,690
SW07	SW grab	New	Probable upstream mining (south east boundary)	430,870	6,410,090
SW08	SW grab Turbidity WQ logger Diver WL logger	New	Downstream proposed Serpentine River conveyor crossing location	423,946	6,412,188

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
Holyoake					
6141333	SW grab	Existing DWER	Northern South Dandalup tributary	422,939	6,388,649
HSW05	SW grab Turbidity WQ logger EC WQ logger Diver WL logger	New	Northern South Dandalup tributary Downstream proposed conveyor crossing location	423,041	6,386,536
HSW01	SW grab	New	Monitoring location sited to capture upstream contributing catchment	428,385	6,386,875
BF20	SW grab	Existing Alcoa	Minor internal tributary of South Dandalup River	428,128	6,386,529
6141352	SW grab	Existing DWER	Location sited to capture upstream Duncans Rd Crossing catchment	428,089	6,384,999
6141349	SW grab	Existing DWER	South Dandalup River Location sited along eastern boundary of proposal area	426,439	6,384,349
HSW04	SW grab	New	Location sited to capture two external tributaries	429,199	6,381,349
6141005	SW grab Turbidity WQ logger EC WQ logger Diver WL logger	Existing DWER	South Dandalup River Location sited along western boundary of proposal area Existing data: 1970s, Cl data, limited EC and turbidity	424,563	6,383,974
SD31	SW grab	Existing Alcoa	Upstream boundary on central South Dandalup – Pindalup tributary. Just downstream of 614043 DWER gauging station (flow data to 1998)	427,208	6,377,990
6141340	SW grab	Existing DWER	Downstream location on South Dandalup – Pindalup tributary Existing data: 1975-1995, EC and turbidity	422,889	6,381,448
6141325	SW grab	Existing DWER	Minor southern tributary Direct discharge into South Dandalup Dam	419,089	6,382,349

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
DV04	SW grab	Existing Alcoa	Characterise discharge of southern Proposal area to Davis Brook (Murray River)	417,714	6,377,514
HSW02	SW grab	New	Location sited to capture upstream and external contributing catchment (Oak Brook)	426,143	6,374,994
6141470	SW grab	Existing DWER	Located on southern Proposal boundary	423,589	6,372,898
HSW03	SW grab Turbidity WQ logger EC WQ logger Diver WL logger	New	Characterise discharge of southern Proposal area to Swamp Oak Brook (Murray River) Located upstream of Lane Poole Reserve which has high social value	422,381	6,371,886



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Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 50

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GHD

Alcoa of Australia Limited

Hydrology Baseline Monitoring Report

Myara North Water Monitoring Locations

Project No. **125120591**

Revision No. **0**

Date **12/01/2022**

FIGURE B-1

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Print date: 12 Jan 2022 - 16:44

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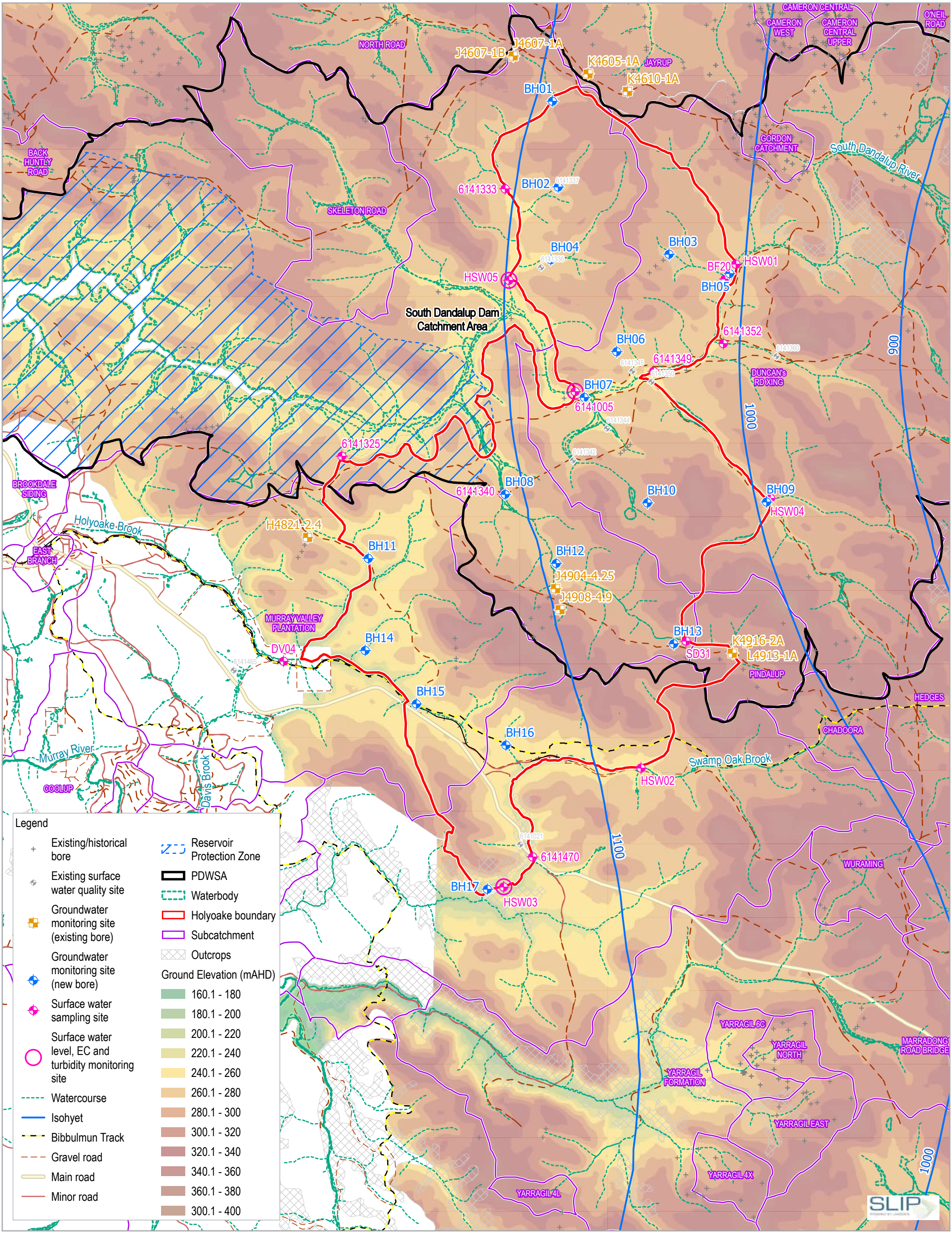

Paper Size ISO A3

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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GHD

Alcoa of Australia Limited
Hydrology Baseline Monitoring Report

Holyoake Water Monitoring Locations

Project No. **125120591**
Revision No. **0**
Date **12/01/2022**

FIGURE B-2

G:\61\12520591\GIS\Maps\Working\12520591-MAP-A-SW\12520591_Hydrology_Overview_PJH.aprx\12520591_A-2_SAQP_HolyoakeWaterMonitoringLocations_RevA
Print date: 12 Jan 2022 - 16:51

Data source: GHD: Proposed monitoring sites - 20200825, Subcatchments - 20200624; Alcoa: Myara North Boundary - 20200618, LiDAR Elevation - 20200626, Reservoir Protection Zone, Isohyet - 20200225, Streams - 20200617; GA: SRTM - 20200526; DWER: SW Monitoring Sites - 20200629; DoW: PDWSA - 20160607; Landgate: Roads - 20190128, . Created by: rbrown3

Appendix C

Laboratory and field duplicate QA/QC analysis summary

Overview

The following sections describe laboratory and field duplicate QA/QC, including summary tables of exceedances and outliers.

Relative percentage difference

The Relative Percentage Differences (RPD) is a measure of the representativeness of duplicate samples. Typical RPDs are expected to range between 0-50% however variation in RPDs may occur for organic analytes, as well as where concentrations of an analyte are very low and close to the laboratory limit of reporting, which exaggerates the percentage differences.

Where a result was reported below the LOR for one of the duplicate pair samples, the sample will be assigned the concentration of the LOR for RPD calculation purposes.

RPD results are summarised in Tables C-1 to C-4. As a conservative measure, for the RPD exceedances the higher value between primary and duplicate sample has been utilised in the assessment of results.

Holding times

Required holding times were breached for the surface water and ground water analysis outlined in Table C-5.

Samples could not be delivered to the laboratory within the holding time for pH due to the remoteness of the monitoring sites. Field analyses were also undertaken for pH for all samples to account for this.

Two and three day holding time exceedances for MBAS were unavoidable due to the analysis only being able to be undertaken in Sydney. No surface water sample exceeded LOR for MBAS which is considered consistent with the Site setting in State forest.

Aside from the above parameters, samples were delivered to the laboratory within the holding time, however extraction occurred 1 day outside of the required holding time. This is outside of GHD's control and is considered to be a nonconformance from the laboratory. Nevertheless, this will be considered when interpreting results.

Matrix spikes

Matrix spikes were carried out to test the potential for contamination of a sample (or samples) during sample collection. Matrix spike recovery was not determined for several analytes during the surface water and ground water sampling events. This is due to the sampled environment and is outside of GHD's and laboratory's control.

Recovery less than the lower data quality objective was reported for three samples, indicating the potential for under-reporting of sample concentration. It is noted that the concentration of these samples was below the detection limit, and therefore this low recovery is unlikely to impact suitability of the data.

The matrix spike outliers are outlined in Table C-6.

Table C-1 Myara North surface water summary of RPD exceedances

Analyte	Date	Primary sample		QC Sample		RPD %
E. coli (orgs/100mL)	12/10/2020	GG03	22	QA09	11	67
Enterococci (orgs/100 ml)	12/10/2020	GG03	43	QA09	20	73
Turbidity (NTU)	9/12/2020	SW05	0.2	QA15	1.0	133

Table C-2 Holyoake surface water summary of RPD exceedances

Analyte	Date	Primary sample		QC Sample		RPD %
Nitrogen (Total) (mg/L)	28/09/2020	6141333	0.4	QA07	0.2	67
Total Kjeldahl Nitrogen (mg/L)	28/09/2020	6141333	0.4	QA07	0.2	67

Table C-3 Myara North ground water summary of RPD exceedances

Analyte	Date	Primary sample		QC Sample		RPD %
Sulfate (filtered) (mg/L)	13/10/2020	B07	24	FD01	7	110
Phenanthrene (µg/L)	13/10/2020	B07	0.004	FD01	<0.002	67
PAHs (Sum of total) (µg/L)	13/10/2020	B07	0.004	FD01	<0.001	120

Table C-4 Holyoake ground water summary of RPD exceedances

Analyte	Date	Primary sample		QC Sample		RPD %
Pyrene (µg/L)	19/10/2020	BH07	0.002	FD02	<0.001	67
Fluoranthene (µg/L)	19/10/2020	BH07	0.002	FD02	<0.001	67
PAHs (Sum of Total) – Lab Calc (µg/L)	19/10/2020	BH07	0.004	FD02	<0.001	120

Table C-5 Holding time outliers

Analyte	Holding time (exceedance)	Sampling Event	Location	Sample ID(s)
pH	6 hrs (> 6 hrs)	All sampling events	Myara North/ Holyoake	All samples
Total Kjeldahl Nitrogen	2 days (1 day)	September 2020	Myara North	TN14
Organochlorine Pesticides	7 days (1 day)	September 2020	Myara North	SW02, SW03, SW04, SW05, SW06, 6141121, 6141125, SN01, SN02, QA06, SW08
Polynuclear Aromatic hydrocarbons	7 days (1 day)	September 2020	Myara North	SW02, SW03, SW04, SW05, SW06, 6141121, 6141125, SN01, SN02, QA06, SW08
	7 days (1 day)	October 2020	Myara North	B08, B10, B11, B24, J3803-4A, K3917-1A
Polynuclear Aromatic hydrocarbons (super trace)	7 days (1 day)	September 2020	Myara North	SW02, SW03, SW04, SW05, SW06, 6141121, 6141125, SN01, SN02, QA06, SW08
	7 days (1 day)	October 2020	Myara North	B08, B10, B11, B24, J3803-4A, K3917-1A
Explosives	7 days (3 days)	October 2020	Myara North	SW02, 6141125, GG03, SN01, SN02, SN04, TN14, TN34, WG42, QA09
	7 days (1 day)	October 2020	Holyoake	BH11, BH14, K4916-2A J4904-4.25
	7 days (1 day)	February 2021	Holyoake	BH07, BH09, BH13, BH12, BH08
Sulfonylurea Herbicides	7 days (1 day)	October 2020	Myara North	SW02, 6141125, GG03, SN01, SN02, SN04, TN14, TN34, WG42, QA09
Anionic Surfactants as MBAS	4 days (2 days)	October 2020	Myara North	SW08
	4 days (3 days)	August 2020	Holyoake	HSW05, 6141005, 6141333
Enterococci	1 day (1 day)	October 2020	Holyoake	HSW01, 6141349, QA11
Turbidity	2 day (5 days)	December 2020	Myara North	SW05, QA15, TN14, SW06,

Table C-6 Matrix spike outliers

Analyte	Sampling event	Location	Site	Comment
Mercury	August 2020	Myara North	SW05	Recovery less than lower data quality objective
Sulfate as SO4 2- Turbidimetric	September 2020	Myara North	WG42	MS recovery not determined, background level greater than or equal to 4x spike level.
	October 2020	Myara North	B12_D	
	August 2020	Holyoake	SW05	
Ammonia as N	September 2020	Myara North	WG42	
	October 2020	Myara North	B12_D	
	August 2020	Holyoake	HSW01	
Chloride	September 2020	Myara North	WG42	
Nitrite plus Nitrate as N	September 2020	Myara North	WG42	
	October 2020	Myara North	B12_D	
	August 2020	Holyoake	HSW01	
Manganese	October 2020	Myara North	B12_D	
	February 2021	Holyoake	BH05	
Mercury	August 2020	Holyoake	HSW01	Recovery less than lower data quality objective
Polynuclear Aromatic Hydrocarbons	February 2021	Myara North	B24	Recovery less than lower data quality objective

Appendix D

Calibration Certificates

ECO Environmental

Environmental monitoring & sampling equipment Rentals and sales.

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214 Lord St Perth WA 6000

EQUIPMENT INFORMATION

Instrument: YSIProDSS-1A

Serial Number: 17K102848 (Display)
17K103853(Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro DSS Display	☑	
YSI 4 port Sonde	☑	
- YSI pH / ORP probe	☑	
- YSI-Turbidity Probe	☑	
- YSI Cond/Temp Probe	☑	
- YSI ODO Sensor	☑	
Flow Cell	☑	
Probe Guard & weight	☑	
Storage/Calibration Sleeve (with Gasket)	☑	
Charger & PC Cable	☑	
Instruction Manual & Field Sheets	☑	
Battery Charged 100%	☑	

SENSOR CALIBRATION DETAILS

		Calibration Undertaken	Accuracy	Pass	Fail
Temperature		Factory Calibrated	±0.2°C	☑	☐
Dissolved Oxygen	☑	100% Saturation	±2%	☑	☐
		Pressure Compensation 1022 hPa		☑	☐
Conductivity	☑	1288mS/cm	±0.5%	☑	☐
	☑	Check linearity at 1.4mS/cm	±0.5%	☑	☐
Salinity		Auto Calibrated	±1%	☑	☐
pH	☑	pH 7.00	± 0.2	☑	☐
	☑	pH 4.00	± 0.2	☑	☐
ORP	☑	229 mV at 25 °C	±20mV	☑	☐
Turbidity		0, 124 NTU / FNU			
		Sonde – 17K103332	±0.3 NTU/FNU	☑	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Paul Goodgame

ECO Environmental Equipment Specialist

Date: 31.07.2020

ECO Environmental

Environmental monitoring
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EQUIPMENT INFORMATION

Instrument: YSIPP6B

Serial Number: 17F104994 (Display)

Lot Number: 12C100157 (Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro Plus Display	☑	
YSI Quatro Sonde	☑	
Flow Cell	☑	
Probe Guard	☑	
Rubber Storage/Calibration	☑	
Sleeve Calibration Cup + Cap	☑	
YSI Pro Series ProComm II Kit	☑	
Instruction Manual & Field Sheets	☑	
Spare Batteries (x 2)	☑	

SENSOR CALIBRATION DETAILS

	Calibration Undertaken		Accuracy	Pass	Fail
Temperature	Factory Calibrated		±0.2°C	☑	☐
Dissolved Oxygen	☑ 100% Saturation		±2%	☑	☐
	Pressure Compensation		1025 hPa	☑	☐
Conductivity	☑ 1288mS/cm		±0.5%	☑	☐
	☑ Check linearity at 1.4mS/cm		±0.5%	☑	☐
Salinity	Auto Calibrated		±1%	☑	☐
pH	☑ pH 7.00		± 0.2	☑	☐
	☑ pH 4.00		± 0.2	☑	☐
ORP	☑ 242 mV at	19 °C	±20mV	☑	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Tim Collins

ECO Environmental Equipment Specialist

Date: 06.08.2020

ECO Environmental

Environmental monitoring
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Rentals and sales.

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214 Lord St Perth WA 6000

EQUIPMENT INFORMATION

Instrument: YSIProDSS-2P

Serial Number: 15H104162 (Display)
17K103332 (Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro DSS Display	✓	
YSI 4 port Sonde	✓	
- YSI pH / ORP probe	✓	
- YSI-Turbidity Probe	✓	
- YSI Cond/Temp Probe	✓	
- YSI ODO Sensor	✓	
Flow Cell	✓	
Probe Guard & weight	✓	
Storage/Calibration Sleeve (with Gasket)	✓	
Charger & PC Cable	✓	
Instruction Manual & Field Sheets	✓	
Battery Charged 100%	✓	

SENSOR CALIBRATION DETAILS

		Calibration Undertaken		Accuracy	Pass	Fail
Temperature		Factory Calibrated		±0.2°C	✓	
Dissolved Oxygen	✓	100% Saturation		±2%	✓	
		Pressure Compensation		1020 hPa	✓	
Conductivity	✓	1288mS/cm		±0.5%	✓	
	✓	Check linearity at 1.4mS/cm		±0.5%	✓	
Salinity		Auto Calibrated		±1%	✓	
pH	✓	pH 7.00		± 0.2	✓	
	✓	pH 4.00		± 0.2	✓	
ORP	✓	240 mV at 20	°C	±20mV	✓	
Turbidity		0, 124 NTU / FNU Sonde – 15H101896		±0.3 NTU/FNU	✓	

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Paul Goodgame

ECO Environmental Equipment Specialist

Date: 04.09.2020

ECO Environmental

Environmental monitoring & sampling equipment Rentals and sales.

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EQUIPMENT INFORMATION

Instrument: YSIProDSS-2P

Serial Number: 15H104162 (Display)

17K103332 (Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro DSS Display	✓	
YSI 4 port Sonde	✓	
- YSI pH / ORP probe	✓	
- YSI-Turbidity Probe	✓	
- YSI Cond/Temp Probe	✓	
- YSI ODO Sensor	✓	
Flow Cell	✓	
Probe Guard & weight	✓	
Storage/Calibration Sleeve (with Gasket)	✓	
Charger & PC Cable	✓	
Instruction Manual & Field Sheets	✓	
Battery Charged 100%	✓	

SENSOR CALIBRATION DETAILS

		Calibration Undertaken		Accuracy	Pass	Fail
Temperature		Factory Calibrated		±0.2°C		
Dissolved Oxygen	✓	100% Saturation		±2%		
		Pressure Compensation		1013 hPa		
Conductivity	✓	1288mS/cm		±0.5%		
	✓	Check linearity at 1.4mS/cm		±0.5%		
Salinity		Auto Calibrated		±1%		
pH	✓	pH 7.00		± 0.2		
	✓	pH 4.00		± 0.2		
ORP	✓	236 mV at 22	°C	±20mV		
Turbidity		0, 124 NTU / FNU Sonde – 15H101896		±0.3 NTU/FNU		

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Paul Goodgame

ECO Environmental Equipment Specialist

Date: 01.10.2020

ECO Environmental

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EQUIPMENT INFORMATION

Instrument: H1001

Serial Number: 0742-T2

Equipment Check	Enclosed	Returned	Comment
Heron Water Level Meter	☑	☐	
Heron Carry Bag	☑	☐	
Spare battery 9v	☑	☐	

Inspection Details	Pass	Fail	Comment
De-con wash of tape (100m)	☑	☐	
De-con wash of reel	☑	☐	
Inspection for faults, corrosion, damage	☑	☐	
Meter in good working order, clean and ready for use	☑	☐	

This is to certify that where possible this instrument has been cleaned in accordance with the manufacture's general maintenance procedure as recommended in the instrument service manual.
ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Paul Goodgame

Equipment Specialist
ECO Environmental

Date: 09.10.2020

ECO Environmental

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EQUIPMENT INFORMATION

Instrument: WATERRA Power Pack: WPP1

Equipment Check	Enclosed	Returned	Comment
Waterra Power Pack	☑	☐	
Waterra Back Pack Frame	☑	☐	
Aluminium Carry Case	☑	☐	
Jerry Can (10L)	☑	☐	
Instruction Manual	☑	☐	

Inspection Details	Pass	Fail	Comment
De-con wash of Waterra Power Pack	☑	☐	
De-con wash of carry case	☑	☐	
Inspection for faults, corrosion, damage	☑	☐	
Unit in good working order, clean & ready for use	☑	☐	

This is to certify that where possible this instrument has been cleaned in accordance with the manufacture's general maintenance procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

T. Collins

Equipment Specialist ECO Environmental

Date: 15.09.2020

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EQUIPMENT INFORMATION

Instrument: WATERRA Power Pack: WPP1

Equipment Check	Enclosed	Returned	Comment
Waterra Power Pack	☑	☐	
Waterra Back Pack Frame	☑	☐	
Aluminium Carry Case	☑	☐	
Jerry Can (10L)	☑	☐	
Instruction Manual	☑	☐	

Inspection Details	Pass	Fail	Comment
De-con wash of Waterra Power Pack	☑	☐	
De-con wash of carry case	☑	☐	
Inspection for faults, corrosion, damage	☑	☐	
Unit in good working order, clean & ready for use	☑	☐	

This is to certify that where possible this instrument has been cleaned in accordance with the manufacture's general maintenance procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Paul Goodgame

Equipment Specialist ECO Environmental

Date: 09.10.2020

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EQUIPMENT INFORMATION

Instrument: YSIPP6B

Serial Number: 17F104994 (Display)

Lot Number: 12C100157 (Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro Plus Display	☑	
YSI Quatro Sonde	☑	
Flow Cell	☑	
Probe Guard	☑	
Rubber Storage/Calibration	☑	
Sleeve Calibration Cup + Cap	☑	
YSI Pro Series ProComm II Kit	☑	
Instruction Manual & Field Sheets	☑	
Spare Batteries (x 2)	☑	

SENSOR CALIBRATION DETAILS

	Calibration Undertaken		Accuracy	Pass	Fail
Temperature	Factory Calibrated		±0.2°C	☑	☐
Dissolved Oxygen	☑ 100% Saturation		±2%	☑	☐
	Pressure Compensation		1016 hPa	☑	☐
Conductivity	☑ 1288mS/cm		±0.5%	☑	☐
	☑ Check linearity at 1.4mS/cm		±0.5%	☑	☐
Salinity	Auto Calibrated		±1%	☑	☐
pH	☑ pH 7.00		± 0.2	☑	☐
	☑ pH 4.00		± 0.2	☑	☐
ORP	☑ 236 mV at	22 °C	±20mV	☑	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Jacques Couronne

ECO Environmental Equipment Specialist

Date: 12.02.2021

Appendix E

Borehole logs

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B01

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 427679, 6410639
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 264
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 7.70	**Logged By** AO
Date Drilled 11/09/2020 - 11/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Clayey gravel. Pea gravel and cobbles, 5-30mm sub rounded with significant silt and clay. Light brown, moist, loose .		264
0.5							263.5
1							263
1.5			Grout Depth: 0.0 - 3.0		Clay . Very stiff clay, plastic when moist. Minor iron cementing. Mottled white to bluish grey, slightly moist, stiff .		262.5
2							262
2.5							261.5
3			Slow release bentonite pellets Depth: 3.0 - 3.7				261
3.5							260.5
4		▽					260
4.5							259.5
5							259
5.5			Gravel pack: 3.2-6.4 mm. Depth: 3.7 - 7.7				258.5
6					Weathered dolerite. Weathered to extremely weathered medium grained dolerite. Significant silty and clay (weathering), red to brown, slightly moist, very stiff .		258
6.5							257.5
7							257
7.5					Dolerite. No sample - assumed fresh dolerite, wet, hard .		256.5
					Termination Depth at: 7.70 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B02

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 428185, 6411584
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 220
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 28.50	**Logged By** AO
Date Drilled 09/09/2020 - 09/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel, 2-20mm sub rounded with significant silt and clay. Light brown, moist, medium dense .		220
2					Caprock. Iron cemented caprock, with up to 20% fine grained sands. Red, slightly moist, dense .		218
4					Clayey silt. Sandy clayey silt. Beige, slightly moist, medium dense .		216
6					Sandy silt. Sandy silt with minor sand (fine grained). White, slightly moist, medium dense .		214
8					Clayey silt. Clayey silt with minor sand (fine grained). White/ red, slightly moist, medium dense .		212
10			Grout Depth: 0.0 - 19.0				210
12					Silty clay. Silty clay. Medium plasticity. Reddish., moist, soft .		208
14							206
16		▽					204
18							202
20			Slow release bentonite pellets Depth: 19.0 - 21.2				200
22					Silty clay. Silty clay with minor coarse sand (quartz). Medium plasticity. Green., very moist, soft .		198
24			Gravel pack: 3.2-6.4 mm. Depth: 21.2 - 28.5				196
26					Silty clay. Silty clay with minor coarse sand (quartz). Medium plasticity. Beige., wet/saturated, soft/loose .	Saturated at 26.5, first groundwater collected (2L/min), pH = 7.3, TDS = 460 mg/L, EC = 716 uS/cm	194
28					Weathered granite. Extremely weathered granite, quartz rich, weakly cemented. White, saturated, medium dense .	Flow at 28.5 (3L/min), pH = 6.1, TDS = 734 mg/L, EC = 1124 uS/cm	192
					Granite. Granite, dry, hard .		
					Termination Depth at: 28.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B03

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 429880, 6412496
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 251.5
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 23.90	**Logged By** AO
Date Drilled 08/09/2020 - 08/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Top soil. Grey silty sand with organic matter. Medium grained, poorly graded, moist, soft/firm .	Drilled to 23.5m, after 1h no water present	251
1					Silty gravelly sand. Grey Silty gravelly sand, minor clay. Medium grained, poorly graded, moist, soft/firm .		250
2					Gravelly sandy silt. Transitioning to silty clay, grey to light orange, slightly moist, medium dense/firm .		249
3					Silty Clay. Silty clay, fine. Partly cemented. Light orange to white, dry, medium dense/firm .		248
4							247
5							246
6							245
7			Grout Depth: 0.0 - 14.5				244
8							243
9							242
10							241
11							240
12					Silty Clay. Silty clay, fine. Partly cemented. Light red to yellow/brown, dry, medium dense/firm .		239
13							238
14							237
15			Slow release bentonite pellets Depth: 14.5 - 16.7				236
16							235
17							234
18							233
19							232
20			Gravel pack: 3.2-6.4 mm. Depth: 16.7 - 23.9				231
21					Sandy Clay. Sandy Clay. Orange, moist, soft/firm .		230
22					Sandy clay. Sandy Clay. Blue/grey, moist, soft/firm .		229
23	DC				Dolerite, basement. Dolerite (core), one small fracture., dry, hard .(diamond)		228
24					Termination Depth at: 23.90 m		227

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B04

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 430635, 6413463
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 269
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 36.00	**Logged By** AO
Date Drilled 07/09/2020 - 08/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel, iron cemented, 2-20mm sub rounded with limited silt and clay. Brown, moist, loose .		268
2					Caprock. Caprock, weakly cemented, dark red to brown, moist, medium dense .		266
4					Silty Clay. Silty clay, fine. Partly cemented. Beige, slightly moist, medium dense/firm .		264
6							262
8					Silty Clay. Silty clay, fine, powdery. Not cemented. White, slightly moist, medium dense/firm .		260
10					Silty Clay. Silty clay with sand, fine. Not cemented. White. Becoming grainy , slightly moist, medium dense/firm .		258
12			Grout Depth: 0.0 - 23.5		Silty Clay. As above, red/white/brown, slightly moist, medium dense/firm .		256
14							254
16							252
18							250
20							248
22		▽					246
24			Slow release bentonite pellets Depth: 23.5 - 27.5				244
26							242
28					Sandy clay. As above, light yellow becoming grainy (fine sand) and moist, moist, medium dense/firm .		240
30			Gravel pack: 3.2-6.4 mm. Depth: 27.5 - 35.5		Clayey Gravel. Weathered rock/saprock. Weakly cemented coarse sand with significant clay at 30-31 and 32.5-33. Gravel is angular quartz and feldspar, wet/saturated, soft/firm .	Wet/saturated (3L/min), pH = 7.18, TDS = 208 mg/L, EC = 321 uS/cm	238
32							236
34			Backfill Depth: 35.2 - 36.0				234
36					Termination Depth at: 36.00 m	Collapse, well installed at 35.2 Water level 22.9 mbgl after air lifting.	

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B07

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 417332, 6419413
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 292
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 8.00	**Logged By** AO
Date Drilled 19/08/2020 - 19/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Top soil. Silty gravel, coarse 5-10mm, poorly graded. Brown, moist, medium dense .		292
0.5					Silty gravel. Course 10-30mm, poorly graded. Brown, moist, medium dense .		291.5
1					Silty gravel. Course 30-50mm, poorly graded. Red/brown, slightly moist, dense .		291
1.5			Grout Depth: 0.0 - 3.0		Clayey sand. Clayey sand with minor gravel, transitioning to fine sandy clay, plastic. Red to beige. , slightly moist, firm .		290.5
2							290
2.5					Lateritic caprock. Cemented sands and gravels. Red, dry, hard .		289.5
3					Sandy clay. Medium grained sands, poorly graded. Grey, slightly moist, firm .		289
3.5			Slow release bentonite pellets Depth: 3.0 - 4.0				288.5
4					Sandstone. Iron cemented sands and gravels. Red/yellow, dry, hard .		288
4.5							287.5
5		▽					287
5.5							286.5
6			Gravel pack: 3.2-6.4 mm. Depth: 4.0 - 8.0		Dolerite. Weathered dolerite. Iron stained, coarse grained, fractured. Grey/black, saturated, hard .	Diamond core from 6.5 m. Saturated, minor flow (0.01 L/s), pH = 7.44, TDS = 377 mg/L, EC = 576 uS/cm	286
6.5	DC				Dolerite. Fresh dolerite with minor fractures. Dark grey, saturated, very hard .(diamond)		285.5
7							285
7.5						End of hole in hard basement dolerite. Flow from above. (0.01 L/s), pH = 5.34, TDS = 352 mg/L, EC = 542 uS/cm	284.5
8					Termination Depth at: 8.00 m		284

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B08

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 415946, 6417938
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 223
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 13.10	**Logged By** AO
Date Drilled 04/09/2020 - 04/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.7		Ferricrete/caprock. Pea gravel, iron cemented, 2-20mm sub rounded with significant silt and clay. Light brown, moist, loose .		
1					Clay. Mottled clay, stiff, minor silt/sand iron cementing. Light brown to cream, slightly moist, stiff .		222
2							221
3			Slow release bentonite pellets Depth: 0.7 - 6.1		Gravelly clay. Clay, variably stiff, with up to 50% angular quartz gravel, weakly cemented/brittle. Cream, saturated/moist, medium dense .		220
4		▽					219
5					Clayey gravel (Saprock). Saprock, gravel quartz, angular, weakly cemented, with clay/silt. White, saturated, medium dense .		218
6							217
7						Flow at 7 m (5L/30sec), pH = 7.04, TDS = 422 mg/L, EC = 585 uS/cm	216
8						Flow at 8.5 m (5L/30sec), pH = 6.5, TDS = 349 mg/L, EC = 555 uS/cm	215
9					Clayey gravel (Saprock). As above, increase in iron mineralisation, mottled. Brittle becoming hard. Brown, saturated, medium dense .		214
10			Gravel pack: 3.2-6.4 mm. Depth: 6.1 - 13.			Flow at 10 m (1L/s), pH = 6.4, TDS = 448 mg/L, EC = 694 uS/cm	213
11						Drop in flow 11-12m with more silty rock structur	212
12							211
13					Quartzite/metamorphic?. Quartz dominant rock. Very fine grained/glassy. Significant mafic minerals. Very hard with depth. White/dark brown, saturated, hard .	End of hole flow (1L/s), pH = 6.8, TDS = 422 mg/L, EC = 650 uS/cm	210
					Termination Depth at: 13.10 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B09

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420093, 6418114
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 230
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 3.20	**Logged By** AO
Date Drilled 28/08/2020 - 28/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.3		Silty sand. Medium grained sand, sub angular, with significant pea gravel. Light brown. , moist, loose .		230
0.2							229.8
0.4			Slow release bentonite pellets Depth: 0.3 - 0.5				229.6
0.6							229.4
0.8							229.2
1	DC				Granite. Fresh to slightly weathered granite, coarse grained. Minor sub vertical fracture at 2.4m, moist, hard .(diamond)		229
1.2							228.8
1.4							228.6
1.6							228.4
1.8							228.2
2		▽					228
2.2							227.8
2.4							227.6
2.6							227.4
2.8							227.2
3			Gravel pack: 3.2-6.4 mm. Depth: 0.5 - 3.2				227
3.2						Minor seepage only from airlift (<1L/min), pH = 7.3, TDS = 399 mg/L, EC = 615 uS/cm	226.8
3.4					Termination Depth at: 3.20 m		226.6
3.6							226.4
3.8							226.2

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B09_B

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 419196, 6418601
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 255
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 8.90	**Logged By** AO
Date Drilled 10/09/2020 - 10/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel and cobbles, 5-30mm sub rounded with significant silt and clay. Light brown, moist, loose .		254.5
0.5			Grout Depth: 0.0 - 1.8				
1							254
1.5					Sandy silt. Coarse sand and brown to white silt, slightly moist, stiff .		253.5
2							253
2.5							252.5
3			Slow release bentonite pellets Depth: 1.8 - 5.0		Sandy silt. Sandy silt with minor clay. Red/ white/beige, slightly moist, stiff .		252
3.5							251.5
4							251
4.5							250.5
5							250
5.5							249.5
6							249
6.5							248.5
7			Gravel pack: 3.2-6.4 mm. Depth: 5.0 - 8.9				248
7.5					Sandy silt. Weathered granite, quartz rich. Brown to white, wet/saturated, firm .	Wet/saturated, water level recorded at 7.55 m bgl	247.5
8		▽					247
8.5							246.5
9					Termination Depth at: 8.90 m		246
9.5							245.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B10

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426297, 6419709
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 292
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 21.50	**Logged By** AO
Date Drilled 25/08/2020 - 26/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel, fine grained cemented clasts 2-15mm, sub rounded. Silt matrix 20%. Light brown, moist, very loose .		292
1							291
2					Ferricrete/caprock. Iron cemented caprock. Significant silt/uncemented. Brown, moist, hard .		290
3					Ferricrete/caprock. As above, less cemented, moist, very stiff .		289
4					Silty clay. Clay with significant silt and minor sands. Light brown, dry/slightly moist, soft/firm .		288
5							287
6			Grout Depth: 0.0 - 12.		Silty clay. Clay with significant iron cementation. Red, dry/slightly moist, soft/firm .		286
7							285
8					Silty clay. As above. Colour change to red/brown, dry/slightly moist, soft/firm .		284
9							283
10							282
11		▽			Silty clay. As above. Grading to pink/orange, slightly moist, soft/firm .		281
12			Slow release bentonite pellets Depth: 12. - 14.		Silty clay. As above. Minor cemented white mottled clays, occasionally gravelly. Red/brown, very moist, firm .		280
13							279
14							278
15							277
16							276
17			Gravel pack: 3.2-6.4 mm. Depth: 14. - 21.		Gravelly clay. Clay with variably cemented gravels, mottled red/white. Increasingly hard with depth and rock texture, wet, very stiff .		275
18							274
19							273
20						Very hard at 21.5m, basement. Very minor seepage. (1L/2 mins), pH = 7.8, TDS = 357 mg/L, EC = 546 uS/cm	272
21			Backfill Depth: 21. - 21.				271
					Termination Depth at: 21.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B11

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 414746, 6416766
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 257
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 14.10	**Logged By** AO
Date Drilled 04/09/2020 - 04/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.5		Gravel. Pea gravel, iron cemented, 2-20mm sub rounded with significant silt and clay. Light brown, moist, loose .		
1					Ferricrete/caprock. Strongly cemented caprock, massive, dark red to brown, slightly moist, hard .		256
2					Silty clay. Clay, generally firm. Occasional gravel/iron cemented mottled. Light brown, cream with depth, moist, firm .		255
3						Becoming wet at 3m	254
4			Backfill Depth: 0.5 - 7.5				253
5							252
6							251
7		▽					250
						Saturated at 7.5	
8			Slow release bentonite pellets Depth: 7.5 - 10.				249
9					Gravelly clay. Brittle cemented quartz gravel and sand with 40% clay/weathered quartz. White to cream, moist, soft/firm .		248
10					Clayey sand. Coarse grained angular quartz sand, with significant silt and clay. Occasionally iron cemented zones. Red to dark brown, saturated, soft/firm .	Flow at 10m, slop only (<1L/10 secs), pH = 6.3, TDS = 84 mg/L, EC = 125 uS/cm	247
11						Flow at 11.5m (4L/15 secs), pH = 5.3, TDS = 140 mg/L, EC = 215 uS/cm	246
12			Gravel pack: 3.2-6.4 mm. Depth: 10. - 14.		Gravelly clay. Extremely weathered rock/saprock. Weakly cemented gravel with significant clay. Gravel is angular quartz and feldspar. Iron stained, brown, saturated, soft/firm .		245
13							244
14			Backfill Depth: 14. - 14.		Granite?. Refusal. No sample. Likely granite, , .	Flow at 14m (1 L/s), pH = 5.4, TDS = 131 mg/L, EC = 190 uS/cm	243
					Termination Depth at: 14.10 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B12_D

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 421673, 6418956
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 228
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 24.50	**Logged By** AO
Date Drilled 20/08/2020 - 21/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Gravel 5-50mm, with minor sand and silt. Red, saturated, Loose .	Minor flow in perched unit. (<0.01 L/s), pH = 6.13, TDS = 59 mg/L, EC = 92.5 uS/cm	228
1		▽			Sandy clay. Clay with medium to fine grained sands and silts, poorly graded. Light Beige/brown, slightly moist, medium dense .		227
2							226
3					Silty clay. As above, increase in clay, light beige. , moist, medium dense .		225
4					Sandy clay. As above, minor increase in sand. Light brown/reddish brown, moist, medium dense .		224
5							223
6							222
7							221
8			Grout Depth: 0.0 - 16.				220
9					Sandy clay. As above, some cementing of sands, minor gravel. Light brown, saturated, soft .		219
10						Minor flow at 11m, possibly from above. (7L/min), pH = 5.65, TDS = 364 mg/L, EC = 560 uS/cm	218
11							217
12							216
13					Sandy clay. As above, slight increase in sands/gravel 1-5mm. , wet, soft .		215
14							214
15					Silty/gravelly clay. As above, minor cementing and gravels. Occasionally very firm and dry. , moist, medium dense .		213
16			Slow release bentonite pellets Depth: 16. - 17.				212
17							211
18							210
19							209
20			Gravel pack: 3.2-6.4 mm. Depth: 17. - 24.				208
21						Flow in weathered basement/sands. (40L/min), pH = 6.26, TDS = 416 mg/L, EC = 642 uS/cm	207
22							206
23					Granite. Coarse sand, and weathered granite, iron stained, weakly cemented. , wet, medium dense .		205
24					Granite. Fresh granite. Minor iron staining. , wet, hard .		204
					Termination Depth at: 24.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B12_S

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 421673, 6418956
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 223
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 3.50	**Logged By** AO
Date Drilled 21/08/2020 - 21/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.2		Gravel. Gravel 5-50mm, with minor sand and silt. Red, saturated, Loose .		222.
0.2							
0.4			Slow release bentonite pellets Depth: 0.2 - 0.5				222.
0.6							222.
0.8							222.
1					Sandy clay. Clay with medium to fine grained sands and silts, poorly graded. Light Beige/brown, slightly moist, medium dense .	Minor flow in perched unit. (<0.01 L/s), pH = 6.13, TDS = 59 mg/L, EC = 92.5 uS/cm	222
1.2							221.
1.4		▽					221.
1.6							221.
1.8					Silty clay. As above, increase in clay, light beige. , moist, medium dense .		221.
2			Gravel pack: 3.2-6.4 mm. Depth: 0.5 - 3.5				221
2.2							220.
2.4							220.
2.6							220.
2.8							220.
3							220
3.2							219.
3.4							219.
3.6					Termination Depth at: 3.50 m		219.
3.8							219.

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B13

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 413149, 6421902
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 228
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 18.50	**Logged By** AO
Date Drilled 31/08/2020 - 31/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Clayey gravel. Pea gravel, iron cemented, 2-20mm sub rounded with significant silt and clay. Light brown, wet/moist, loose .		228
1							227
2		▽			Sandy clay. Clay with significant fine to medium grained sand/silt, cemented in parts, clay increasing with depth. Light brown. , moist, soft .		226
3							225
4			Grout Depth: 0.0 - 7.5		Sandy clay. As above, becoming cream to white, moist, soft .		224
5						Minor flow from 5.5m (3L/30 sec), pH = 7.5, TDS = 154 mg/L, EC = 227 uS/cm	223
6							222
7					Gravelly clay. Kaolinitic clay, with up to 40% quartz sand and gravel, angular. Partly cemented. White, saturated, soft .	Flow increasing with depth, gravel zones (5L/12 sec), pH = 7.3, TDS = 144 mg/L, EC = 220 uS/cm	221
8			Slow release bentonite pellets Depth: 7.5 - 8.5				220
9							219
10					Gravelly clay. As above, increase in feldspar gravel, brown, saturated, medium dense .		218
11							217
12							216
13			Gravel pack: 3.2-6.4 mm. Depth: 8.5 - 18.				215
14					Silty gravel. Feldspar and quartz angular gravel and weakly cemented/fractured rock, angular to blocky, with significant sand and minor clay. Light brown, saturated, medium dense .	High flow 14-16m in fractures and gravels (1 L/s), pH = 5.5, TDS = 133 mg/L, EC = 205 uS/cm	214
15							213
16							212
17							211
18					Quartzite. Quartz and feldspar rock. Massive with milky to opaque zones, highly fractured, hard with depth. Brown, saturated, very dense .		210
					Termination Depth at: 18.50 m		

Notes

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Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B16_D

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420800, 6421112
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 264
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 17.50	**Logged By** AO
Date Drilled 27/08/2020 - 28/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Clayey gravel. Pisolitic/pea gravel, well rounded, 2-15mm with 30% silt and fine graved sand. Light brown, moist, loose .		264
1							263
2					Clay. Kaolinitic clay, partly stiff. Minor sand 1.5-2.0m, uniform from 2m. , slightly moist, soft/firm .		262
3							261
4			Grout Depth: 0.0 - 8.5				260
5							259
6							258
7							257
8		▽					256
9			Slow release bentonite pellets Depth: 8.5 - 10.				255
10						First water strike, seepage only	254
11					Sandy clay. Clay with fine grained to coarse grained sand and iron cemented silt/gravel. Mottled red to white. , saturated, soft/firm .		253
12							252
13						Good flow (4L/30 sec), pH = 6.1, TDS = 420 mg/L, EC = 650 uS/cm	251
14			Gravel pack: 3.2-6.4 mm. Depth: 10. - 17.				250
15					Gravelly sand. Weakly cemented sand and gravel, coarse grained sand to 2 mm, sub angular, felsic and quartz. With significant slit and clays. Extremely weathered granite. Brown to white, saturated, firm .		249
16							248
17					Granite. Slightly weathered to extremely weathered curse grained granite, quartz dominant. , saturated, hard .	End of hole flow in weathered granite (8L/30 sec), pH = 6.06, TDS = 455 mg/L, EC = 686 uS/cm	247
					Termination Depth at: 17.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B16_S

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420800, 6421112
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 264
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 4.00	**Logged By** AO
Date Drilled 28/08/2020 - 28/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.1		Clayey gravel. Pisolitic/pea gravel, well rounded, 2-15mm with 30% silt and fine graved sand. Light brown, moist, loose .		263.8
0.2			Slow release bentonite pellets Depth: 0.1 - 0.5				263.6
0.4							263.4
0.6							263.2
0.8							263
1							262.8
1.2							262.6
1.4					Clay. Kaolinitic clay, partly stiff. Minor sand 1.5-2.0m, uniform from 2m. , slightly moist, soft/firm .		262.4
1.6							262.2
1.8							262
2			Gravel pack: 3.2-6.4 mm. Depth: 0.5 - 4.0				261.8
2.2							261.6
2.4							261.4
2.6		▽					261.2
2.8							261
3							260.8
3.2							260.6
3.4							260.4
3.6							260.2
3.8							260
4					Termination Depth at: 4.00 m		259.8

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B17

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422519, 6421796
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 280
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 10.70	**Logged By** AO
Date Drilled 26/08/2020 - 26/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.9		Gravel. Course grained pisolitic/pea gravel, with silt and sand. Red/brown, moist, very loose .		280
0.5					Ferricrete/caprock. Iron cemented caprock, cemented gravel concretions. Very hard, slightly moist, hard .		279.5
1							279
1.5							278.5
2			Slow release bentonite pellets Depth: 0.9 - 3.5		Silty/sandy clay. Clay with significant fine grained to medium grained sand and minor gravel. Sand and gravel is cemented lithic fragments, angular. Light brown/cream, moist, soft .		278
2.5							277.5
3							277
3.5							276.5
4							276
4.5							275.5
5							275
5.5							274.5
6							274
6.5							273.5
7		▽	Gravel pack: 3.2-6.4 mm. Depth: 3.5 - 10.				273
7.5					Silty sand. Cemented sands, iron and partly cemented sands, with significant silt/minor clay, moist, stiff .		272.5
8							272
8.5							271.5
9					Gravelly clay. Extremely weathered granite/saprock, quartz rich, weakly cemented. White, wet, firm .		271
9.5						Seepage at 10m. (2L/30 sec), pH = 8.2, TDS = 157 mg/L, EC = 233 uS/cm	270.5
10					Gravel/Granite. Course grained angular quartz (2.4mm) with significant cream clays. Very hard at 10.7 in fresh granite, saturated, hard .	Flow increasing in gravel/granite refusal (5L/30 sec), pH = 6.2, TDS = 170 mg/L, EC = 263 uS/cm	270
10.5							269.5
					Termination Depth at: 10.70 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B18

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426132, 6425488
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 339
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 8.20	**Logged By** AO
Date Drilled 26/08/2020 - 26/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.4		Gravelly sand. Course grained sand/lateritic gravel, with significant silt. Light brown, moist, loose .		339
0.5			Slow release bentonite pellets Depth: 0.4 - 1.0				338.5
1					Sandy clay. Medium grained sand 30-50% with iron cemented nodules. Brown, , medium dense .		338
1.5							337.5
2					Ferricrete/caprock. Iron cemented caprock, with up to 50% fine grained sands, significant silty clay white to brown, increasing with depth. Brown, moist, firm .		337
2.5							336.5
3							336
3.5							335.5
4		▽	Gravel pack: 3.2-6.4 mm. Depth: 1.0 - 7.8				335
4.5					Silty clay. Stiff clay, mottled white to light brown, dry/slightly moist, firm/soft .		334.5
5							334
5.5							333.5
6							333
6.5					Sandy clay. Clay with significant quartz sand, occasionally cemented and remnant rock fabric. Yellow/light brown, moist, stiff .		332.5
7							332
7.5					Granite. Coarse grained, quartz rich. Significant iron staining. Fresh with depth. Grey, moist, hard .	Basement granite, very minor seepage only. No flow	331.5
8			Backfill Depth: 7.8 - 8.2				331
8.5					Termination Depth at: 8.20 m		330.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B24

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 423558, 6418439
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 255
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 24.90	**Logged By** AO
Date Drilled 21/08/2020 - 25/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
1	AH		Grout Depth: 0.0 - 9.5		Silty/gravelly clay. Clay with significant gravel, sand and silt. Gravel is ferricrete/pea gravel to 40mm. Light brown. , moist, loose .		254
2		▽			Ferricrete/caprock. Iron cemented caprock. Vuggy to 20mm. Minor clay. Red/brown, moist, hard .		253
3					Silty clay. Mottled clay with silt. Red brown to white, moist, firm/soft .		252
4					Clay. Plastic clay, with minor sand and silt (Saprolitic clay). White to light grey, moist, firm/soft .		251
5							250
6						Seepage at 7m. Very silty. (10L/4mins), pH = 6.2, TDS = 172 mg/L, EC = 265 uS/cm	249
7							248
8							247
9							246
10			Slow release bentonite pellets Depth: 9.5 - 11.		Silty clay. Clays with minor iron cementing. Becoming mottled clay. Grey to red/brown, moist/dry, firm/soft .	Seepage at 10m. (1L/min), pH = 5.3, TDS = 165 mg/L, EC = 253 uS/cm	245
11							244
12					Clay. Plastic clay, minor silt. Mottled. Cream. Dry in parts. , moist/dry, firm/soft .		243
13							242
14					Clay. Plastic clay, minor silt. Minor iron cementing. Red/brown, moist, firm/soft .		241
15							240
16							239
17			Gravel pack: 3.2-6.4 mm. Depth: 11. - 24.				238
18							237
19							236
20					Gravelly clay. Extremely weathered rock, clays and cemented clays. Significant quartz in clay matrix. , saturated, dense .		235
21							234
22							233
23							232
24					Granite. Weathered granite. Brittle to hard. Quartz dominant. Iron stained. White to grey. , saturated, hard .	EOH in granite. Minor flow. (4L/min), pH = 5.22, TDS = 261 mg/L, EC = 387 uS/cm	231
25					Termination Depth at: 24.90 m		230

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH01

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424054, 6390718
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 259
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 29.50	**Logged By** AO
Date Drilled 12/10/2020 - 13/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Topsoil, silty sand, with minor pea gravel, brown. , moist, loose .		258
2					Caprock/clayey gravel. Lateritic caprock, iron cemented, fine grained, with 40% clay and silty clay. Brown, slightly moist, very stiff .		256
4					Clay/Silty clay. White clay/silty clay. Stiff at first, then powdery. White, dry, soft .		254
6							252
8		▽	Grout Depth: 0.0 - 16.8		Silty clay. As above, transition to yellow/light brown, dry, soft .		250
10					Silty/Sandy clay. Silty clay with minor quartz angular sand. Pink to orange, very moist, soft .		248
12							246
14					Gravelly clay. Silty clay with significant quartz gravel and sand. Bands of angular quartz, milky to white. Sugary 13-13.5m. Occasionally rock texture. , saturated, soft/firm .	Minor flow	244
16							242
18			Slow release bentonite pellets Depth: 16.8 - 18.9		Clay/sandy clay. As above, increase in clay. Fine grained sand and gravel to 10%. Brown, saturated, soft/firm .	Flow increasing slightly	240
20					Quartz/clay. Quartz vein, milky to translucent quartz, dark mineral veins, with 30% clay, saturated, stiff .		238
22					Sandy clay. Silty clay with significant quartz gravel and sand. Occasionally weak rock structure. Sand to 30%. Light brown, saturated, medium dense .		236
24			Gravel pack: 3.2-6.4 mm. Depth: 18.9 - 29.5				234
26					Clayey gravel. Extremely weathered rock (granite assumed). Quartz and feldspar angular gravel. Firm with depth. Light brown., saturated, dense .		232
28						Flow increasing in basement gravels	230
30					Termination Depth at: 29.50 m	End of hole in transition to basement. No basement rock sampled.	

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH02

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424192, 6388696
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 260
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 17.50	**Logged By** EL
Date Drilled 02/10/2020 - 12/10/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm, brown, wet, loose .		
1					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		259
2					Clayey Silt. Pale brown, silt dominant fines, weakly cemented, dry, dry, soft .		258
3					Clayey Silt. White, silt dominant fines, strongly cemented, dry, dry, soft .		257
4							256
5			Grout Depth: 0.0 - 10.5		Clayey Silt. White, silt dominant fines, very weakly cemented, dry, dry, soft .		255
6							254
7					Clayey Silt. Red, silt dominant fines, weakly cemented, dry, increasing clay content with depth, dry, soft .		253
8							252
9							251
10					Silty Clay. Grey and brown, soft, moderate plasticity, moist, moist, soft .		250
11			Slow release bentonite pellets Depth: 10.5 - 11.5		Silty Clay. Brown, very moist, soft, high plasticity, highly weathered granite fragments (1-60mm), very moist, soft .		249
12		▽					248
13							247
14			Gravel pack: 3.2-6.4 mm. Depth: 11.5 - 17.7		Clayey Sand. Grey/brown, fine to coarse grained, well graded, poorly sorted, highly weathered granite/quartz, angular (1-25mm), wet, soft .		246
15					Silty Clay. Brown, clay dominant fines, soft, moderate plasticity, wet, soft .		245
16							244
17					Weathered Granite. Weathered quartz rich granite, medium grained,		243
					Termination Depth at: 17.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH03

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426806, 6387108
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 274
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 40.20	**Logged By** EL
Date Drilled 29/09/2020 - 30/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Sand. Pale grey to brown, fine to medium grained, poorly graded, well sorted, subangular/subrounded, wet, loose .		274
2					Sandy Clay. Brown, soft, moderate plasticity, moist, soft .		272
4					Clayey Silt. White, silt dominant fines, weak cementation, dry, soft .		270
6							268
8					Clayey Silt. Brown/orange, silt dominant fines, weak cementation, increasing clay content with depth, dry, soft .		266
10							264
12			Grout Depth: 0.0 - 24.0				262
14							260
16							258
18							256
20		▽			Silty Clay. Brown, clay dominant fines, weakly cemented, soft, moderate plasticity, moist, soft .		254
22							252
24			Slow release bentonite pellets Depth: 24.0 - 26.5		Clay. Brown, soft, moderate plasticity, minor granite and quartz fragments (1-5mm), wet, soft .		250
26						Flow increasing in the weathered basement, high yield	248
28					Highly weathered granite. Highly weathered quartz rich granite, very grainy (1-5mm, angular) in brown clay matrix, wet, hard .		246
30							244
32			Gravel pack: 3.2-6.4 mm. Depth: 26.5 - 40.2				242
34							240
36							238
38							236
40					Granite. Medium grained granite, weathered, high quartz component, wet, hard .		234
					Termination Depth at: 40.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH04

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424015, 6386978
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 242
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 29.70	**Logged By** EL
Date Drilled 01/10/2020 - 01/10/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm, brown, wet, loose .		
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		240
4					Clayey SAND. Pale brown, fine to coarse grained, well graded, poorly sorted, angular. Weathered quartz fragments, 1-50mm, moist, loose .		238
6					Clayey Silt. Pale yellow/cream, very weakly cemented, silt dominant fines, dry, soft .		236
8					Clayey Silt. White, silt dominant fines, uncemented, dry, soft .		234
10			Grout Depth: 0.0 - 19.0		Clayey Silt. Brown/red, silt dominant fines, weakly cemented, clay content increasing with depth, dry, soft .		232
12					Clayey Silt. Brown/red, silt dominant fines, weakly cemented, clay content increasing with depth, moist, soft .		230
14					Clayey Silt. Brown/red, silt dominant fines, weakly cemented, clay content increasing with depth, very moist, soft .		228
16		▽					226
18					Silty Clay. Brown, clay dominant fines, soft, moderate plasticity, increasing clay content with depth, very moist, soft .		224
20			Slow release bentonite pellets Depth: 19.0 - 22.0				222
22							220
24			Gravel pack: 3.2-6.4 mm. Depth: 22.0 - 29.7		Sandy Clay. Brown, very soft, moderate plasticity, clay dominant fines, wet, soft .		218
26					Clayey Sand. Highly weathered quartz (1-2mm), angular, fine to coarse grained, well graded, poorly sorted, wet, loose .		216
28					Sandy Clay. Brown, very soft, moderate plasticity, clay dominant fines, highly weathered quartz (1-2mm), angular, wet, soft .	Flow increasing in weathered basement, low yield	214
30					Clayey Sand. Highly weathered quartz (1-2mm), angular, fine to coarse grained, well graded, poorly sorted, wet, loose .		212
32					Highly weathered granite. Highly weathered quartz rich granite, very grainy (1-5mm, angular) in brown clay matrix, wet, hard .		210
34					Granite. Medium grained granite, weathered, high quartz component, wet, hard .		208
					Termination Depth at: 29.70 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH05

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 428234, 6386651
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 233
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 14.20	**Logged By** EL
Date Drilled 29/09/2020 - 29/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		
1					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		232
2					Clayey Gravel. Red/brown, brown, iron cemented gravel, subrounded, moist, loose .		231
3			Grout Depth: 0.0 - 4.8		Clayey Silt. Pale red, turning white at 3m, silt dominant fines, weak cementation, minor ferrite band at 4m, dry, soft .		230
4							229
5			Slow release bentonite pellets Depth: 4.8 - 6.9				228
6					Clayey Silt. Dark red, silt dominant fines, very weak cementation, dry, soft .		227
7							226
8					Clayey Silt. Orange, silt dominant fines, very weak cementation, moist, soft .		225
9					Silty Clay. Clay dominant fines, brown, soft, moderate plasticity, moist, soft .		224
10			Gravel pack: 3.2-6.4 mm. Depth: 6.9 - 14.				223
11		▽			Clay. Clay dominant fines, brown, high plasticity, soft, highly weathered granite and quartz fragments (2-3mm), angular, wet, soft .		222
12							221
13					Highly weathered granite. Highly weathered granite/quartz in a brown clayey matrix, fragments (4-10mm), angular, wet, hard .		220
14					Granite. Medium grained granite, unweathered, minor quartz component, wet, hard .	Flow increasing in the weathered basement, low yield	219
					Termination Depth at: 14.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH06

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 425573, 6384809
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 272
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 40.30	**Logged By** EL
Date Drilled 24/09/2020 - 25/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		272
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		270
4					Clayey Silt. silt dominant fines, very weak cementation pale brown getting lighter with depth to white, increasing clay content with depth, slightly moist, soft .		268
6							266
8					Clayey Silt. silt dominant fines, very weak cementation pale red, turning white (11-12.5), increasing clay content with depth, slightly moist, soft .		264
10							262
12							260
14			Grout Depth: 0.0 - 30.8				258
16					Silty Clay. clay dominant fines, very weak cementation, soft, moderate plasticity. Orange/dark red. Increasing clay content with depth, slightly moist, soft .		256
18							254
20							252
22					Silty Clay. Clay dominant fines, red/brown, with white clay clods + quartzite grains, soft, high plasticity, moist, soft .		250
24		▽			Silty Clay. Clay dominant fines, red/brown very grainy with quartzite in soft brown clayey matrix, wet, soft .		248
26							246
28							244
30			Slow release bentonite pellets Depth: 30.8 - 33.1				242
32							240
34							238
36			Gravel pack: 3.2-6.4 mm. Depth: 33.1 - 40.3		Highly weathered granite. Highly weathered quartz rich granite, very grainy in brown clay matrix, wet, soft .		236
38							234
40						Flow increasing in the weathered basement	232
					Termination Depth at: 40.30 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH07

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424805, 6383732
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 251
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 18.00	**Logged By** EL
Date Drilled 23/09/2020 - 23/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		
1							250
2					Clayey Silt. silt dominant fines, very grainy and high in quartzite, soft. Brown getting lighter with depth, moist, soft .		249
3					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, dry, hard .		248
4			Grout Depth: 0.0 - 8.7		Silty Clay. Dark red, soft with a moderate plasticity. weakly cemented. Turning pale brown/yellow from 4.5m with a ferrite band at 6m, dry, soft .		247
5							246
6							245
7					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, dry, hard .		244
8					Clayey Silt. silt dominant fines, weakly cementing, dark red/brown, slightly moist, soft .		243
9			Slow release bentonite pellets Depth: 8.7 - 10.		Silty Clay. clay dominant fines, weakly cementation, soft, moderate plasticity, dark red/brown, clay content increasing with depth, moist, soft .		242
10							241
11							240
12		▽					239
13							238
14			Gravel pack: 3.2-6.4 mm. Depth: 10. - 18.				237
15					Silty Clay. clay dominant fines, weak cementation, soft, moderate plasticity, dark red/brown, clay content increasing with depth. Highly weathered granite/quartzite at 13-14m. Colour change 16-17m(brown), wet, soft .		236
16							235
17					Clayey Silt. silt dominant fines, very weak cementation, brown, moist, soft .		234
18					Granite. Medium grained granite, unweathered, rich in quartz, wet, hard .	Flow decreasing with depth	233
19					Termination Depth at: 18.00 m		232

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH08

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422941, 6381445
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 246
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 19.00	**Logged By** AO
Date Drilled 17/09/2020 - 17/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Lateritic gravel and cobbles, 5-60mm, sub rounded. With silt and sand. Brown, moist, loose .		246
1					Caprock/duricrust. Fine grained cemented ferricrete/caprock. Increasing clay and silt with depth. Occasionally very hard. Light brown to brown, moist, hard .		245
2					Silty clay. Clay and silt, occasionally granular and weakly cemented. White, dry , soft/firm .		244
3							243
4			Grout Depth: 0.0 - 9.0		Clay/ferricrete. Clay and weakly cemented ferricrete/fine grained sand. Clays are iron stained. Ferricrete occasionally very hard. Red/brown, moist, very stiff .		242
5							241
6					Clay . Medium plasticity clay. White to mottled pink 6-8m. Darker with depth. Micaceous. Minor quartz increasing from 13m. Quartz vein at 13.5m. Light orange/brown, moist, soft .		240
7							239
8		▽					238
9			Slow release bentonite pellets Depth: 9.0 - 11.5				237
10							236
11							235
12							234
13						First seepage. Slop only	233
14							232
15			Gravel pack: 3.2-6.4 mm. Depth: 11.5 - 19.0				231
16							230
17							229
18					Granite. Weathered granite, course grained 2mm, quartz rich. Very hard with depth. Pink, wet, ver dense .	Flow increasing in weathered basement.	228
19					Termination Depth at: 19.00 m		227

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH09

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 429106, 6381269
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 275
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 28.20	**Logged By** EL
Date Drilled 22/09/2020 - 23/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		274
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		272
4					Silty Clay. clay dominant fines, weakly cementing, pale red to white, firm, high plasticity, moist, firm .		270
6					Clayey Silt. Silt dominant fines, weakly cementing, pale brown/cream, dry, soft .		268
8					Silty Clay. Clay and silt, occasionally granular and weakly cemented. White, dry, soft .		266
10			Grout Depth: 0.0 - 19.1		Clayey Silt. Silt dominant fines, weakly cementing, brown/dark red, dry, soft .		264
12					Silty Clay. Clay dominant fines, weakly cementing, soft, moderate plasticity, moist, soft .		262
14		▽					260
16							258
18						Flow decreasing with depth - highest in the highly cemented clays	256
20			Slow release bentonite pellets Depth: 19.1 - 21.0		Clay. Brown clay, very soft, high plasticity weak cementation from 19.5m, wet, very soft .		254
22					Weathered granite. Medium grained granite, highly weathered with Strongly cemented hard clays, wet, hard .		252
24			Gravel pack: 3.2-6.4 mm. Depth: 21.0 - 282.		Weathered granite. Coarse grained, highly weathered granite, very gritty in a soft brown clay matrix, wet, hard .		250
26					Weathered granite. Highly weathered granite with weakly cemented hard clays, in very soft and very plastic clay matrix, wet, hard .		248
28					Termination Depth at: 28.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH10

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426113, 6381245
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 292
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 18.20	**Logged By** EL
Date Drilled 18/09/2020 - 21/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		
1					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		291
2							290
3					Clayey silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. , slightly moist, soft .		289
4			Grout Depth: 0.0 - 9.0				288
5							287
6							286
7					Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		285
8					Clayey silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. , slightly moist, soft .		284
9			Slow release bentonite pellets Depth: 9.0 - 10.5				283
10					Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		282
11					Clayey silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. , slightly moist, soft .		281
12							280
13							279
14			Gravel pack: 3.2-6.4 mm. Depth: 10.5 - 18.2		Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		278
15					Silty sand. Fine grained sand and silt, angular, quartz. Possibly sandy with depth. Cream to red/brown., moist, loose .		277
16	DC				Weathered granite. Medium grained granite, moderately to well weathered, quartz veins. , wet, hard .		276
17		▽			Granite. Medium grained granite, unweathered, minor quartz component, wet, hard .(diamond)		275
18						No flow due to diamond core	274
					Termination Depth at: 18.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH11

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 419714, 6379933
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 258
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 33.00	**Logged By** AO
Date Drilled 15/10/2020 - 19/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Gravelly clay. Pea gravel 5-15mm, sub rounded with 40% clay and silt. Brown, wet/very moist, loose .		258
2					Caprock. Iron cemented caprock. 20% silt and clay. Brown, moist, hard .		256
4			Grout Depth: 0.0 - 8.2		Clay. Stiff clay, mottled cream to brown, slightly moist, soft/firm .		254
6					Silty clay/silt. Powdery silt to clay, occasionally partly cemented and iron stained. White, dry, loose .		252
8			Slow release bentonite pellets Depth: 8.2 - 10.5		Clayey silt. As above, becoming orange to brown, slightly moist, loose .		250
10		▽			Clay. Plastic clay with trace of fine grained sand. Brown to red, saturated, loose/medium dense .		248
12					Clay. As above, grading to orange. , very moist, loose/medium dense .		246
14					Clay. As above, grading to red/pink orange, very moist, loose/medium dense .		244
16			Gravel pack: 3.2-6.4 mm. Depth: 10.5 - 22.5		Clay. As above grading to light brown, very moist, loose/medium dense .		242
18							240
20							238
22							236
24							234
26							232
28			Backfill Depth: 22.5 - 33.0				230
30						High torque forcing end of hole. Moist clays to base from 8.5m. Dipped static in rods of 9m.	228
32							226
					Termination Depth at: 33.00 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH12

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424142, 6379814
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 268
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 6.10	**Logged By** AO
Date Drilled 17/09/2020 - 18/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR		Grout Depth: 0.0 - 0.3		Silty gravel. Pea gravel with significant cobbles 5-50mm. Occasionally massive caprock. Dark brown, moist, loose/medium dense .		268
0.5							267.5
1			Slow release bentonite pellets Depth: 0.3 - 1.9		Clay. Stiff clay, plastic. Mottled cream. Quartz vein at 3.5m. , moist, medium dense .		267
1.5							266.5
2							266
2.5							265.5
3							265
3.5							264.5
4	AR	▽	Gravel pack: 3.2-6.4 mm. Depth: 1.9 - 6.1		Quartzite/Granite. Quartz rich granite. Quartz phenocrysts to 50mm. Large quartz vein at 4m. , moist, hard .(diamond)		264
4.5							263.5
5							263
5.5							262.5
6						No flow due to diamond core	262
6.5					Termination Depth at: 6.10 m		261.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH13

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426917, 6377918
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 289
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 34.00	**Logged By** EL
Date Drilled 21/09/2020 - 22/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		288
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, dry, hard .		286
4					Clayey Silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. Light brown clay clods present from 5-6m, dry, soft .		284
6							282
8							280
10					Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		278
12			Grout Depth: 0.0 - 24.5		Clayey Silt. Silt dominant fines, very weak cementing. Light brown, lighter with depth., moist, soft .		276
14					Silty Clay. Clay dominant fines, very weak cementing. Dark red/brown. White (with red mottles) clay clods present from 14-16m and 19m. Clay content increasing with depth, moist, soft .		274
16							272
18		▽					270
20					Silty Clay. Clay dominant fines, weak cementing. Brown/green. White (with red and black mottles (minor granite component?) clay clods @ 20m, moist, soft .		268
22							266
24			Slow release bentonite pellets Depth: 24.5 - 26.9				264
26							262
28			Gravel pack: 3.2-6.4 mm. Depth: 26.9 - 34.0		Silty Clay. Clay dominant fines, weak cementation, brown, very soft with moderate plasticity. Very granular with highly weathered quartz, wet, soft .		260
30							258
32					Weathered Granite. Medium grained granite, rich in quartz in a soft brown silty clay matrix, wet, hard .	Flow increasing in weathered basement	256
34					Mica Schist. dark grey schist with mica - layers easily broken with finger pressure, wet, hard .		254
					Termination Depth at: 34.00 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH14

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 419640, 6377768
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 224
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 38.60	**Logged By** DB
Date Drilled 14/10/2020 - 15/10/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0					Gravel, red/brown, well graded, sub rounded, with orange, plastic clay, dry, loose .		224
2					Clay with fine gravel, dry, loose .		222
					Sandy clay, white, moist, moderate plasticity, with sub rounded quartz grains , moist, soft/firm .		
4					Clay with gravel. Clay, white/yellow mottled, with coarse, sub rounded quartz grains, moist, soft/firm .		220
6					Clay, white, moist, moderate plasticity, moist, soft/firm .		218
8					Sandy clay, red, moist, moderate to highly plastic, moist, soft/firm .		216
10					Clay with sand, indurated, weakly to moderately cemented, minor vugs, moist, soft/firm .		214
					Sandy clay, orange, moderate plasticity, moist, moist, soft/firm .		
12			Grout Depth: 0.0 - 22.7				212
					Clay (kaolinite), high plasticity, moist, soft/firm .		
14					Clay with trace sand, red/orange, moderate to high plasticity, saturated, soft/firm .		210
16							208
18							206
20		▽			Clay, orange, highly plastic, saturated, soft/firm .		204
22			Slow release bentonite pellets Depth: 22.7 - 25.3				202
24					Quartzite, saturated, hard .		200
					Clay, orange, highly plastic, saturated, stiff .		
26							198
28							196
						10L/min	
30					Granite, highly weathered, with quartz grains, saturated, hard .		194
32			Gravel pack: 3.2-6.4 mm. Depth: 25.3 - 38.6				192
34							190
36							188
38							186
					Termination Depth at: 38.60 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH15

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420847, 6376506
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 212
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 9.30	**Logged By** AO
Date Drilled 13/10/2020 - 14/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Pea gravel, rounded, 10-20mm, with silt and sand. Dark brown, moist, loose .		212
0.5							211.5
1							211
1.5			Backfill Depth: 0.0 - 2.7				210.5
2					Clay. Stiff clay, grey to mottled. , dry, very stiff .		210
2.5							209.5
3			Slow release bentonite pellets Depth: 2.7 - 3.4				209
3.5							208.5
4							208
4.5					Silty clay. Transition from above into loose silty clay/silt. Powdery, white, dry, loose .		207.5
5							207
5.5							206.5
6			Gravel pack: 3.2-6.4 mm. Depth: 3.4 - 9.3				206
6.5	DC				Diorite/diabase/dolerite?. Sudden transition to fresh intrusive rock. Minor weathering for 50mm. Fine grained, dominance of quartz and dark minerals. Quartz bands of phenocrysts at 7m. Dark mineral phenocrysts at9-9.4m. Sub horizontal quartz veins. No open fractures. , dry, hard .(diamond)	Very minor moisture at top of basement rock.	205.5
7							205
7.5							204.5
8							204
8.5							203.5
9							203
9.5					Termination Depth at: 9.30 m		202.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH16

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422958, 6375535
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 261
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 34.00	**Logged By** AO
Date Drilled 19/10/2020 - 20/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Sand. Fine to medium grained sand. Quartz dominant. Light brown/grey, moist, loose .		260
2							
4					Clayey sand. As above with significant clay/silty to 40%, partly cemented/stiff. Grey, moist, stiff .		258
6					Silt. Powdery silt. Minor cementing and iron stained, trace to 10% fine grained quartz. White, slightly moist, soft .		256
8							254
10					Silt. As above, more floury, orange brown, slightly moist, soft .		252
12			Grout Depth: 0.0 - 25.5		Silt. As above, significant band of quartz, weakly cemented. White, slightly moist, stiff .		250
14					Silt. As above, floury silt, white, dry/slightly moist, loose .		248
16							246
18					Quartz. Possible pegmatite/quartz, white crystalline, friable, slightly moist, very stiff .		244
20					Silt/clay. Silt like above, becoming moist, minor quartz bands, weakly cemented in part. White to light orange, moist, soft .		242
22		▽					240
24						Becoming saturated in clays	238
26			Slow release bentonite pellets Depth: 25.5 - 27.5		Sandy clay. Grading from above with increase in quartz, gravel to and sand to 5 mm, angular. White to light brown, wet, stiff .		236
28							234
30			Gravel pack: 3.2-6.4 mm. Depth: 27.5 - 34.0				232
32					Gravelly clay. Grading from above with increase in quartz gravel to 10 mm, angular. White to light brown, wet, stiff .		230
34						Seepage only	228
					Termination Depth at: 34.00 m	End of hole, close to basement, difficult ~~drilling with clays/gravel blocking inner~~ tubes.	226

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH17

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422522, 6372129
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 221
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 25.20	**Logged By** AO
Date Drilled 20/10/2020 - 20/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
1	AR				Gravelly clay. Clay/silt/sandy clay with 20-40% pea gravel 5-30mm, weakly cemented. Dark brown, moist, loose .		220
2					Clay. Plastic clay, occasionally weakly cemented. Minor quartz gravel 2-10mm. Light brown, slightly moist, medium dense .		219
3							218
4					Ferricrete. Fine grained iron cemented sands, very hard in parts, slightly moist, loose/medium dense .		217
5					Silty clay. Silt and clay, with very minor cementing/iron staining. Pink to white, dry, loose .		216
6							215
7					Silty clay. As above, grading to orange, dry, loose .		214
8			Grout Depth: 0.0 - 15.7				213
9							212
10							211
11							210
12							209
13							208
14		▽					207
15							206
16			Slow release bentonite pellets Depth: 15.7 - 17.5		Clay. Grading from above, becoming moist, moist, loose .		205
17					Gravelly clay. Clay with up to 30% quartz gravel to 10mm. Angular, mostly friable, wet, loose/medium dense .		204
18							203
19							202
20						Minor seepage	201
21			Gravel pack: 3.2-6.4 mm. Depth: 17.5 - 25.2				200
22							199
23					Clay. As above, drop in quartz gravel, wet, loose/medium dense .		198
24							197
25						End of hole minor flow only. End due to difficult drilling in clays.	196
					Termination Depth at: 25.20 m		

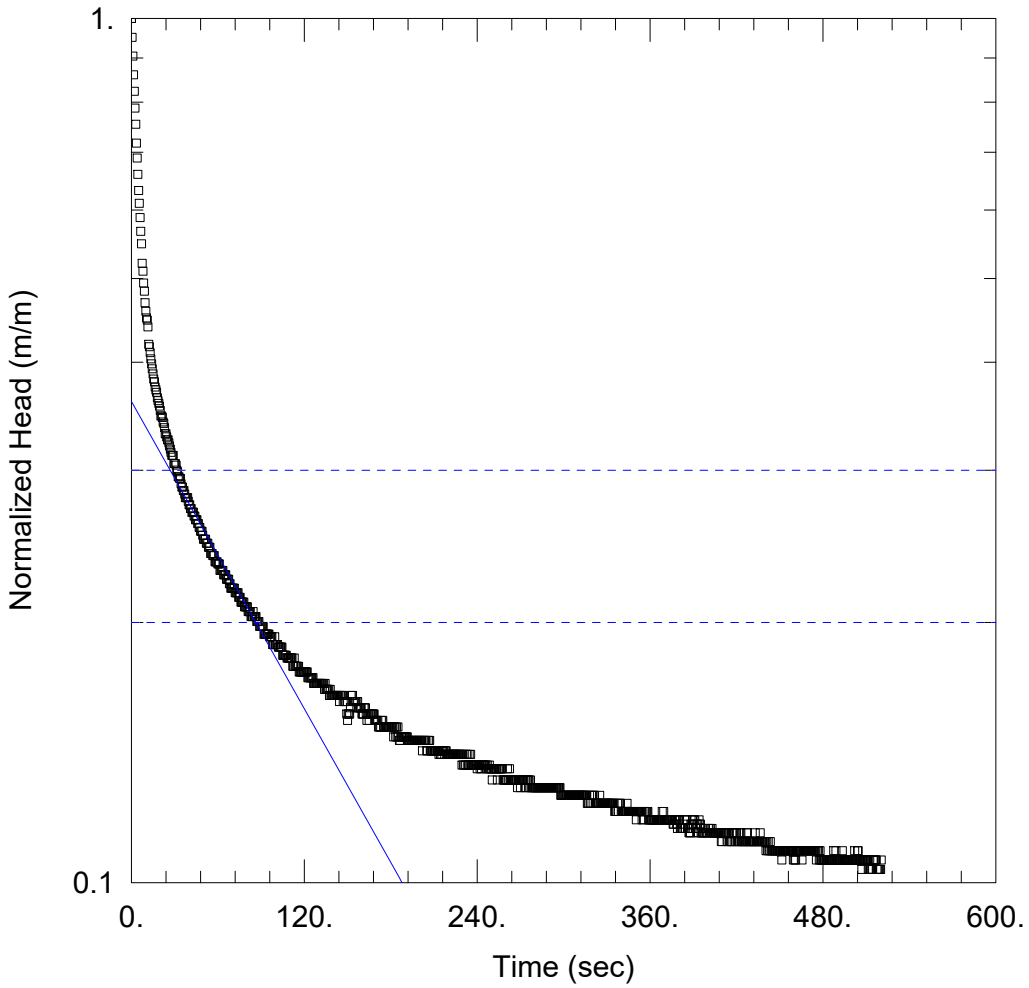
Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

Appendix F

Slug test analysis



WELL TEST ANALYSIS

Data Set: \...\B01.aqt
Date: 12/09/20 Time: 09:22:15

PROJECT INFORMATION

Test Well: B01

AQUIFER DATA

Saturated Thickness: 3.7 m Anisotropy Ratio (Kz/Kr): 1.

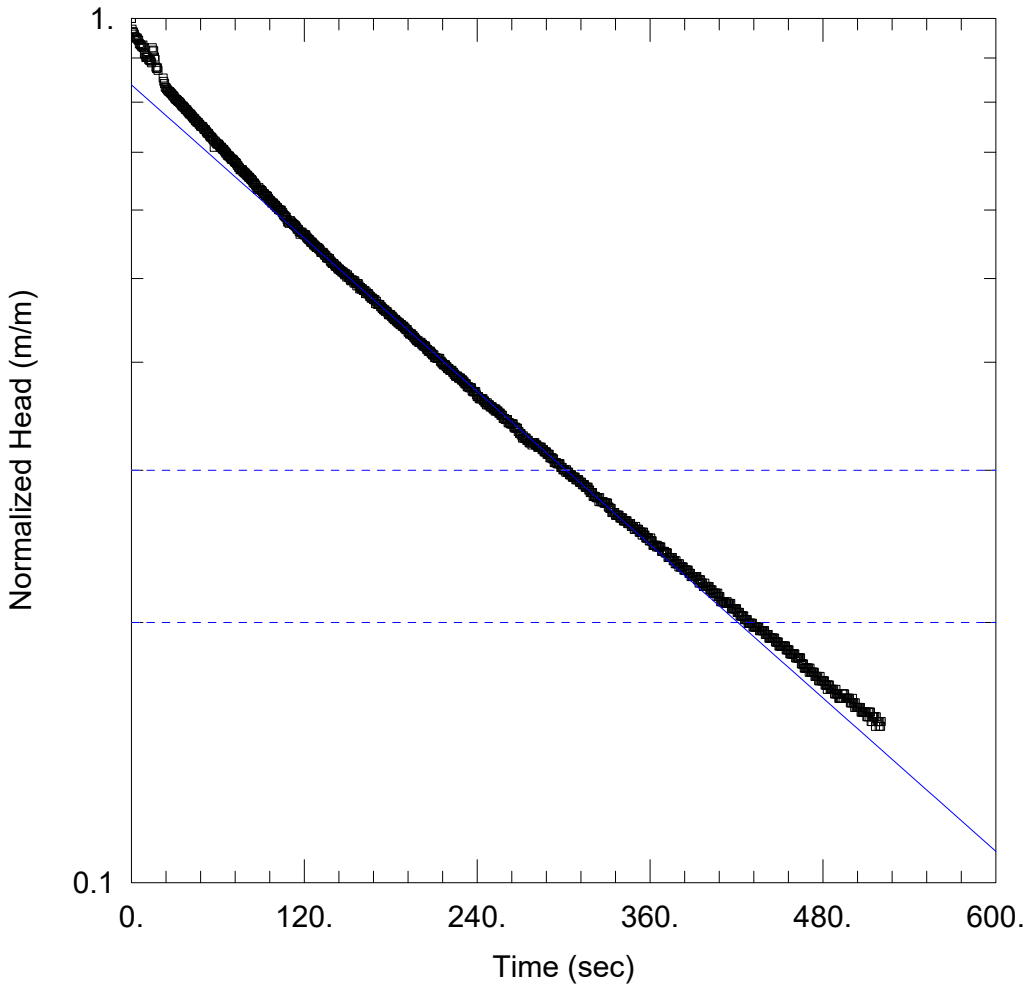
WELL DATA (B01)

Initial Displacement: 0.753 m
Total Well Penetration Depth: 3.4 m
Casing Radius: 0.025 m
Static Water Column Height: 3.7 m
Screen Length: 3. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.2185 m/day y0 = 0.2714 m



WELL TEST ANALYSIS

Data Set: \...\B02.aqt
Date: 12/09/20 Time: 09:24:16

PROJECT INFORMATION

Test Well: B02

AQUIFER DATA

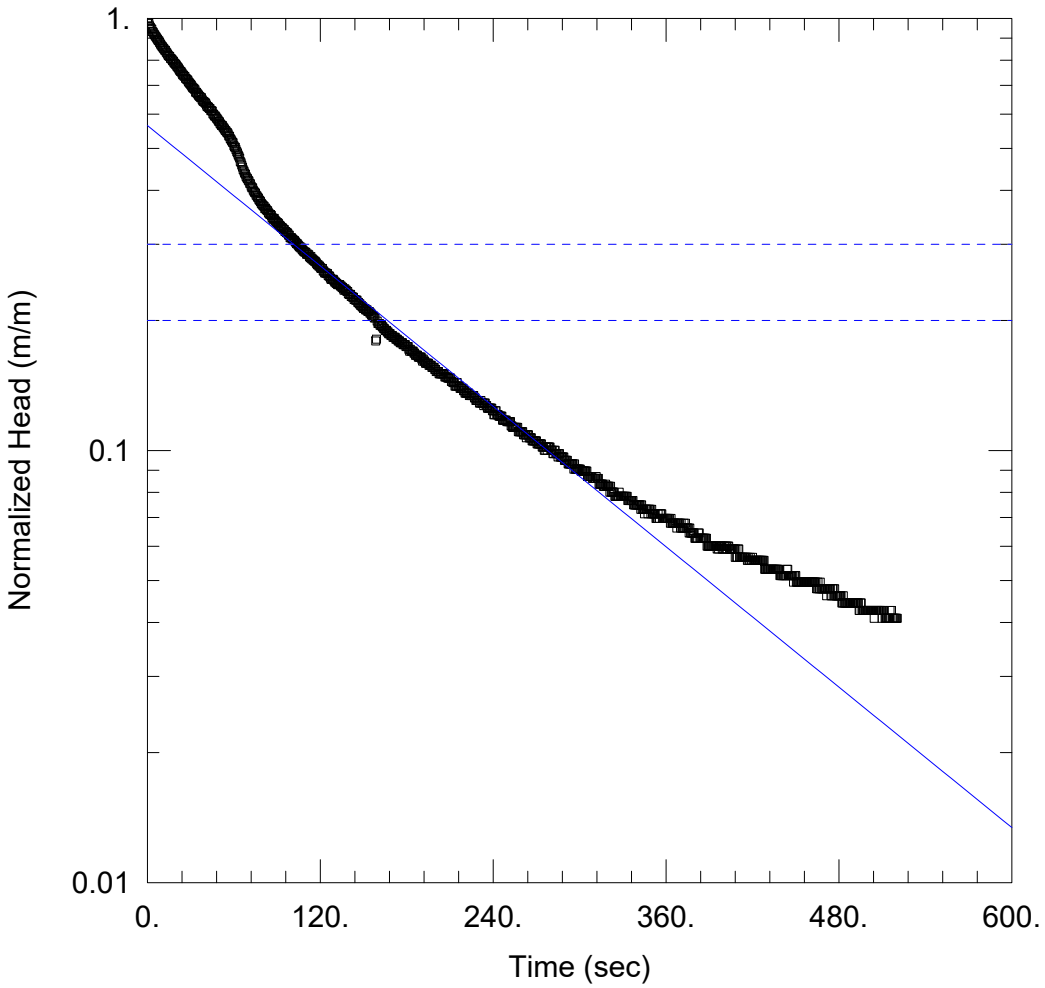
Saturated Thickness: 12.48 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B02)

Initial Displacement: 1.022 m
Total Well Penetration Depth: 12.48 m
Casing Radius: 0.025 m
Static Water Column Height: 12.48 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.07328 m/day
y0 = 0.8561 m



WELL TEST ANALYSIS

Data Set: \...\B04.aqt
Date: 12/09/20 Time: 09:25:54

PROJECT INFORMATION

Test Well: B04

AQUIFER DATA

Saturated Thickness: 13.32 m Anisotropy Ratio (Kz/Kr): 1.

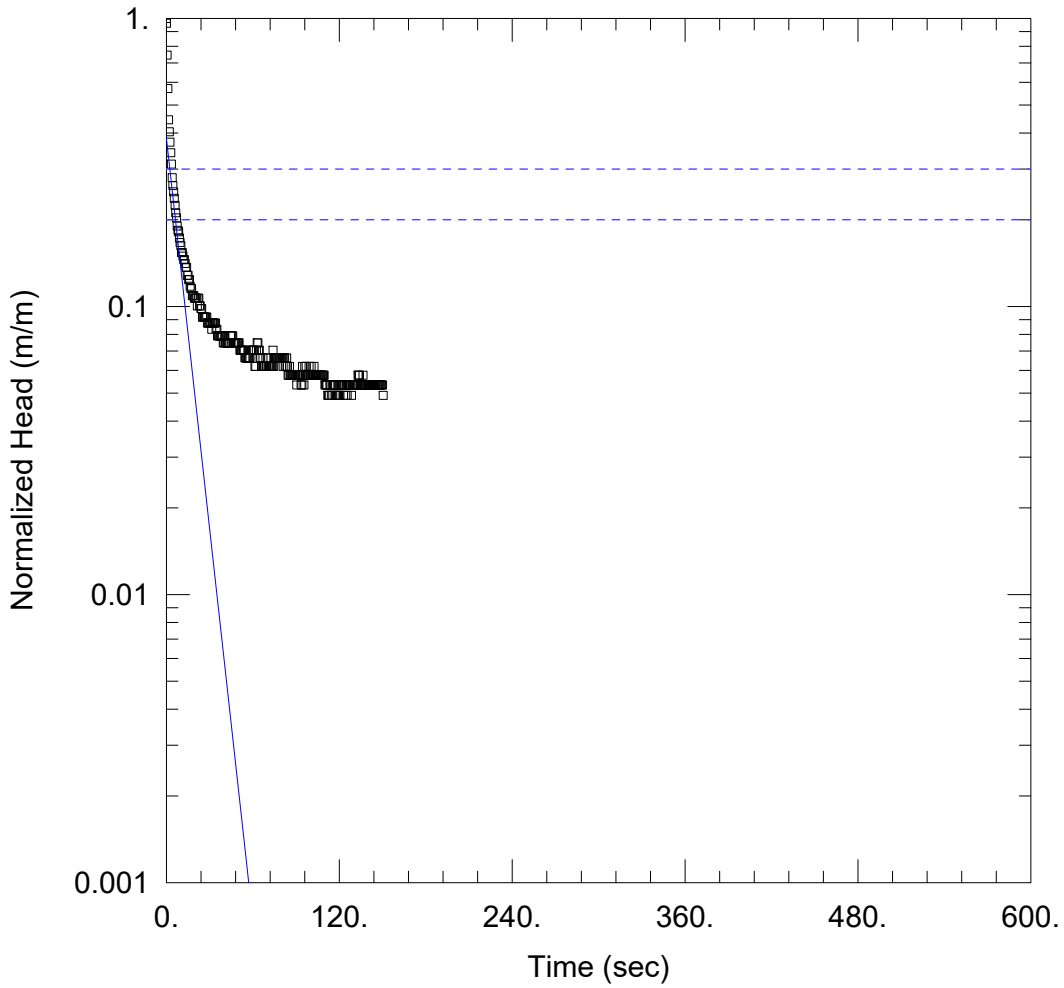
WELL DATA (B04)

Initial Displacement: 1.149 m
Total Well Penetration Depth: 12.52 m
Casing Radius: 0.025 m
Static Water Column Height: 13.32 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.1257 m/day y0 = 0.6492 m



WELL TEST ANALYSIS

Data Set: \...\B08.aqt
Date: 12/10/20 Time: 10:32:11

PROJECT INFORMATION

Test Well: B08

AQUIFER DATA

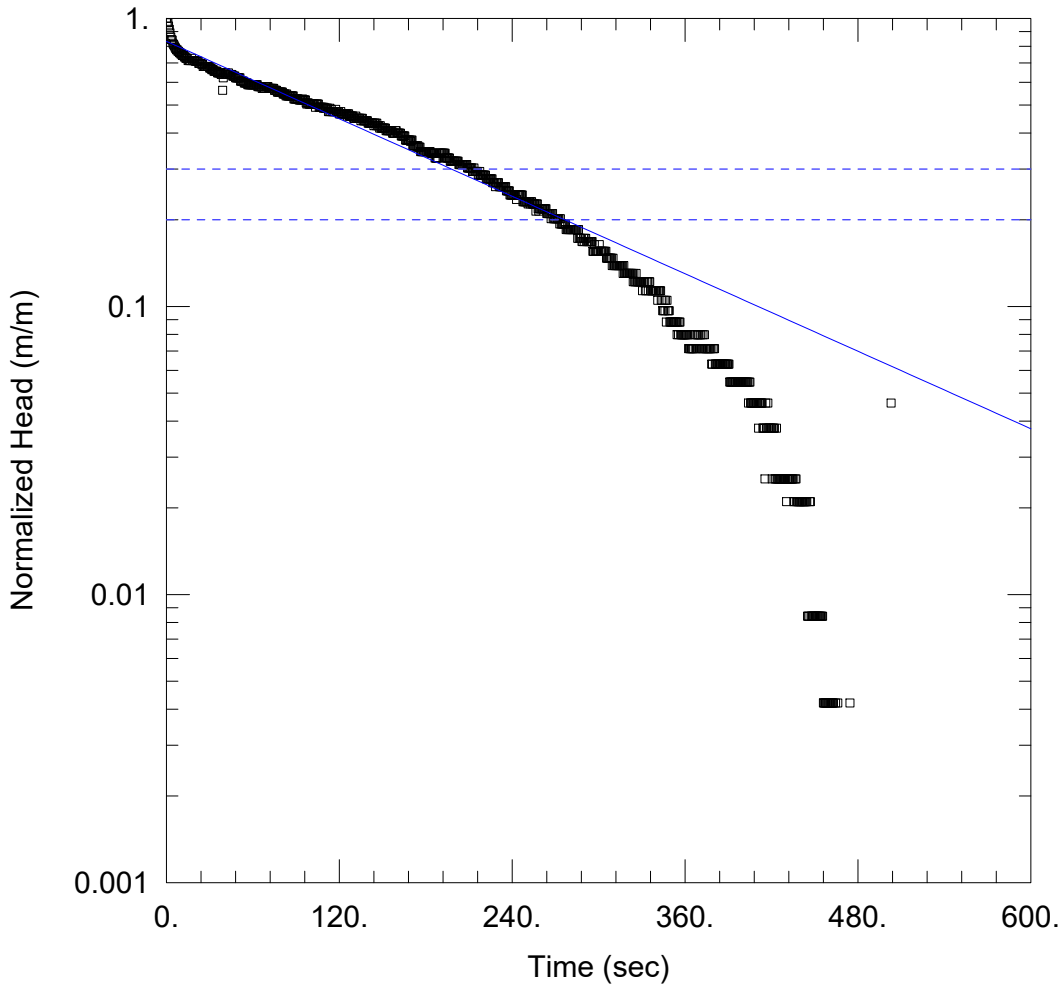
Saturated Thickness: 9.05 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B08)

Initial Displacement: 0.468 m
Total Well Penetration Depth: 9.05 m
Casing Radius: 0.025 m
Static Water Column Height: 9.05 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.143 m/day
y0 = 0.1794 m



WELL TEST ANALYSIS

Data Set: \...\B09.aqt
Date: 12/09/20 Time: 09:29:19

PROJECT INFORMATION

Test Well: B09

AQUIFER DATA

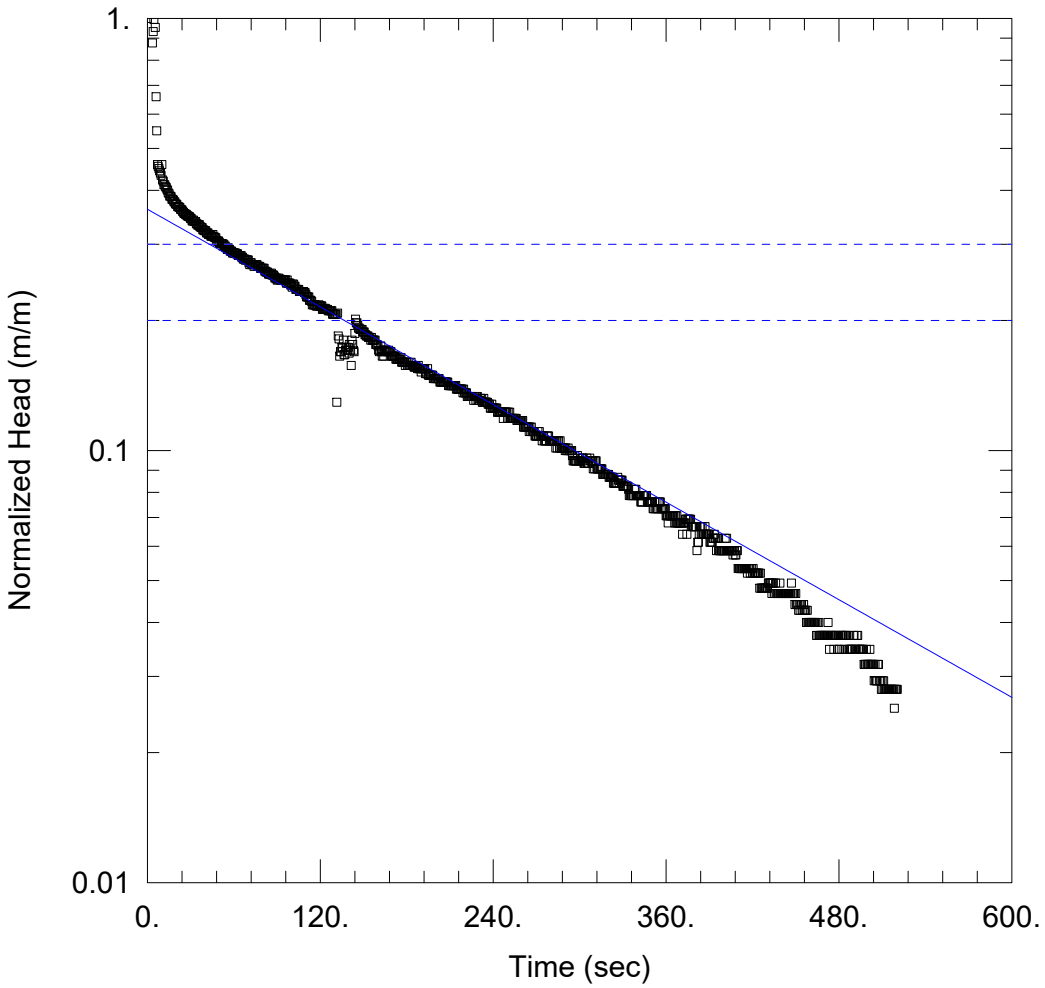
Saturated Thickness: 1.28 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B09)

Initial Displacement: 0.238 m
Static Water Column Height: 1.28 m
Total Well Penetration Depth: 1.28 m
Screen Length: 1.28 m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3281 m/day
y0 = 0.1982 m



WELL TEST ANALYSIS

Data Set: \...\B09_B.aqt
Date: 12/09/20 Time: 09:31:17

PROJECT INFORMATION

Test Well: B09_B

AQUIFER DATA

Saturated Thickness: 0.75 m Anisotropy Ratio (Kz/Kr): 1.

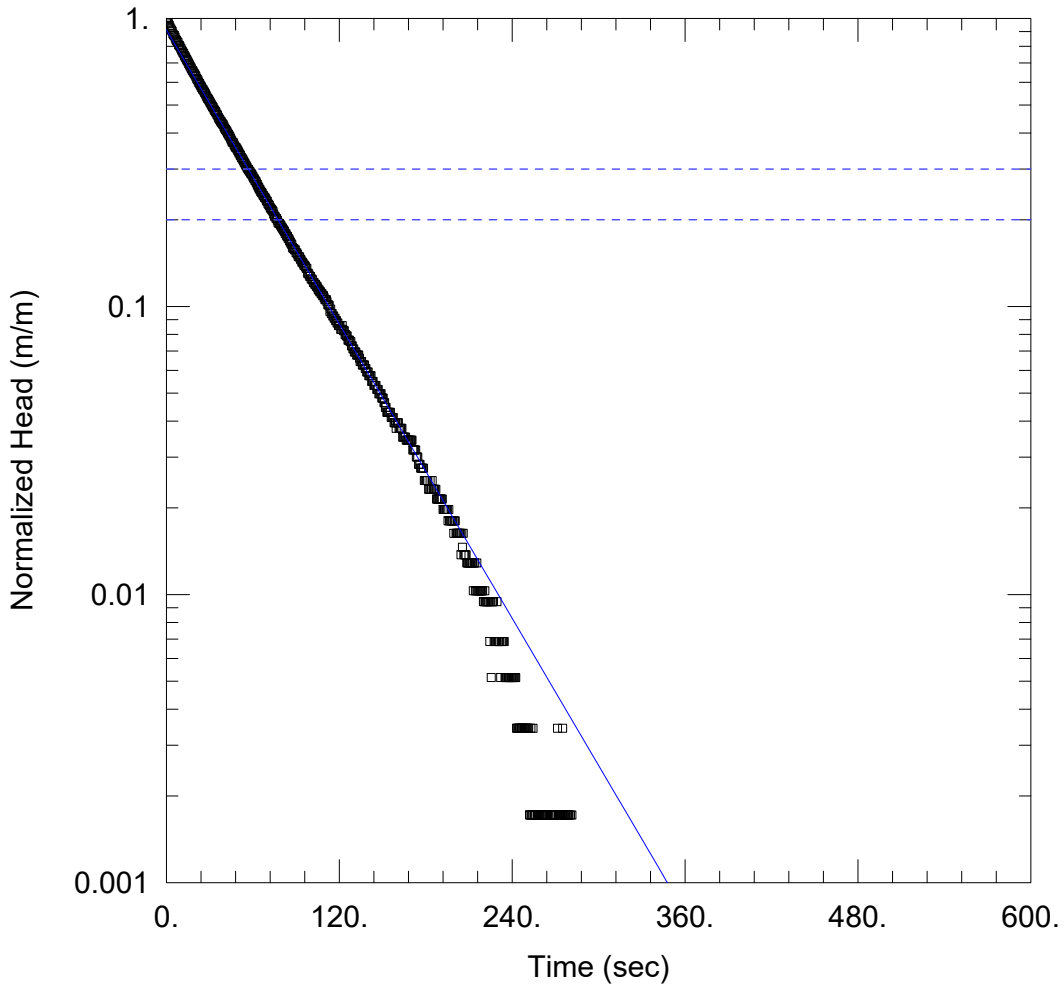
WELL DATA (B09_B)

Initial Displacement: 0.75 m
Total Well Penetration Depth: 0.75 m
Casing Radius: 0.025 m
Static Water Column Height: 1.28 m
Screen Length: 0.75 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.4011 m/day y0 = 0.2712 m



WELL TEST ANALYSIS

Data Set: \...\B10.aqt
Date: 12/09/20 Time: 09:33:32

PROJECT INFORMATION

Test Well: B10

AQUIFER DATA

Saturated Thickness: 10.2 m Anisotropy Ratio (Kz/Kr): 1.

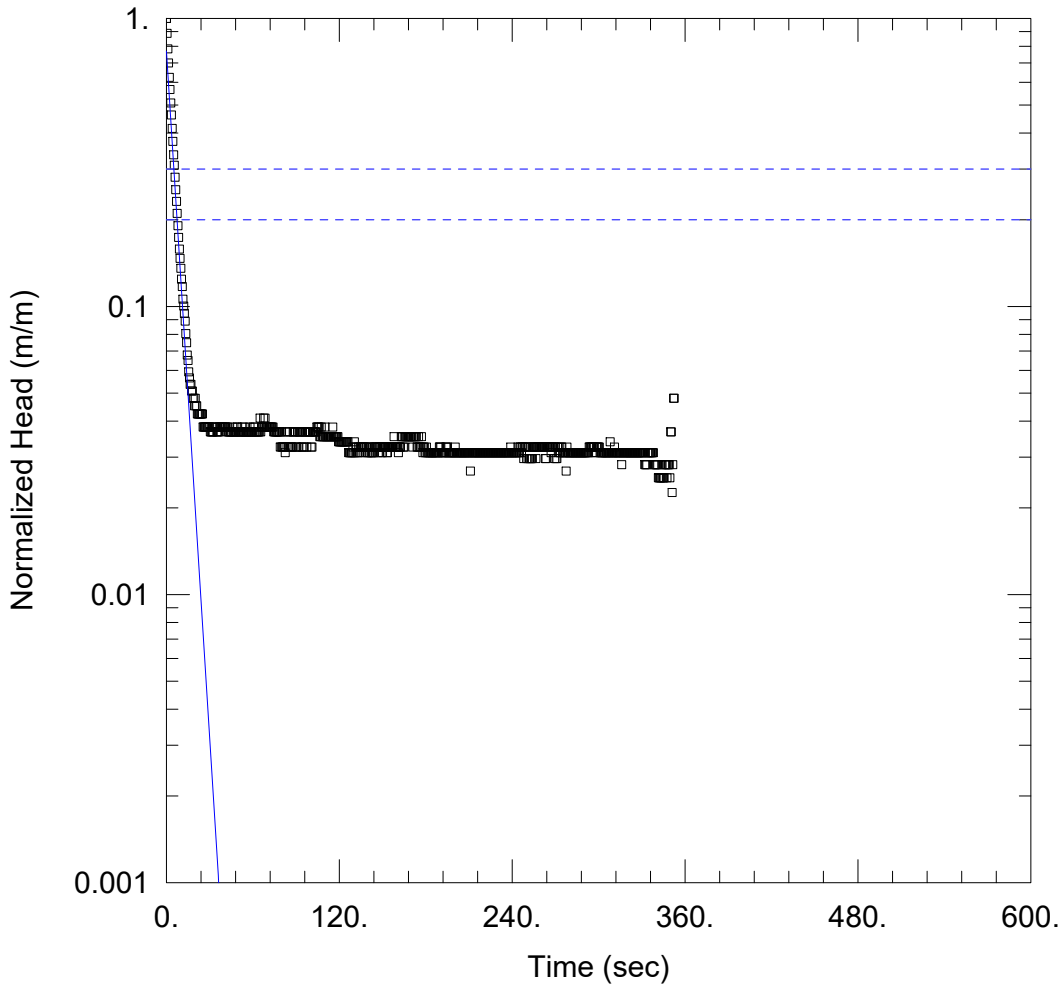
WELL DATA (B10)

Initial Displacement: 1.165 m
Total Well Penetration Depth: 9.9 m
Casing Radius: 0.025 m
Static Water Column Height: 10.2 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.3923 m/day y0 = 1.063 m



WELL TEST ANALYSIS

Data Set: \...\B11.aqt
Date: 12/10/20 Time: 09:33:40

PROJECT INFORMATION

Test Well: B11

AQUIFER DATA

Saturated Thickness: 6.72 m Anisotropy Ratio (Kz/Kr): 1.

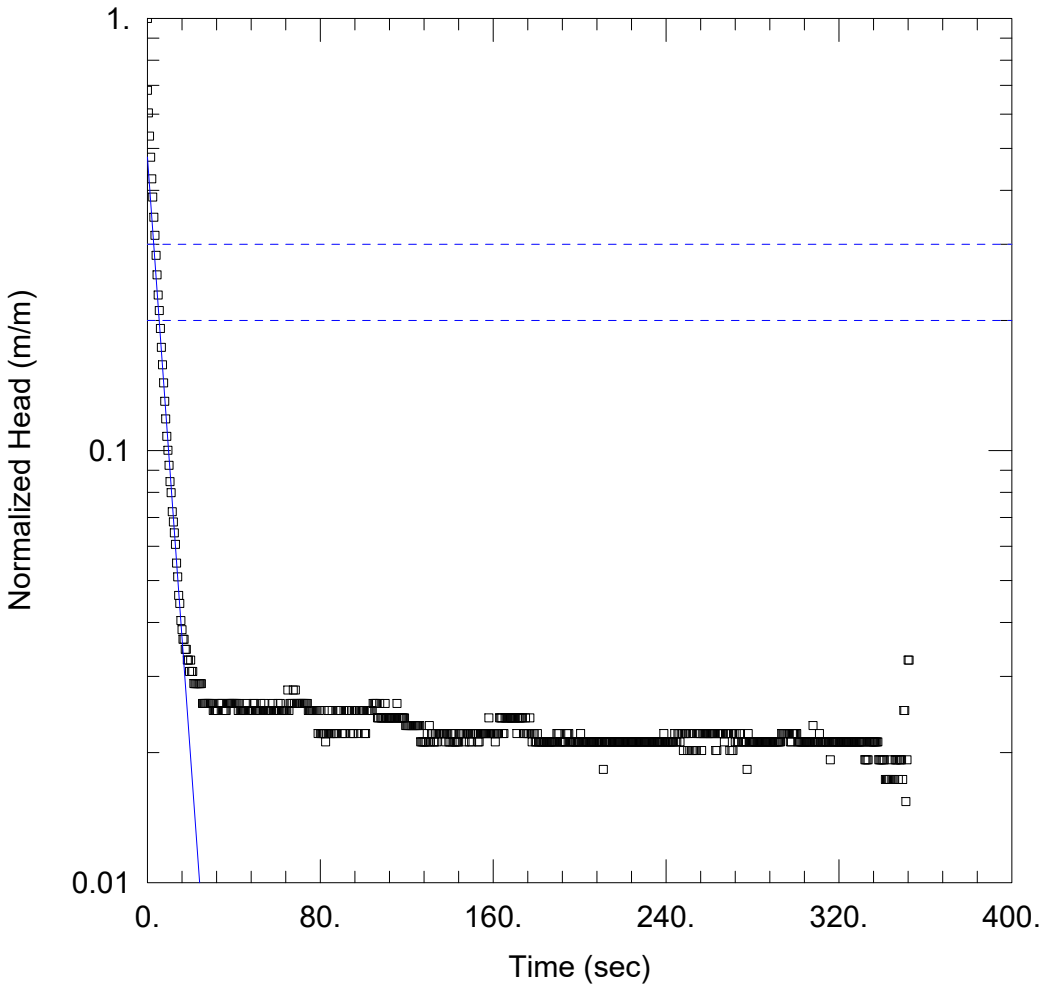
WELL DATA (B11)

Initial Displacement: 0.708 m
Total Well Penetration Depth: 6.72 m
Casing Radius: 0.025 m
Static Water Column Height: 6.72 m
Screen Length: 3. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.926 m/day y0 = 0.5453 m



WELL TEST ANALYSIS

Data Set: \...\B12_D.aqt
Date: 12/10/20 Time: 10:43:18

PROJECT INFORMATION

Test Well: B12_D

AQUIFER DATA

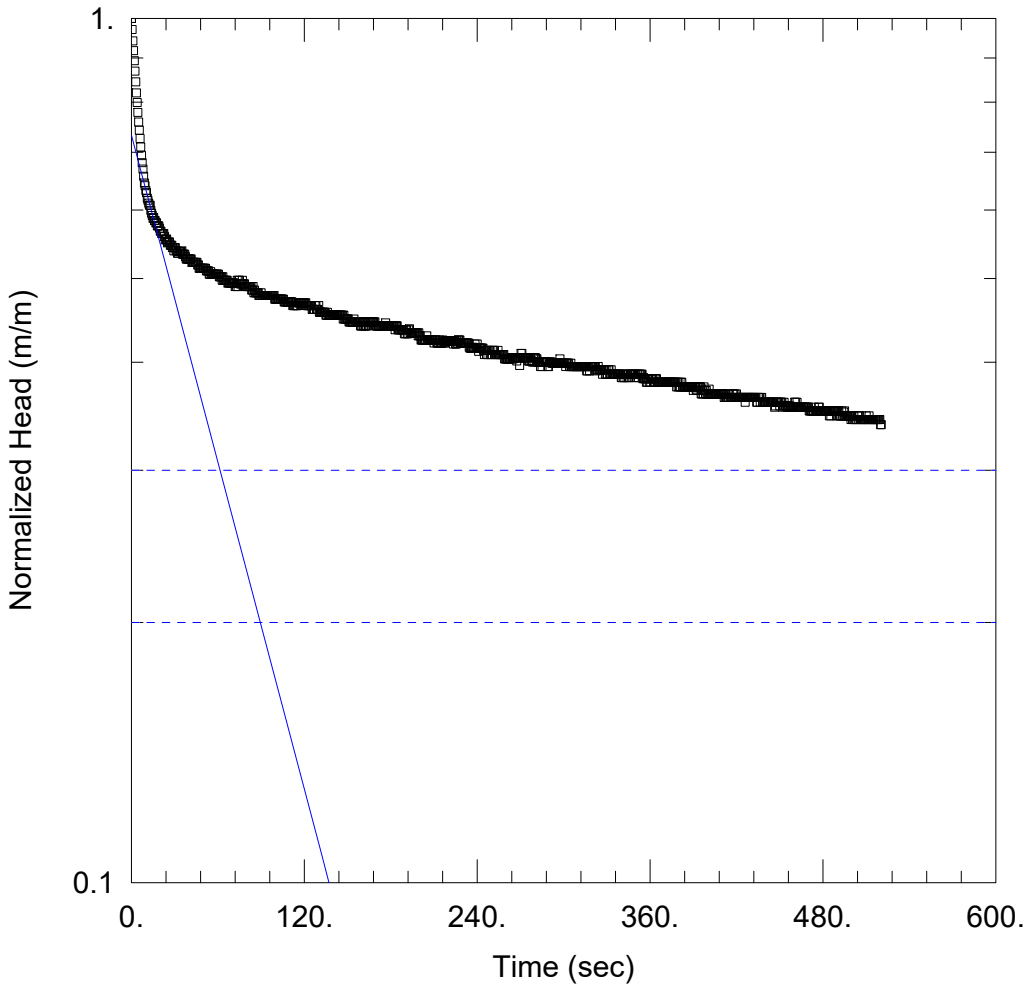
Saturated Thickness: 23.14 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B12_D)

Initial Displacement: 1.039 m
Total Well Penetration Depth: 23.14 m
Casing Radius: 0.025 m
Static Water Column Height: 23.14 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.733 m/day
y0 = 0.4964 m



WELL TEST ANALYSIS

Data Set: \...\B12_S.aqt
Date: 12/09/20 Time: 09:38:45

PROJECT INFORMATION

Test Well: B12_S

AQUIFER DATA

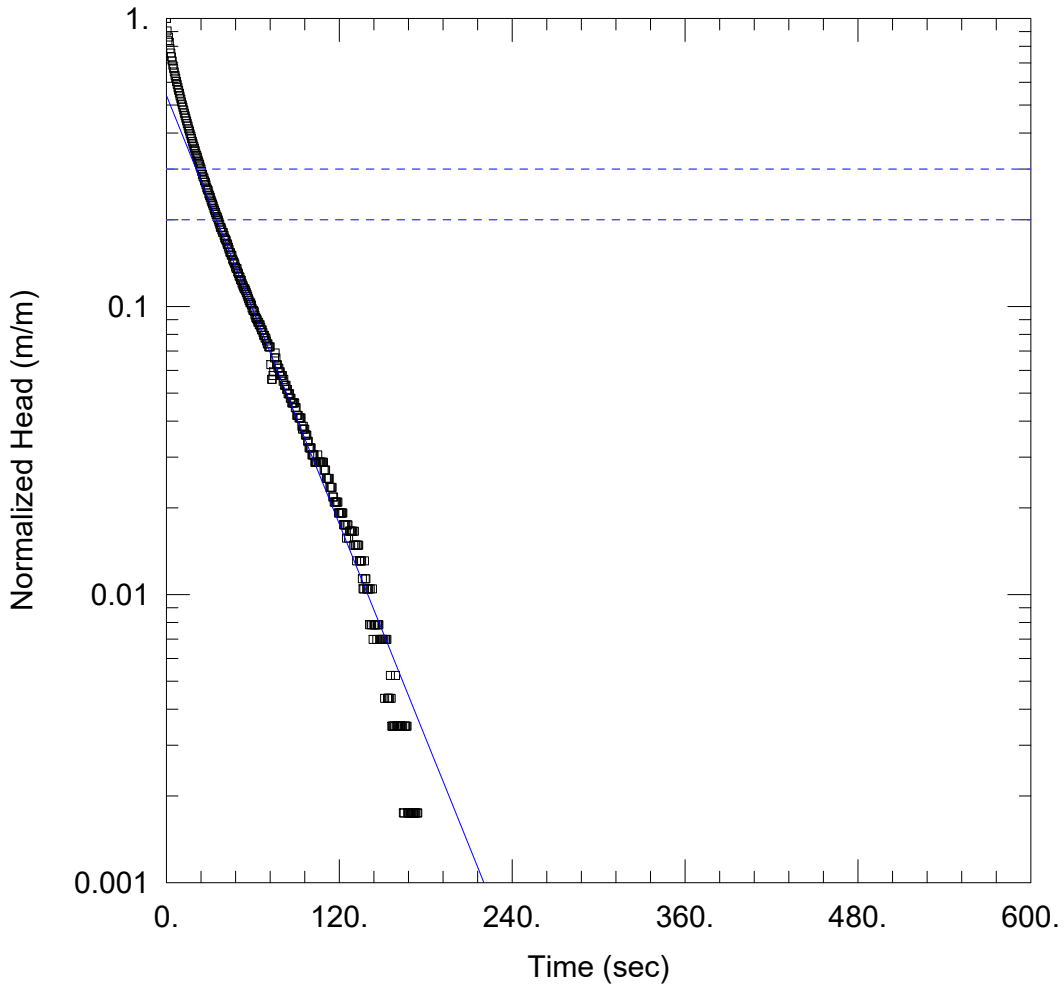
Saturated Thickness: 2.06 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B12_S)

Initial Displacement: 0.503 m
Static Water Column Height: 2.06 m
Total Well Penetration Depth: 2.06 m
Screen Length: 2.06 m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.645 m/day
y0 = 0.3685 m



WELL TEST ANALYSIS

Data Set: \...\B13.aqt
Date: 12/09/20 Time: 09:40:34

PROJECT INFORMATION

Test Well: B13

AQUIFER DATA

Saturated Thickness: 16.81 m Anisotropy Ratio (Kz/Kr): 1.

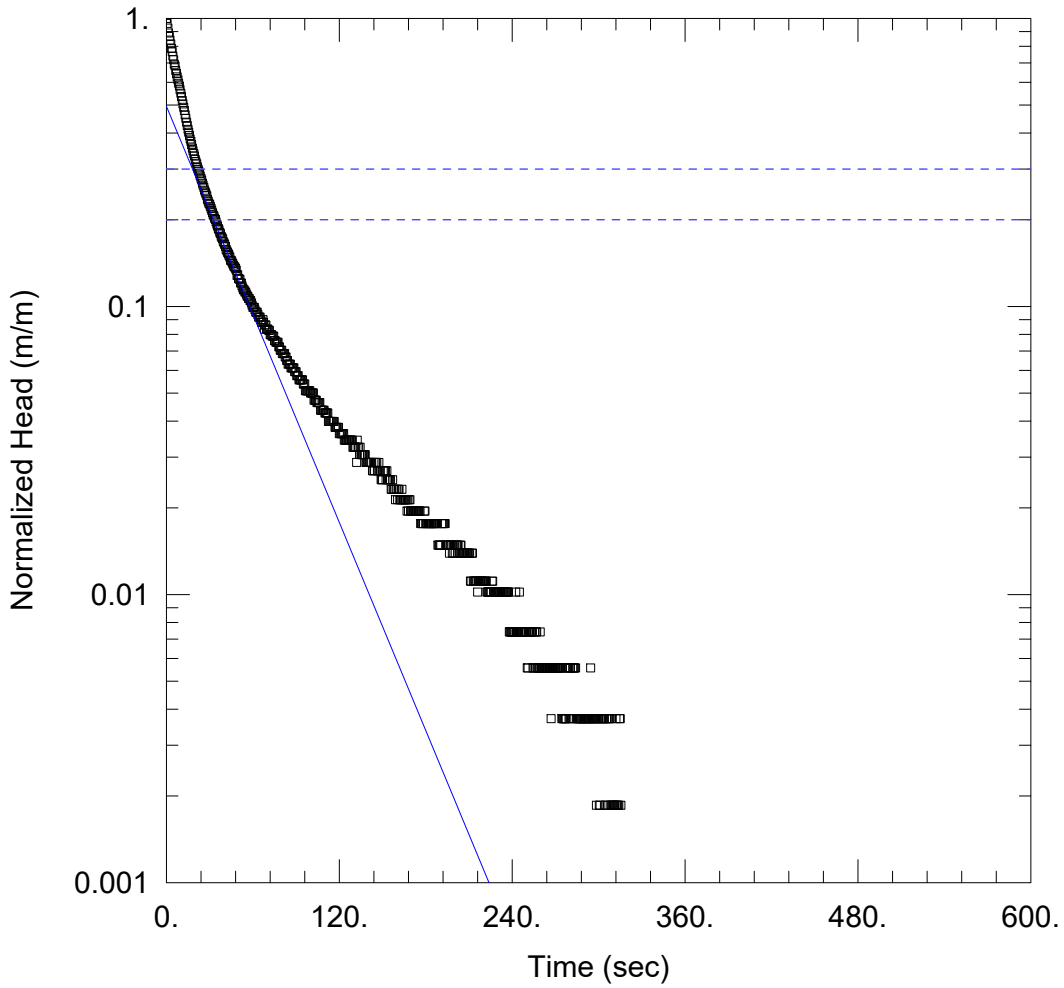
WELL DATA (B13)

Initial Displacement: 1.146 m
Total Well Penetration Depth: 16.71 m
Casing Radius: 0.025 m
Static Water Column Height: 16.81 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.4358 m/day y0 = 0.6192 m



WELL TEST ANALYSIS

Data Set: \...\B16_D.aqt
Date: 12/09/20 Time: 09:42:55

PROJECT INFORMATION

Test Well: B16_D

AQUIFER DATA

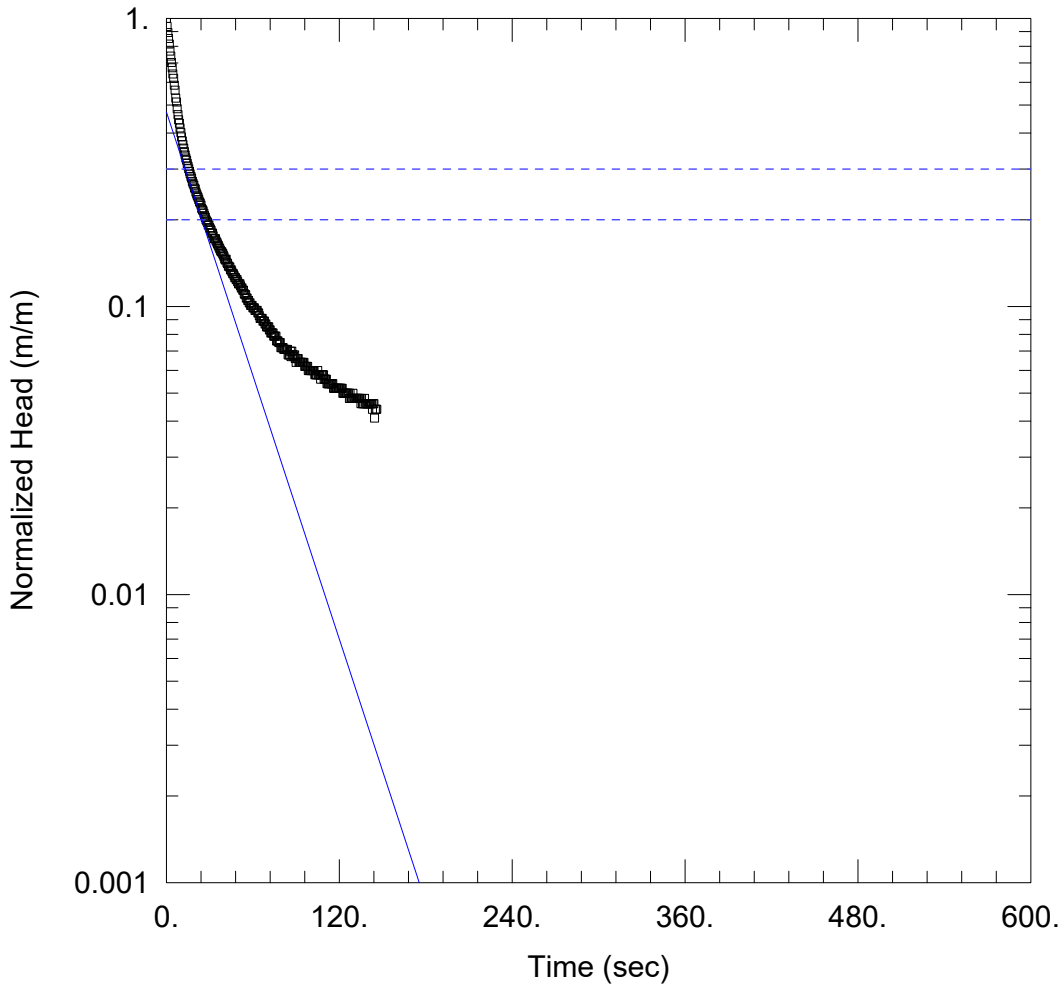
Saturated Thickness: 9.61 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B16_D)

Initial Displacement: 1.078 m
Total Well Penetration Depth: 9.61 m
Casing Radius: 0.025 m
Static Water Column Height: 9.61 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.5753 m/day
y0 = 0.5335 m



WELL TEST ANALYSIS

Data Set: \...\B17_2.aqt
Date: 12/10/20 Time: 10:51:09

PROJECT INFORMATION

Test Well: B17_2

AQUIFER DATA

Saturated Thickness: 3.55 m Anisotropy Ratio (Kz/Kr): 1.

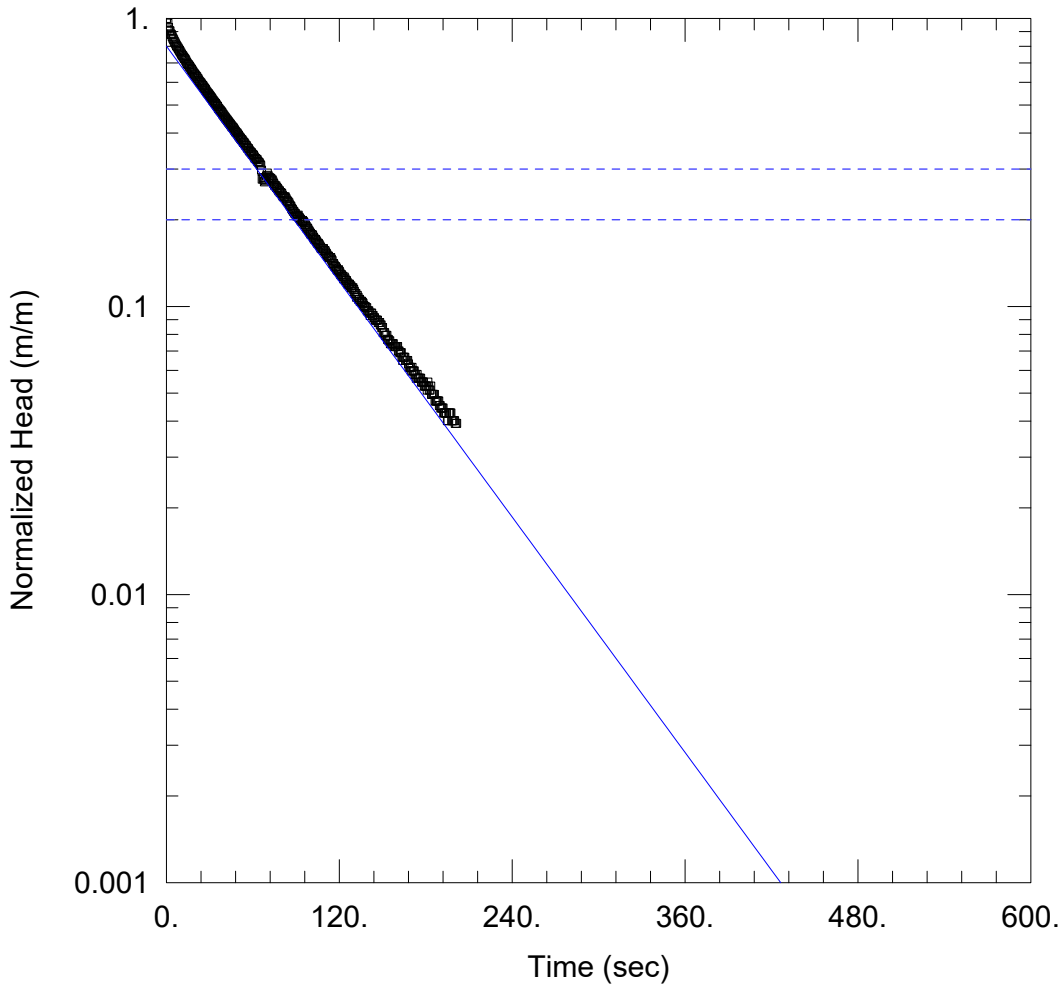
WELL DATA (B17_2)

Initial Displacement: 1.001 m
Total Well Penetration Depth: 6. m
Casing Radius: 0.025 m
Static Water Column Height: 3.55 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.114 m/day y0 = 0.4736 m



WELL TEST ANALYSIS

Data Set: \...\B24.aqt
Date: 12/09/20 Time: 09:47:52

PROJECT INFORMATION

Test Well: B24

AQUIFER DATA

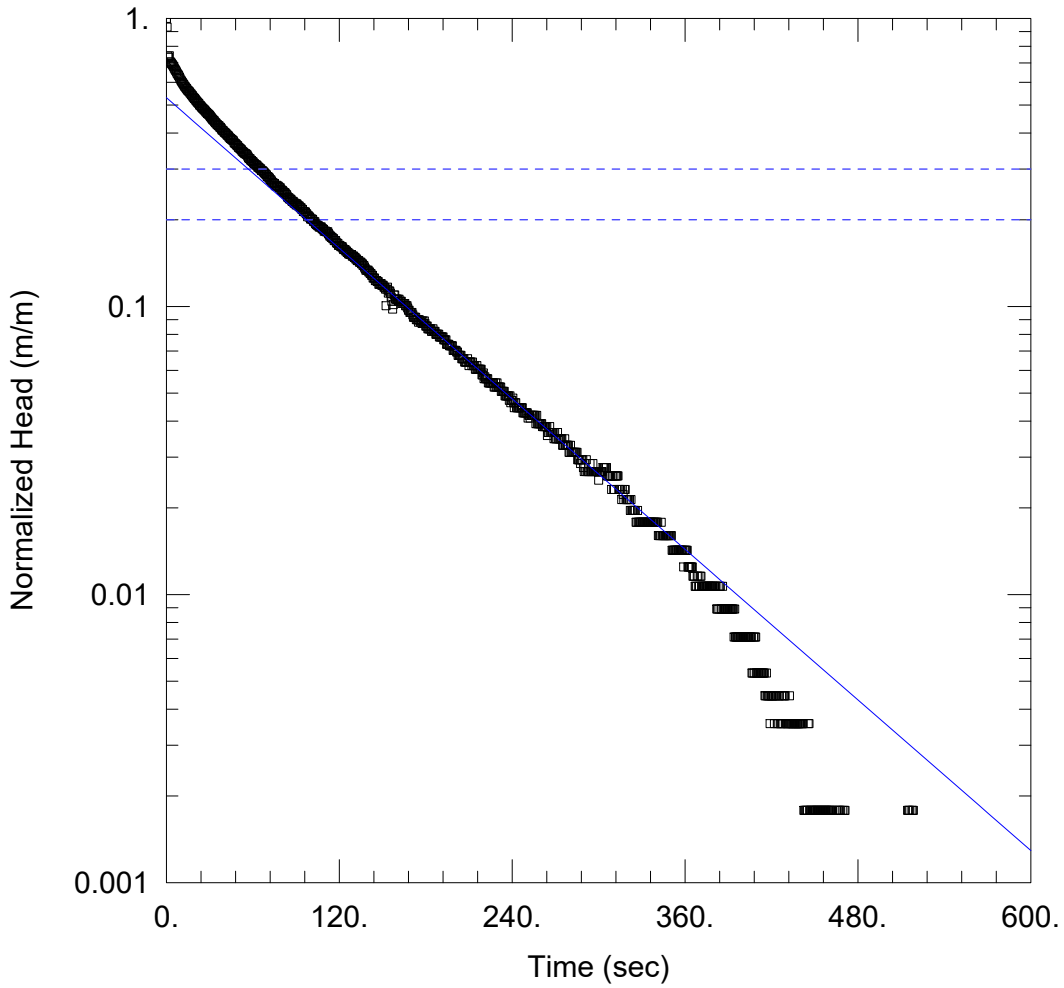
Saturated Thickness: 21.88 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (B24)

Initial Displacement: 1.171 m
Total Well Penetration Depth: 21.88 m
Casing Radius: 0.025 m
Static Water Column Height: 21.88 m
Screen Length: 12. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1916 m/day
y0 = 0.9376 m



WELL TEST ANALYSIS

Data Set: \...\BH01.aqt
Date: 12/09/20 Time: 08:51:07

PROJECT INFORMATION

Test Well: BH01

AQUIFER DATA

Saturated Thickness: 20.95 m Anisotropy Ratio (Kz/Kr): 1.

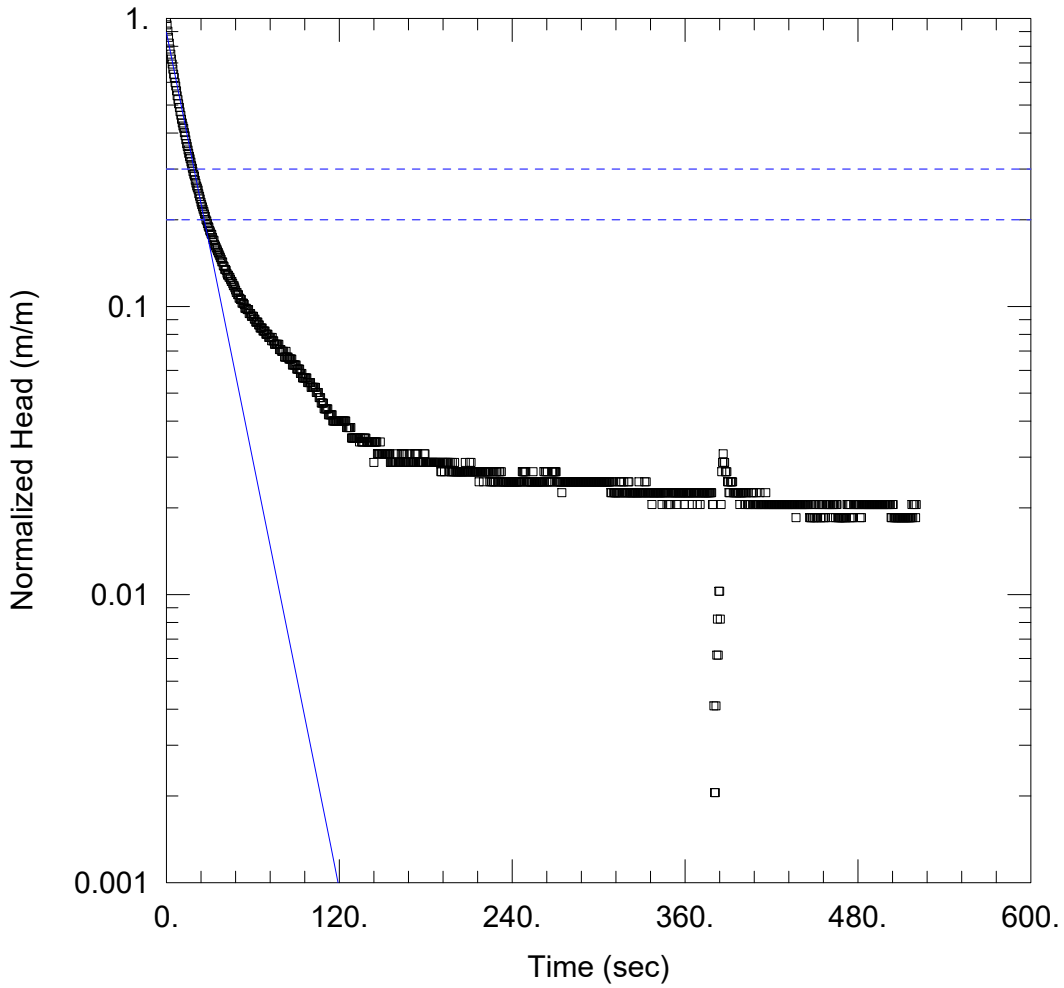
WELL DATA (BH01)

Initial Displacement: 1.123 m
Total Well Penetration Depth: 20.95 m
Casing Radius: 0.025 m
Static Water Column Height: 20.95 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.1705 m/day y0 = 0.5955 m



WELL TEST ANALYSIS

Data Set: \...\BH02.aqt
Date: 12/10/20 Time: 09:56:43

PROJECT INFORMATION

Test Well: BH02

AQUIFER DATA

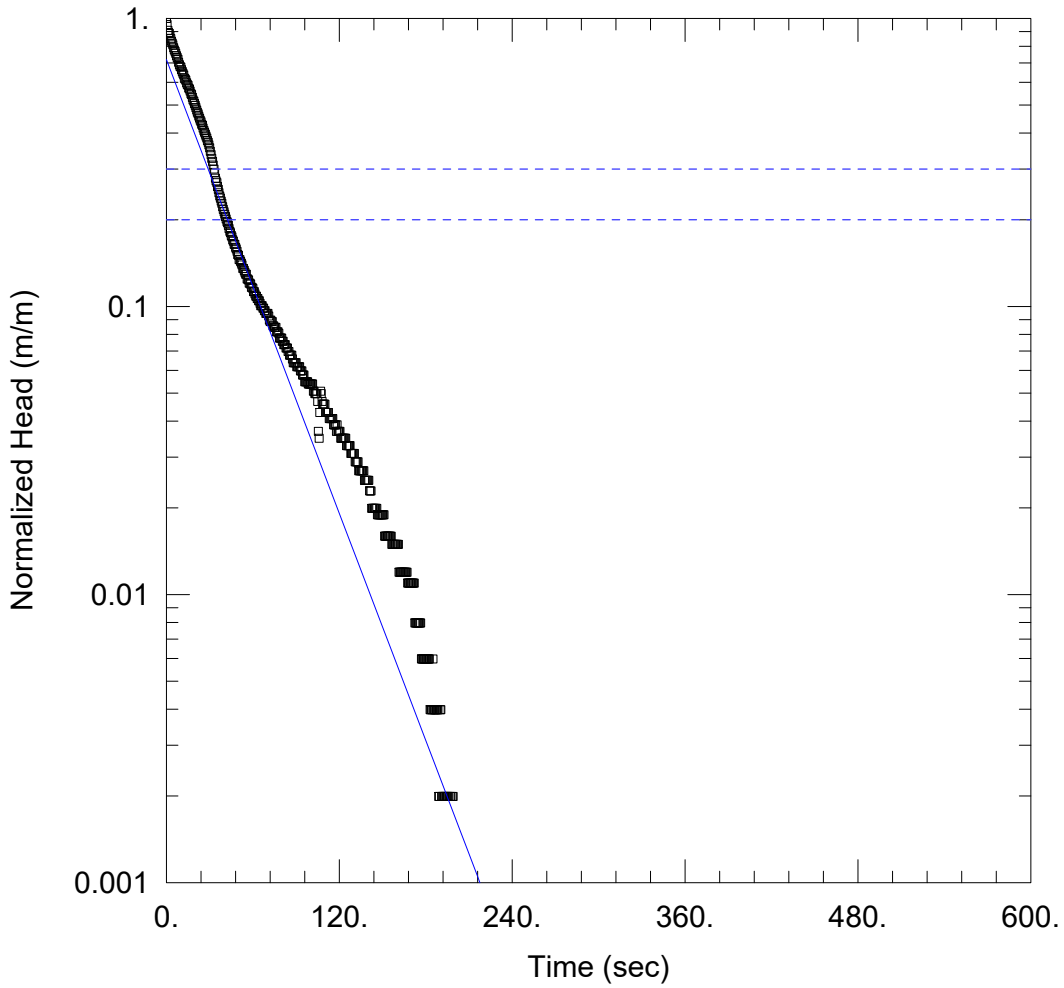
Saturated Thickness: 5.47 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH02)

Initial Displacement: 0.974 m
Total Well Penetration Depth: 5.472 m
Casing Radius: 0.025 m
Static Water Column Height: 5.47 m
Screen Length: 5. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.29 m/day
y0 = 0.8706 m



WELL TEST ANALYSIS

Data Set: \...\BH03.aqt
Date: 12/09/20 Time: 08:59:53

PROJECT INFORMATION

Test Well: BH03

AQUIFER DATA

Saturated Thickness: 19.72 m Anisotropy Ratio (Kz/Kr): 1.

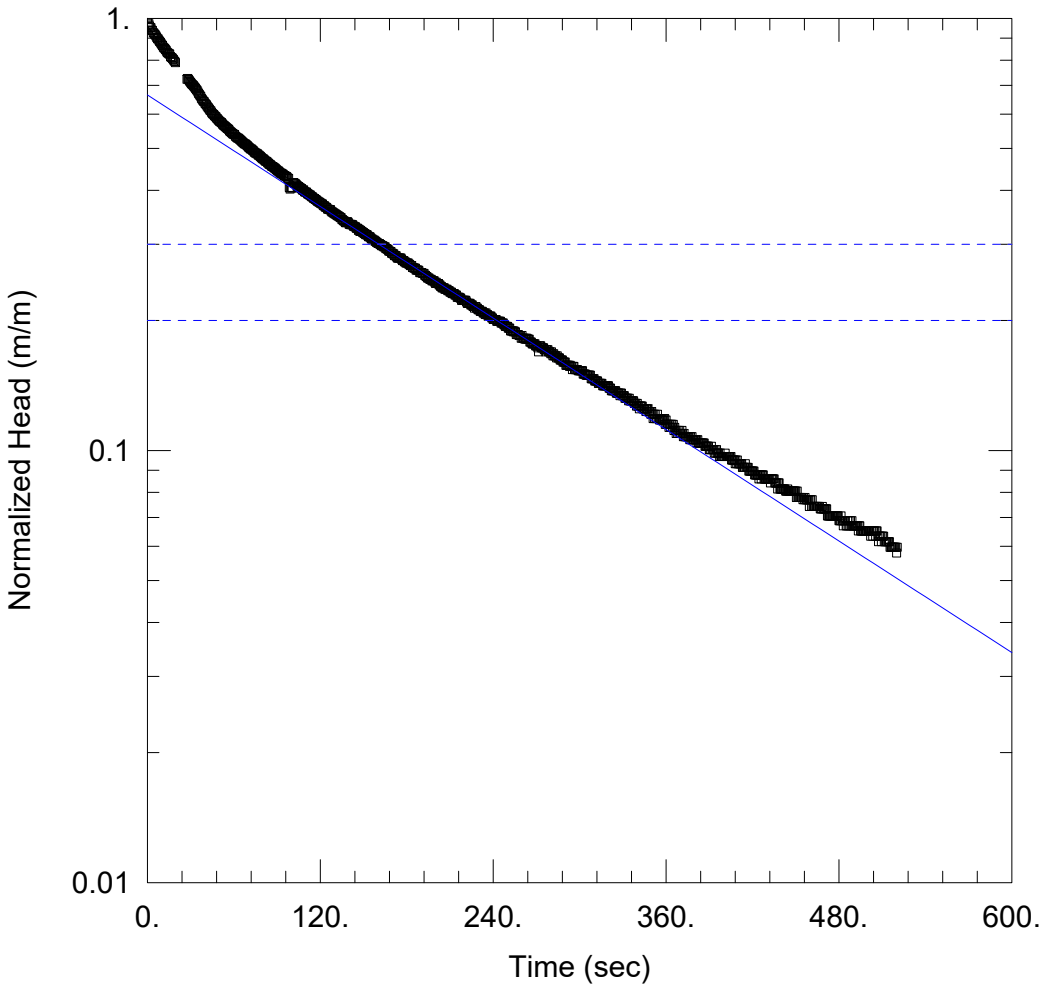
WELL DATA (BH03)

Initial Displacement: 1.004 m
Total Well Penetration Depth: 19.72 m
Casing Radius: 0.025 m
Static Water Column Height: 19.72 m
Screen Length: 12. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.3891 m/day y0 = 0.7219 m



WELL TEST ANALYSIS

Data Set: \...\BH04.aqt
Date: 12/09/20 Time: 09:02:08

PROJECT INFORMATION

Test Well: BH04

AQUIFER DATA

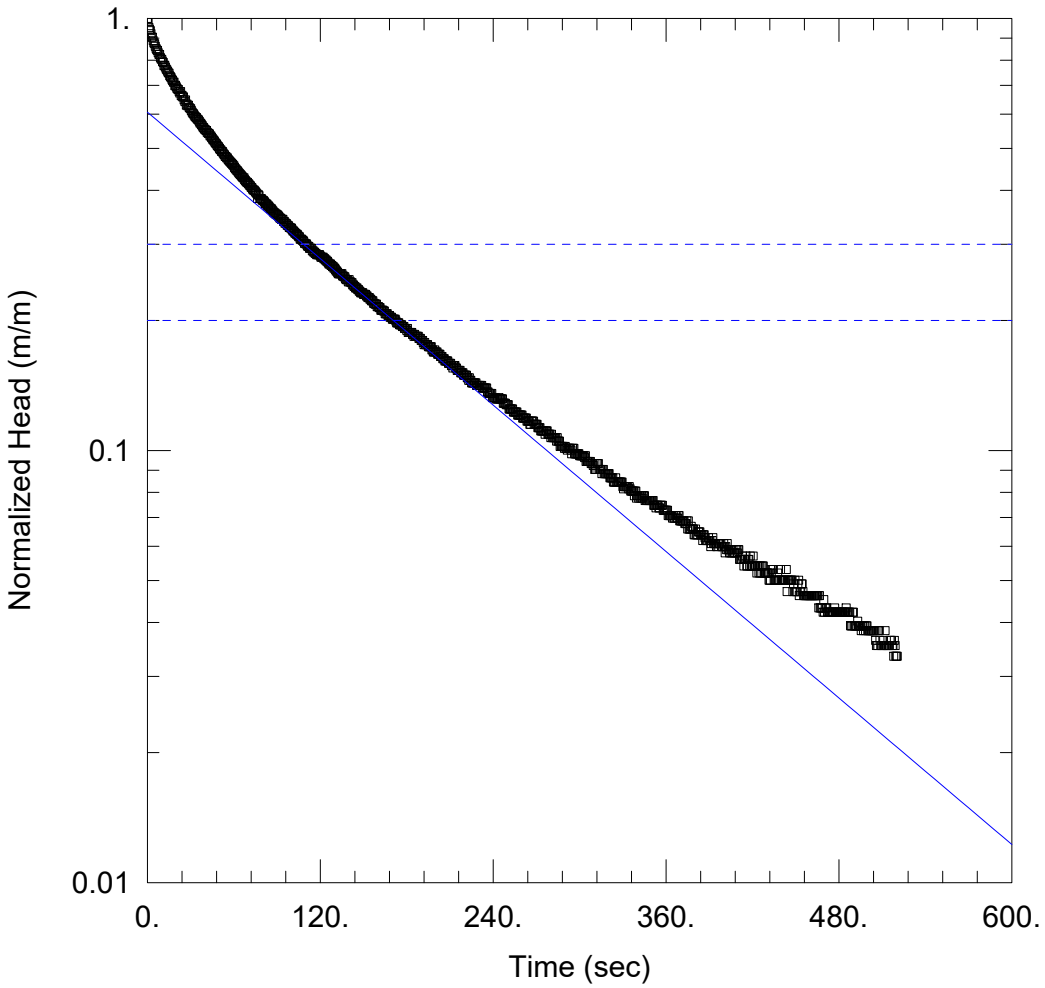
Saturated Thickness: 14.01 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH04)

Initial Displacement: 1.105 m
Total Well Penetration Depth: 14.01 m
Casing Radius: 0.025 m
Static Water Column Height: 14.01 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1166 m/day
y0 = 0.7346 m



WELL TEST ANALYSIS

Data Set: \...\BH06.aqt
Date: 12/09/20 Time: 09:04:21

PROJECT INFORMATION

Test Well: BH06

AQUIFER DATA

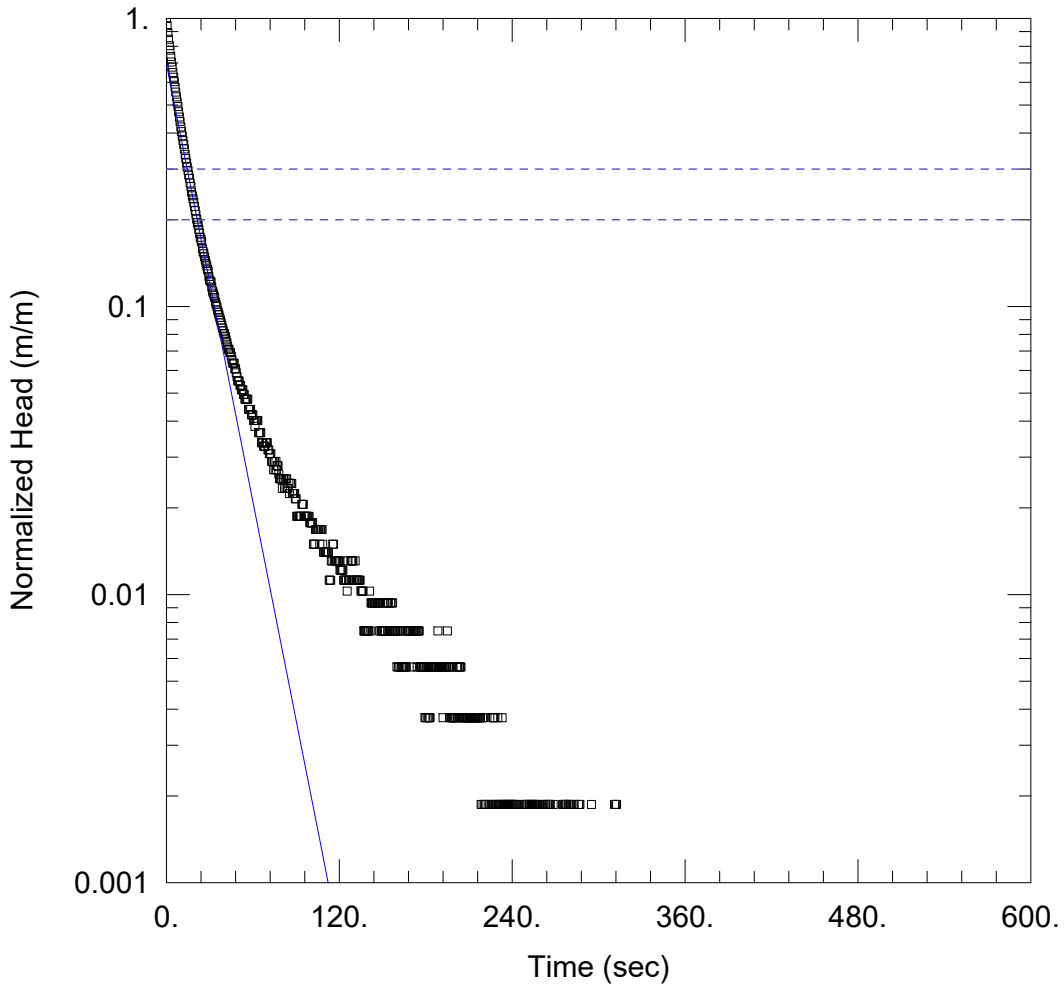
Saturated Thickness: 15.03 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH06)

Initial Displacement: 1.018 m
Total Well Penetration Depth: 15.03 m
Casing Radius: 0.025 m
Static Water Column Height: 15.03 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1612 m/day
y0 = 0.6176 m



WELL TEST ANALYSIS

Data Set: \...\BH08.aqt
Date: 12/10/20 Time: 10:00:38

PROJECT INFORMATION

Test Well: BH08

AQUIFER DATA

Saturated Thickness: 10.65 m Anisotropy Ratio (Kz/Kr): 1.

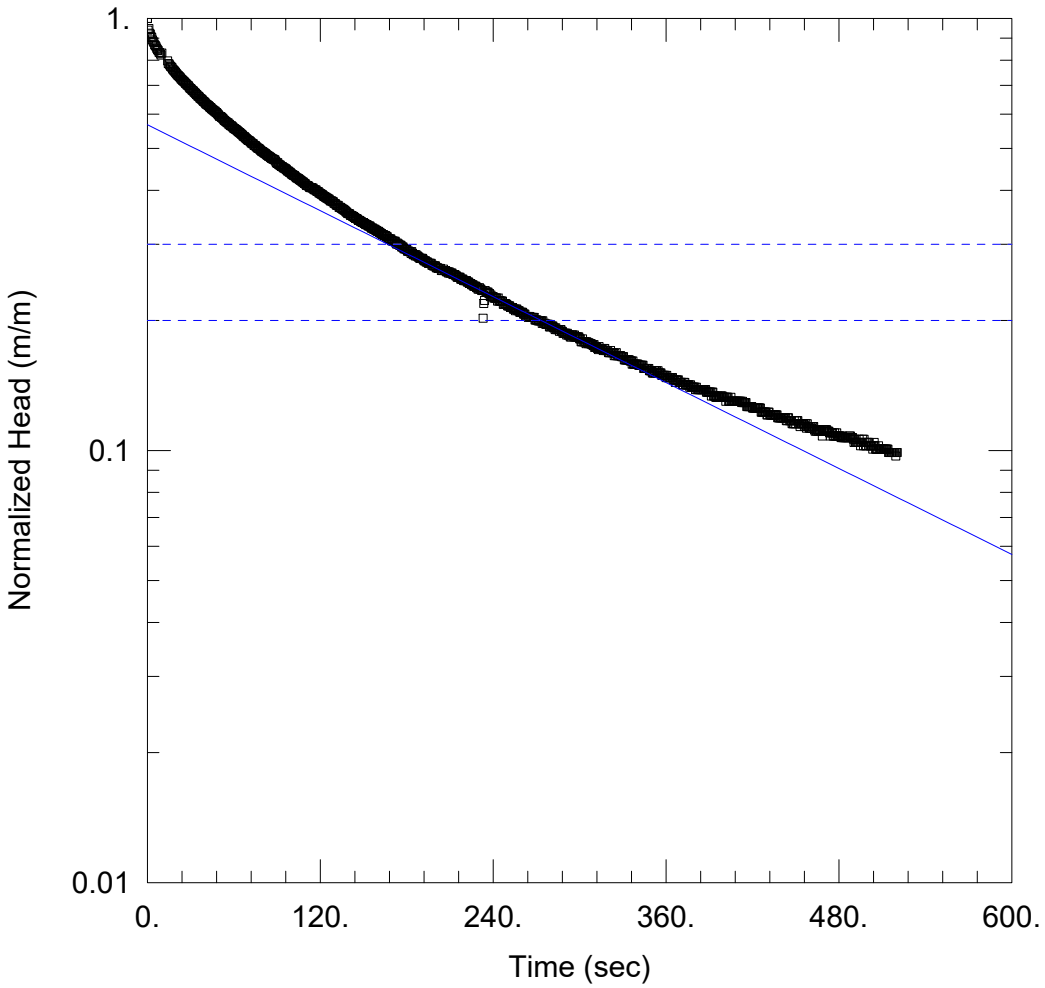
WELL DATA (BH08)

Initial Displacement: 1.07 m
Total Well Penetration Depth: 10.65 m
Casing Radius: 0.025 m
Static Water Column Height: 10.65 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.37 m/day y0 = 0.7414 m



WELL TEST ANALYSIS

Data Set: \...\BH11.aqt
Date: 12/09/20 Time: 09:09:02

PROJECT INFORMATION

Test Well: BH11

AQUIFER DATA

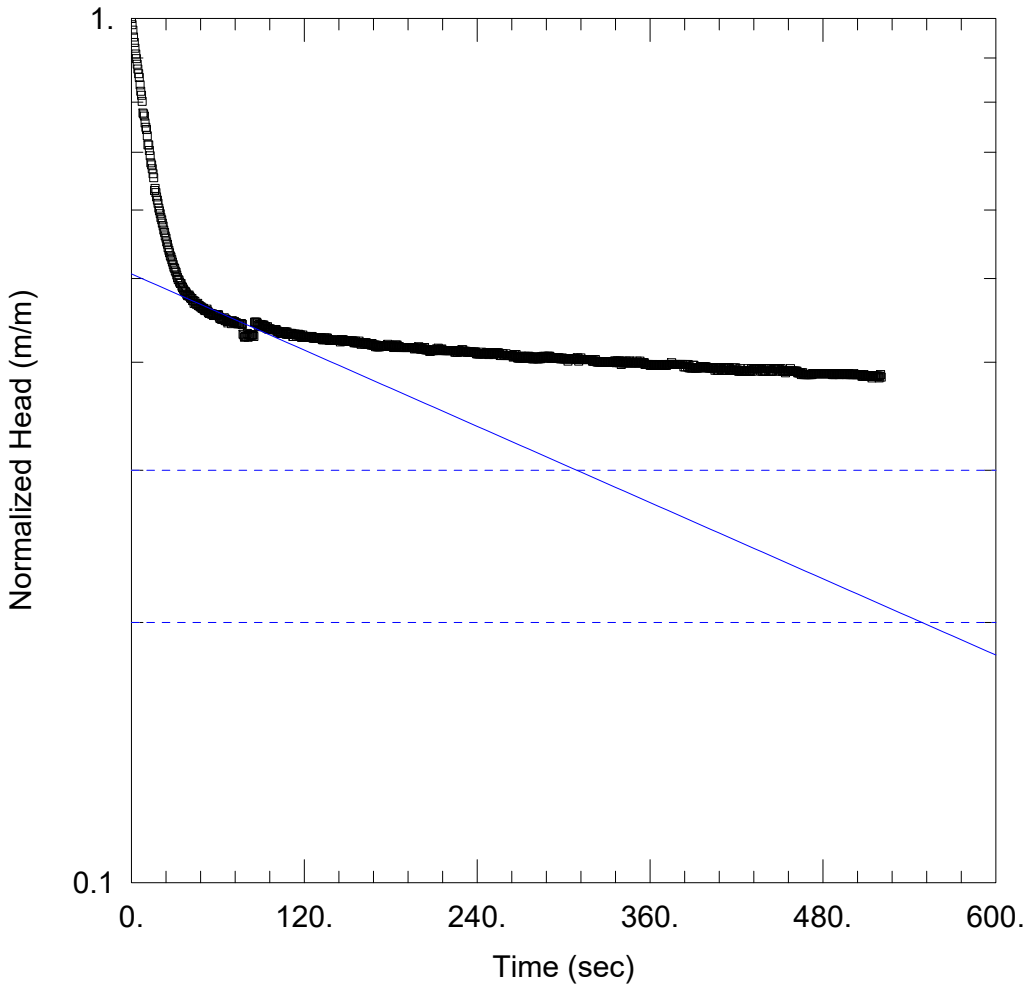
Saturated Thickness: 23.3 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11)

Initial Displacement: 1.092 m
Total Well Penetration Depth: 12.8 m
Casing Radius: 0.025 m
Static Water Column Height: 23.3 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.05066 m/day
y0 = 0.6194 m



WELL TEST ANALYSIS

Data Set: \...\BH12.aqt
Date: 12/09/20 Time: 09:10:42

PROJECT INFORMATION

Test Well: BH12

AQUIFER DATA

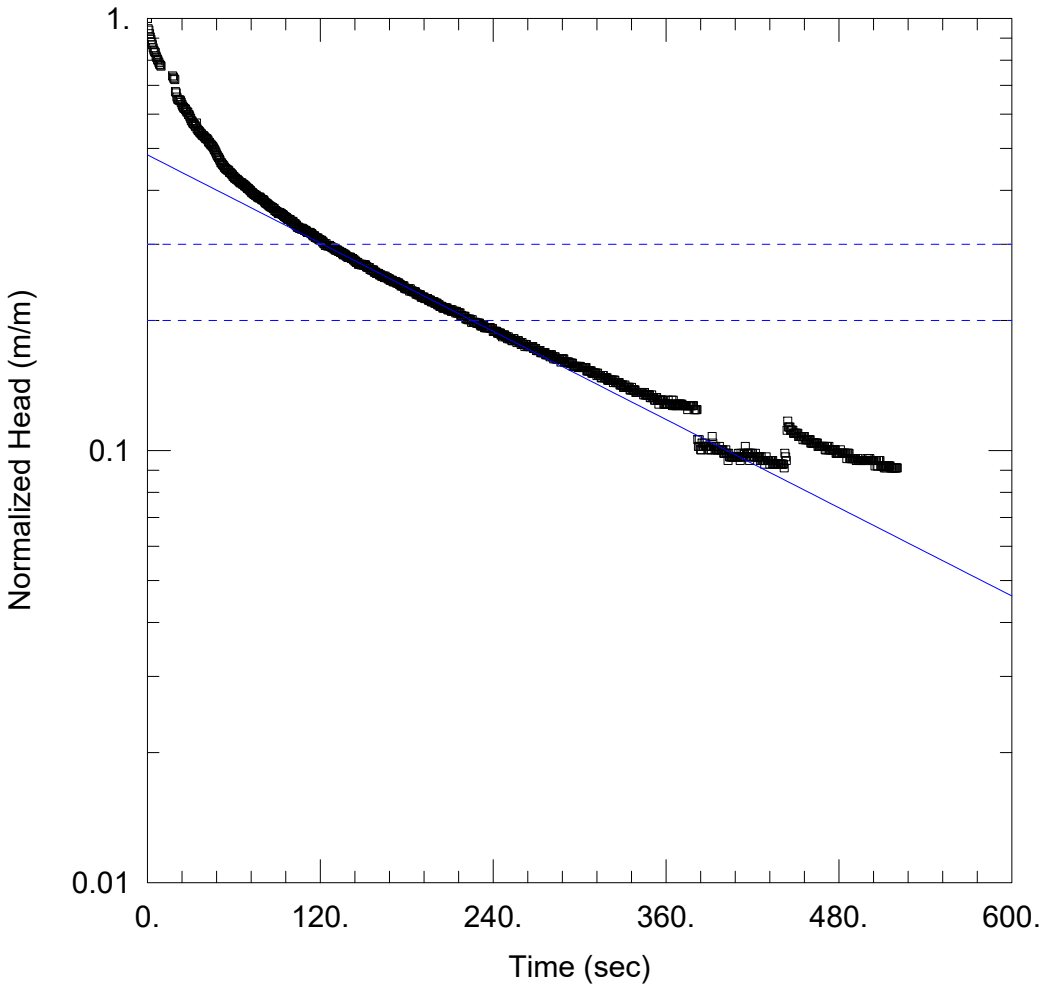
Saturated Thickness: 1.9 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12)

Initial Displacement: 1.139 m
Total Well Penetration Depth: 1.901 m
Casing Radius: 0.025 m
Static Water Column Height: 1.9 m
Screen Length: 1.901 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.08002 m/day
y0 = 0.5766 m



WELL TEST ANALYSIS

Data Set: \...\BH13.aqt
Date: 12/09/20 Time: 09:15:32

PROJECT INFORMATION

Test Well: BH13

AQUIFER DATA

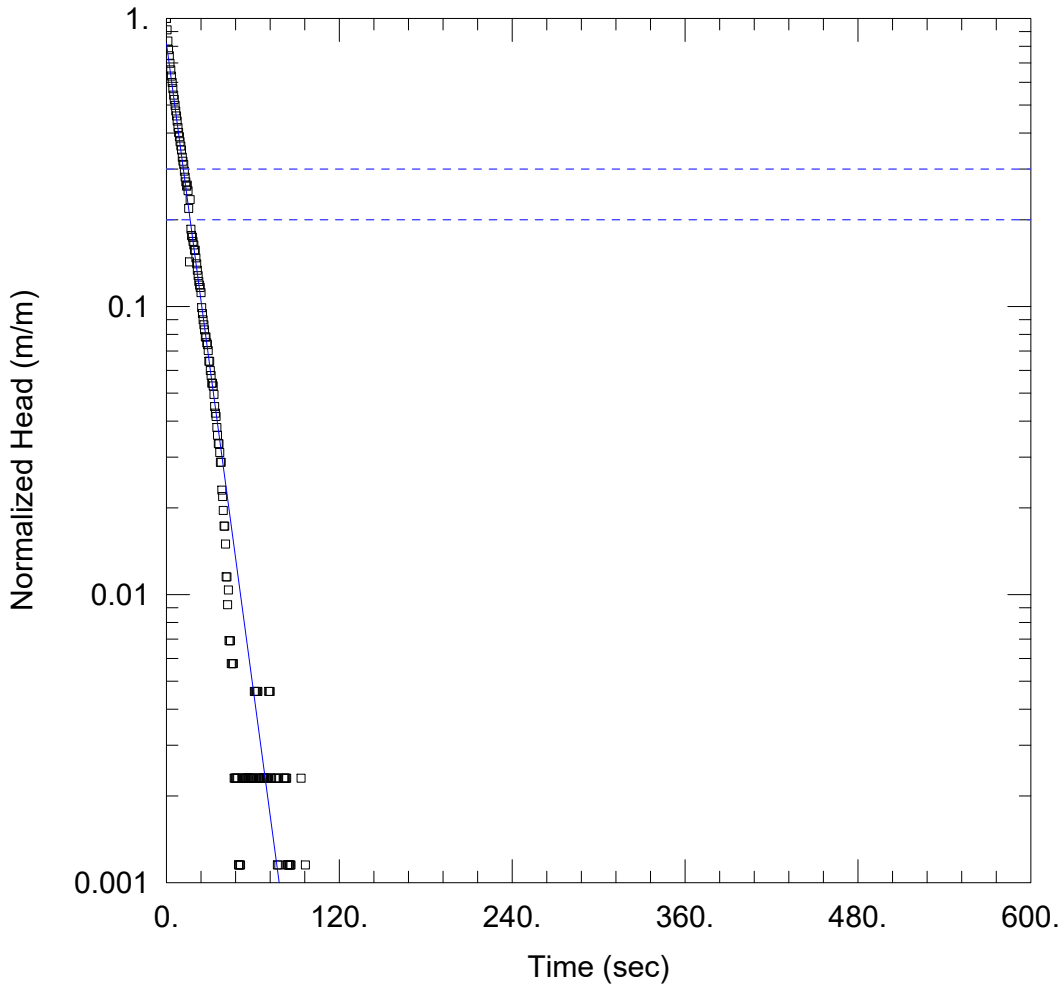
Saturated Thickness: 15.71 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH13)

Initial Displacement: 1.086 m
Total Well Penetration Depth: 15.71 m
Casing Radius: 0.025 m
Static Water Column Height: 15.71 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.08698 m/day
y0 = 0.5248 m



WELL TEST ANALYSIS

Data Set: \...\BH14.aqt
Date: 12/09/20 Time: 09:17:15

PROJECT INFORMATION

Test Well: BH14

AQUIFER DATA

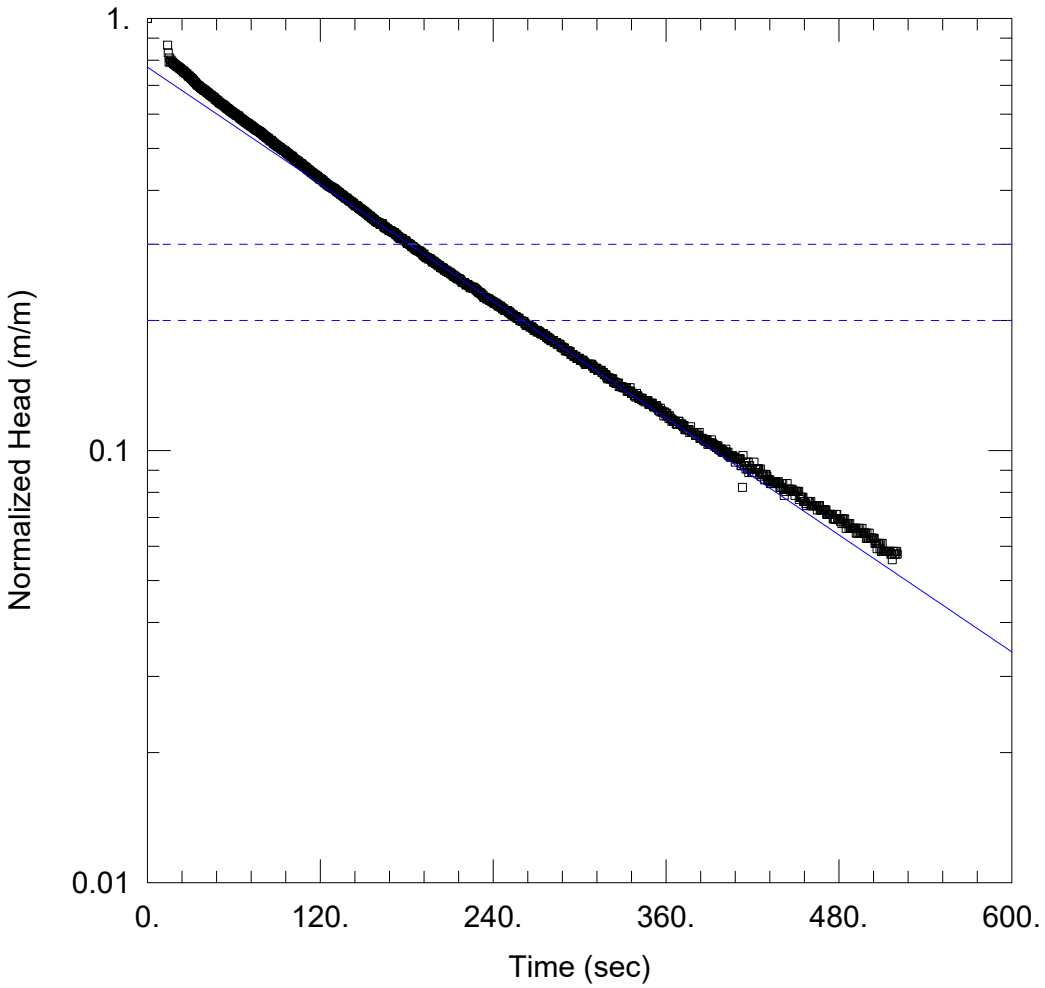
Saturated Thickness: 17.86 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH14)

Initial Displacement: 0.868 m
Total Well Penetration Depth: 17.86 m
Casing Radius: 0.025 m
Static Water Column Height: 17.86 m
Screen Length: 12. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.02 m/day
y0 = 0.7111 m



WELL TEST ANALYSIS

Data Set: \...\BH16.aqt
Date: 12/09/20 Time: 09:18:52

PROJECT INFORMATION

Test Well: BH16

AQUIFER DATA

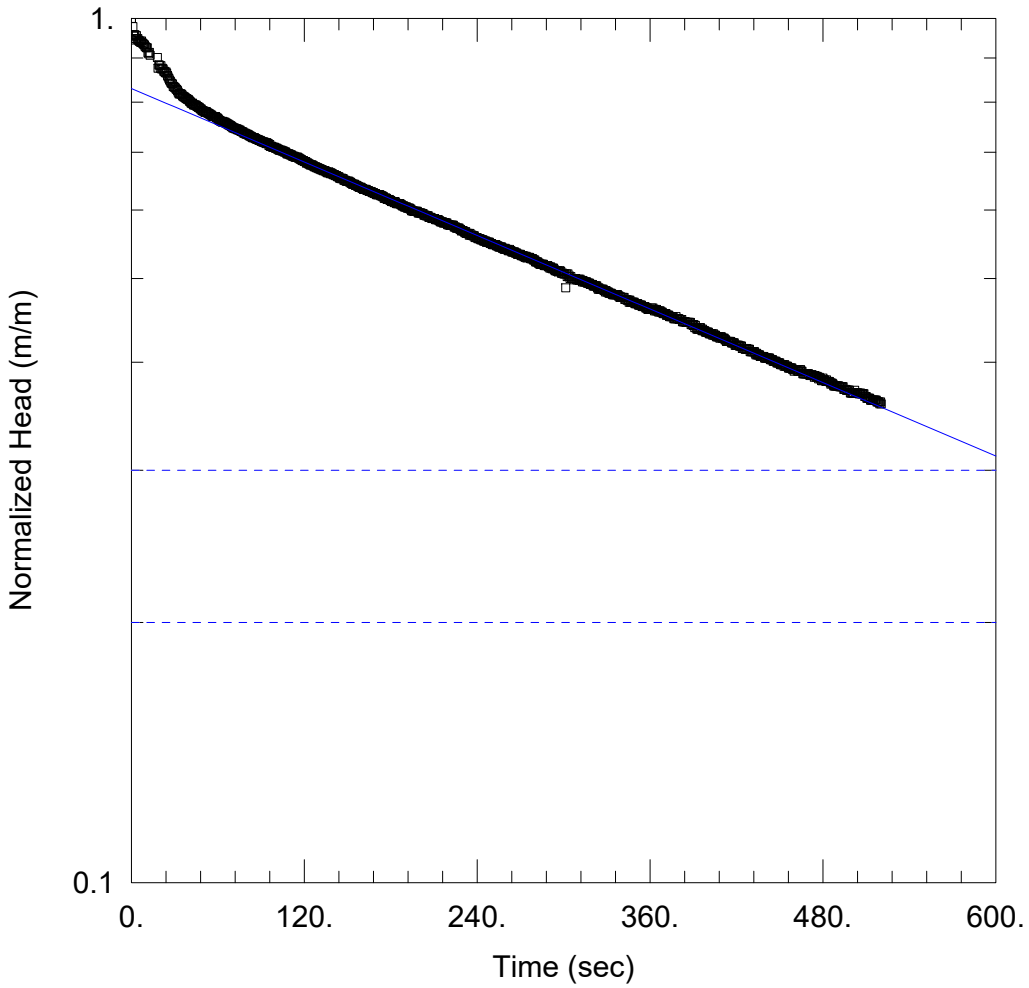
Saturated Thickness: 11.87 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH16)

Initial Displacement: 1.181 m
Total Well Penetration Depth: 11.87 m
Casing Radius: 0.025 m
Static Water Column Height: 11.87 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1186 m/day
y0 = 0.9108 m



WELL TEST ANALYSIS

Data Set: \...\BH17.aqt
Date: 12/09/20 Time: 09:20:45

PROJECT INFORMATION

Test Well: BH17

AQUIFER DATA

Saturated Thickness: 11.6 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH17)

Initial Displacement: 1.142 m
Total Well Penetration Depth: 11.6 m
Casing Radius: 0.025 m
Static Water Column Height: 11.6 m
Screen Length: 6. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.03479 m/day
y0 = 0.9474 m

Appendix G

Surface water flow data - long term monitoring sites

Myara North mine region streamflow gauging station

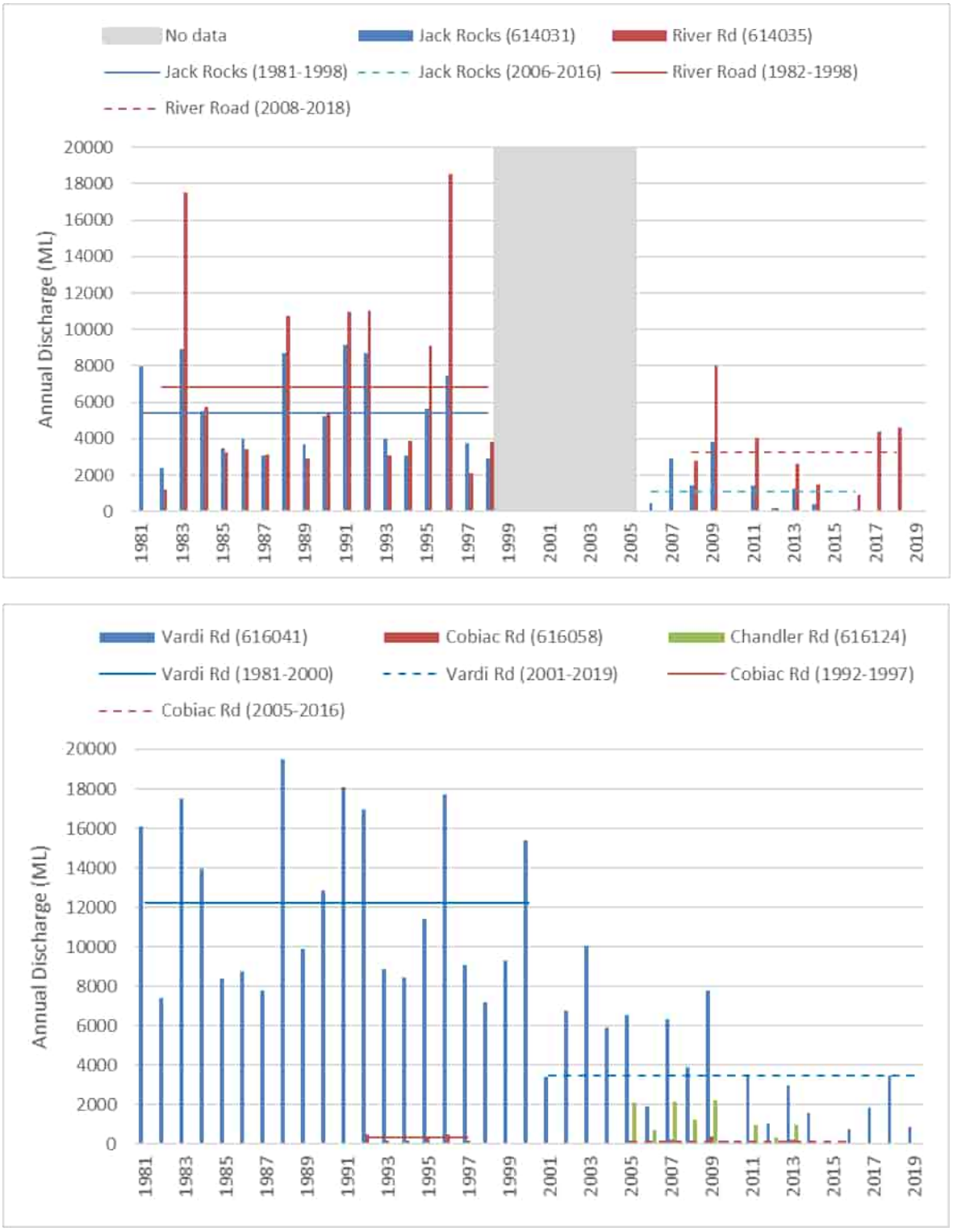


Figure G-1 *Myara North mine region gauging station annual flows*

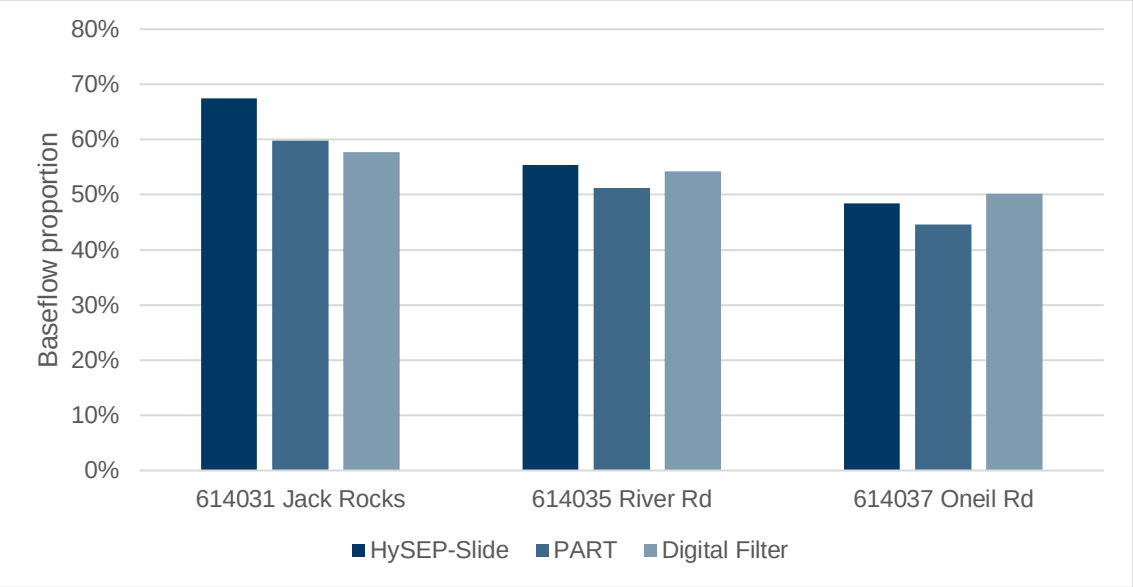


Figure G-2 ***Baseflow contribution to runoff***

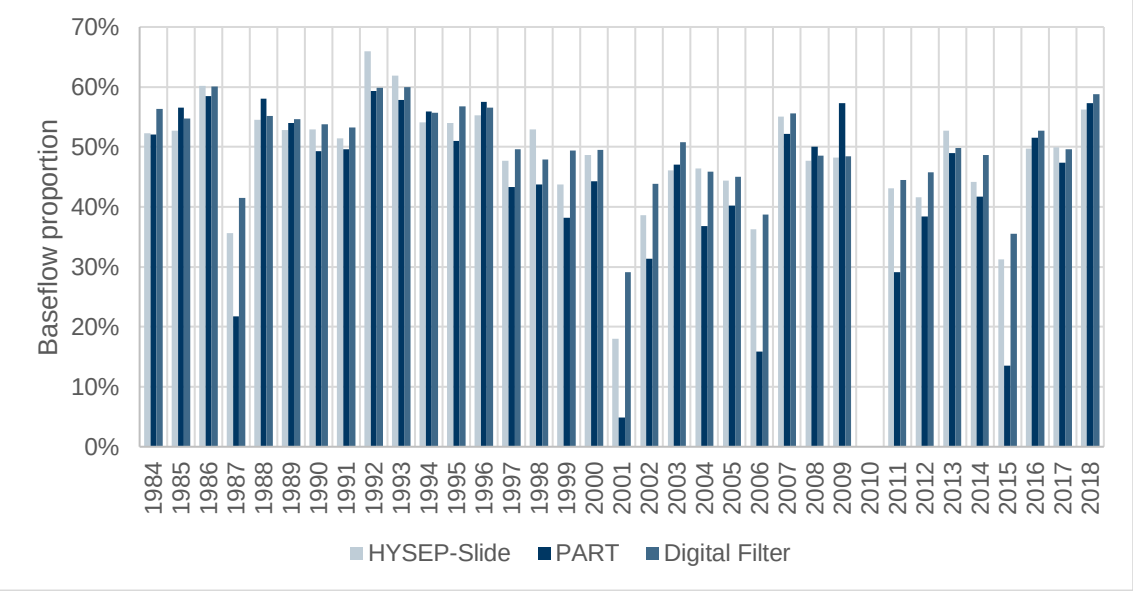


Figure G-3 ***Baseflow trends***

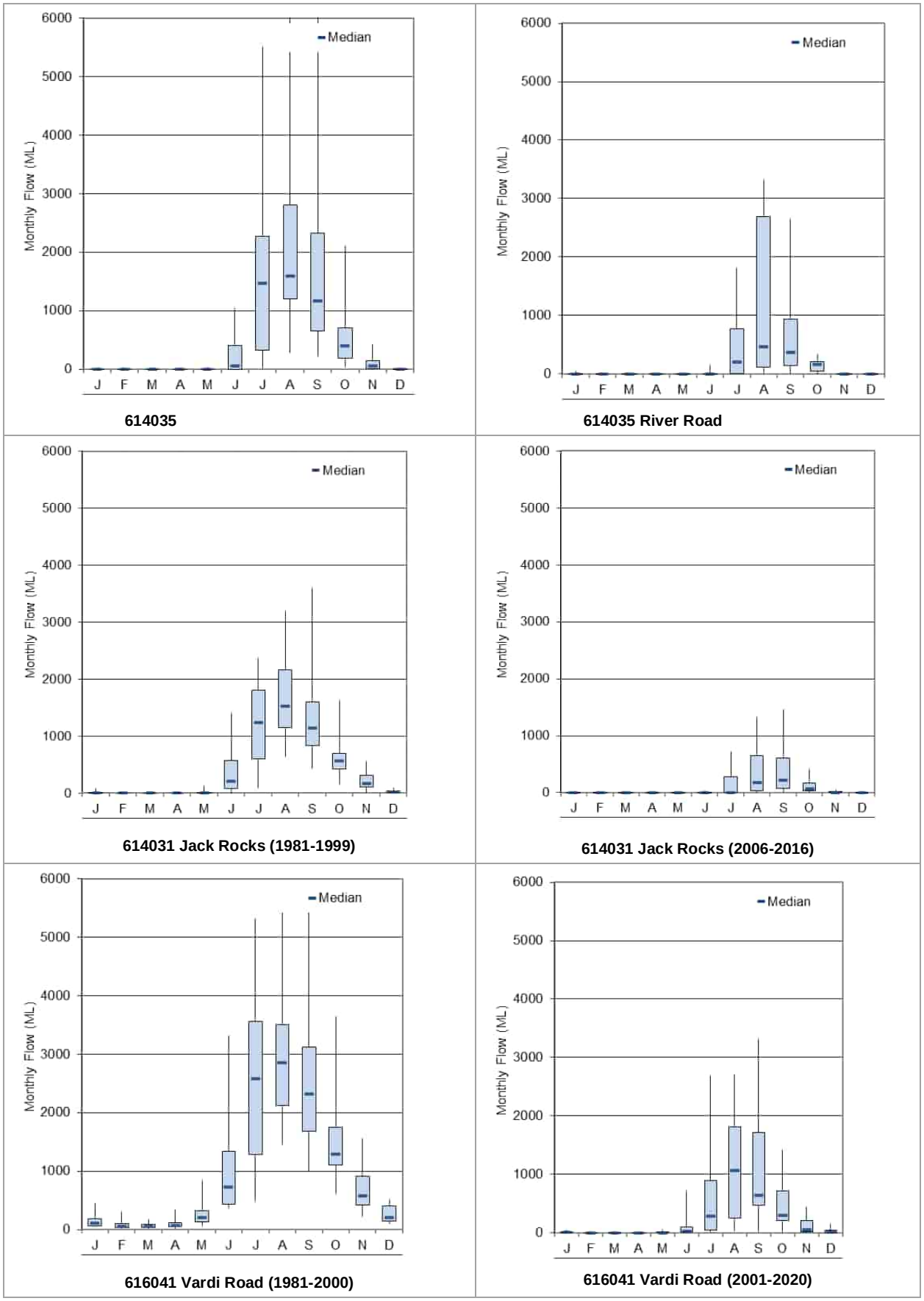


Figure G-4 Myara North mine region gauging station flow seasonality

Holyoake mine region streamflow gauging station

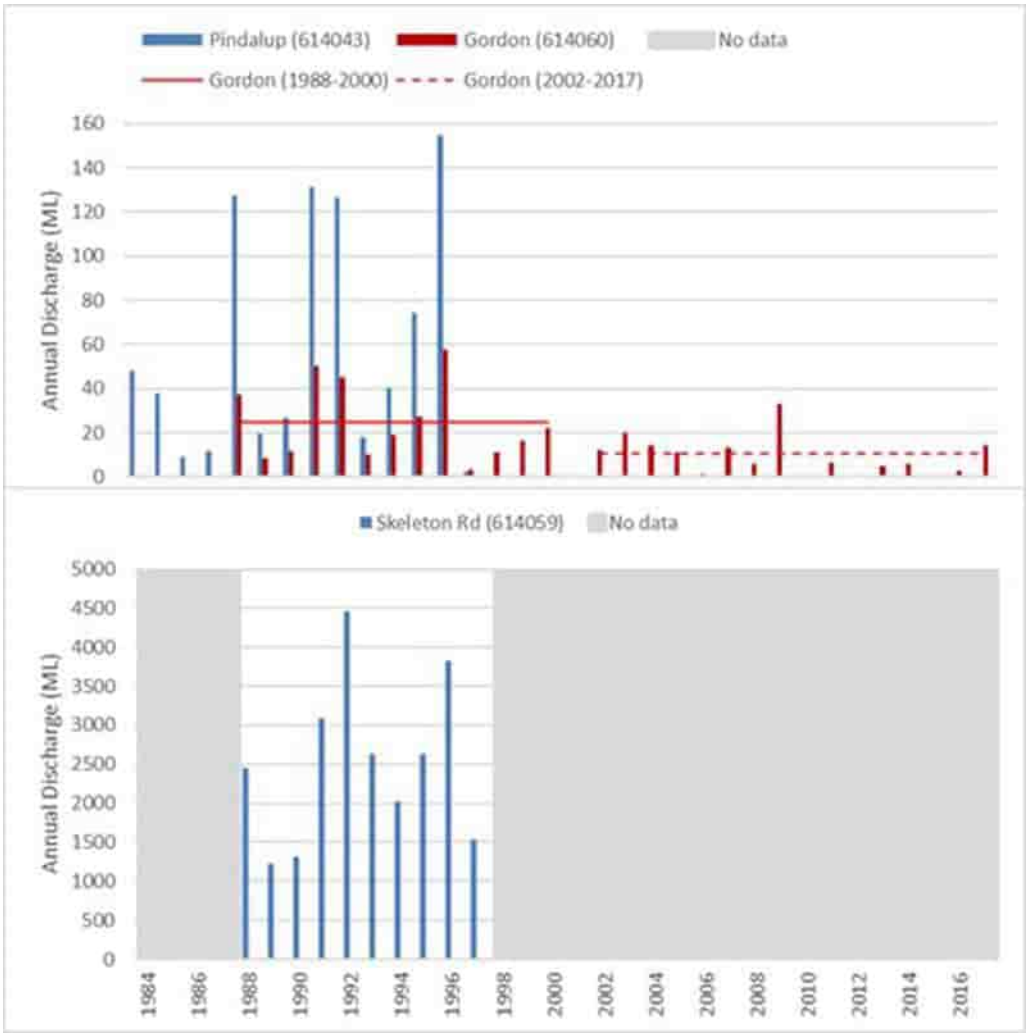


Figure G-5 Holyoake mine region (South Dandalup catchment) gauging station annual flows

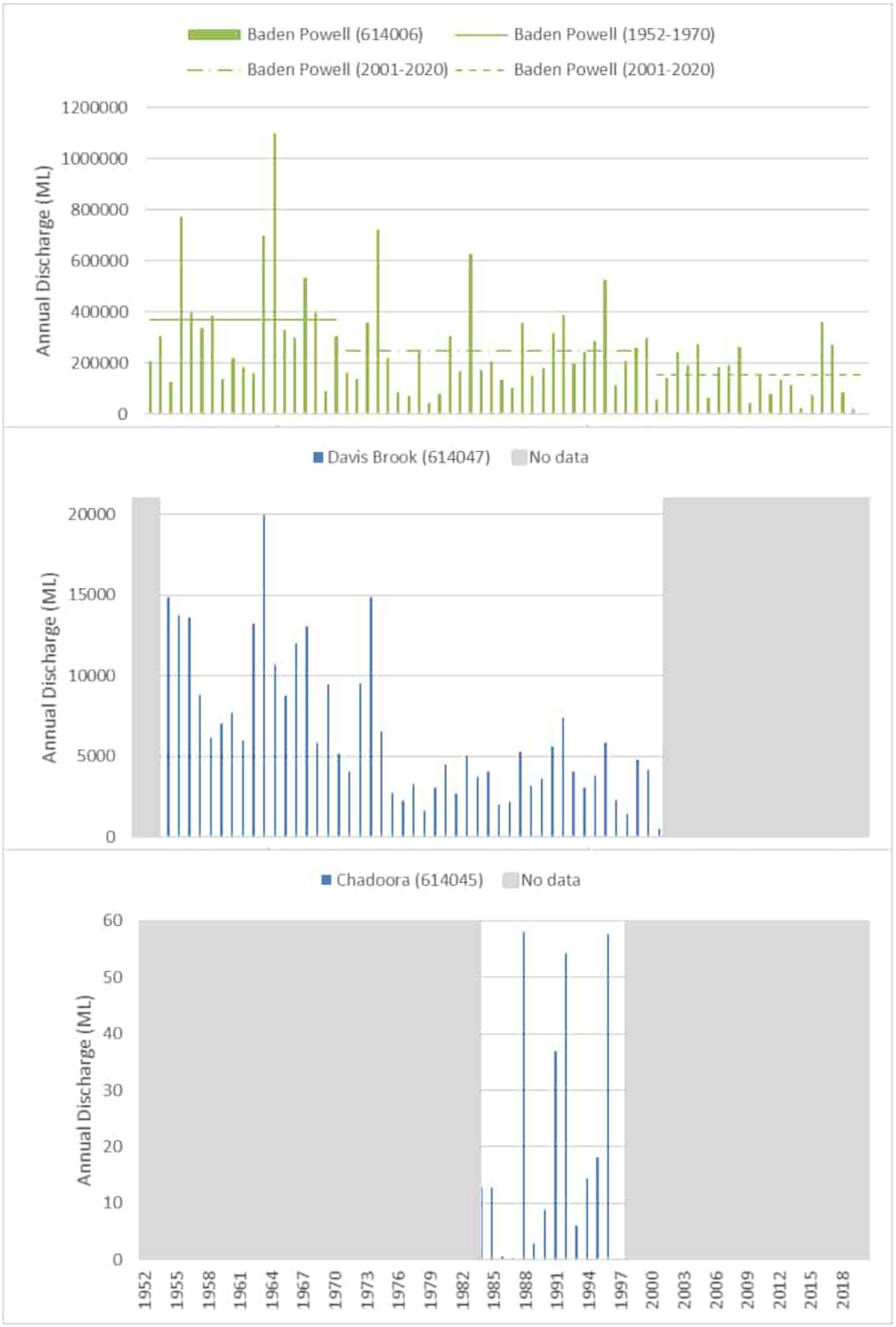


Figure G-6 Holyoake mine region (Murray catchment) gauging station annual flows

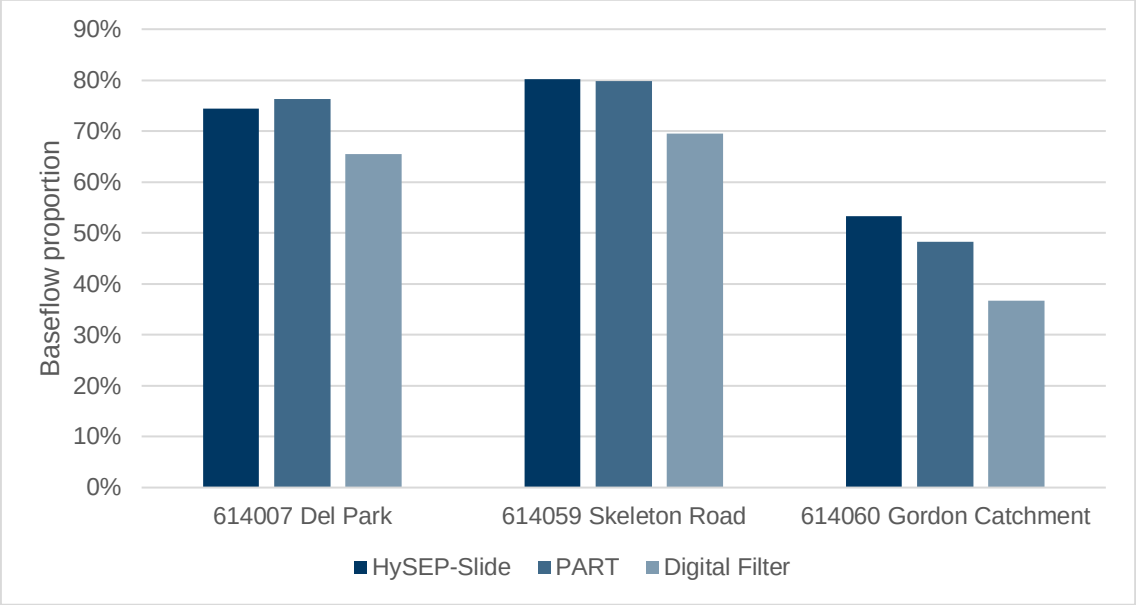


Figure G-7 Baseflow contribution to runoff

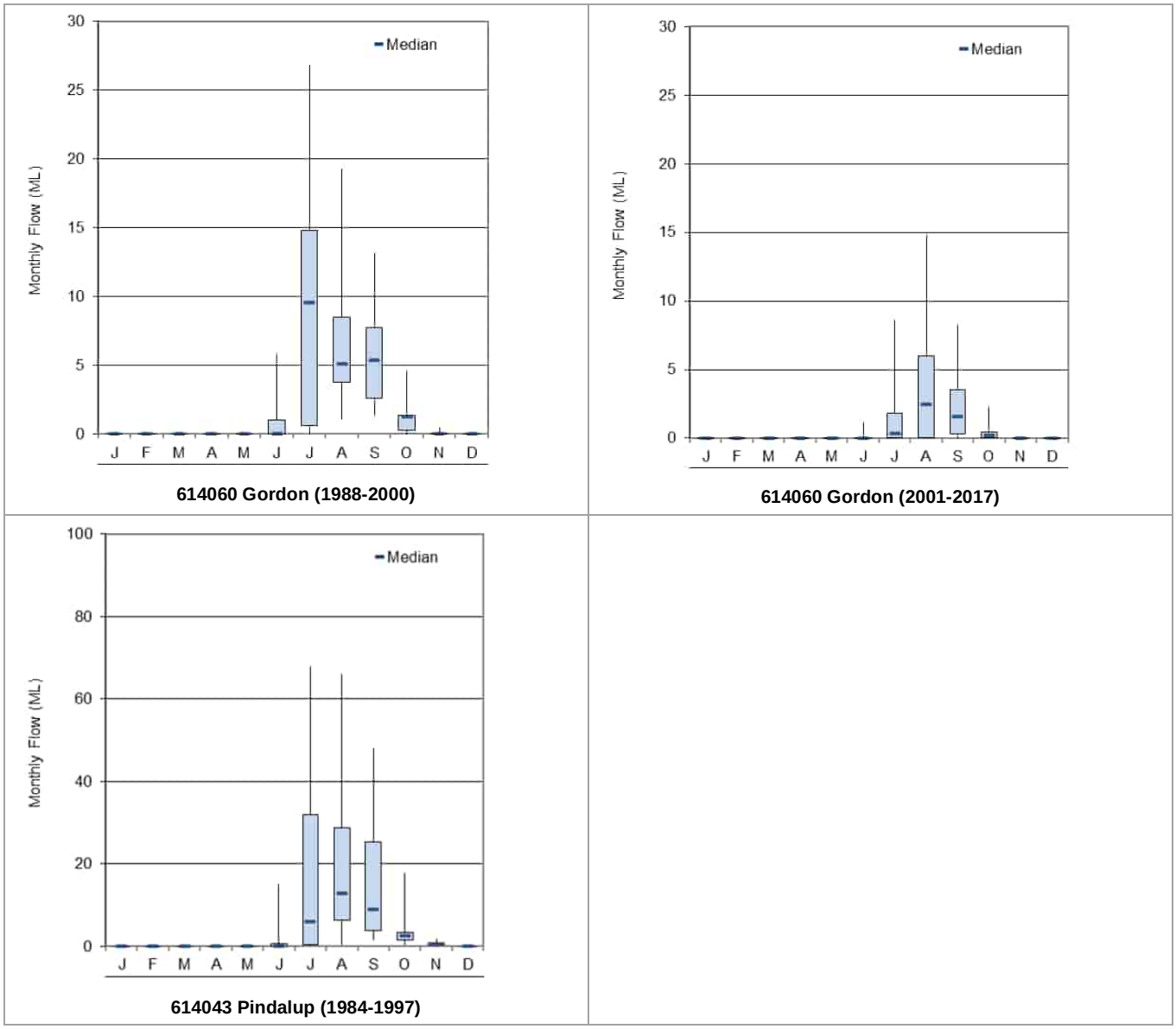


Figure G-8 Holyoake mine region gauging station flow seasonality

Appendix H

Surface water quality summary statistics – Long term monitoring sites

Myara North

Table H-1 Myara North surface water TDS (mg/L) – Alcoa sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	WG72	26	113	147	142	191	1/09/1991	18/11/1997
	WG67	9	115	154	130	230	1/01/1991	21/08/1996
	WG20	36	112	158	149	230	22/12/1975	20/10/1997
	WG16	8	131	217	218	285	22/12/1975	12/12/1978
	WG17	12	184	312	334	398	22/12/1975	12/12/1978
	WG19	20	148	276	294	334	24/08/1977	24/07/1991
	WG63	22	103	206	211	282	1/07/1991	18/08/2000
	WG61	27	96	183	189	275	1/01/1991	2/08/1999
	WG68	13	80	103	95	205	1/07/1991	18/08/2000
	WG14	33	141	232	243	305	27/07/1977	20/10/1993
	WG13	12	155	226	228	280	22/12/1975	12/12/1978
	WG54	14	157	237	239	296	25/01/1979	23/06/1994
	WG15	9	134	209	206	293	22/12/1975	12/12/1978
Gooralong Brook	GG08	14	103	176	178	243	19/01/1976	11/12/1978
	GG07	14	121	171	165	231	19/01/1976	11/12/1978
	GG06	9	108	132	128	162	19/12/1975	11/12/1978
	GG05	13	117	129	131	138	19/12/1975	11/12/1978
	GG03	52	89	151	153	247	19/12/1975	20/10/1993
39 Mile Brook	TN11	28	103	177	178	265	4/11/1975	21/06/1994
	TN30	13	131	183	190	231	4/11/1975	26/10/1993
	TN34	6	157	179	173	225	1/09/1991	18/10/1993
	TN33	17	178	255	267	306	22/11/1990	21/06/1994
	TN10	24	118	188	187	284	22/11/1990	21/06/1994
	TN09	20	123	250	250	357	18/10/1977	21/06/1994
	TN31	16	133	226	197	343	19/11/1975	12/10/1992
	TN01	60	116	255	261	419	30/10/1975	19/11/1993
	TN02	52	114	216	219	330	4/11/1975	19/11/1993
	TN13	9	113	212	217	280	18/10/1977	11/12/1978
	TN14	126	101	232	229	486	25/01/1979	13/02/1990
East of 1100mm isohyet								
Banksia Gully	SN01	86	82	229	210	583	22/06/1981	8/09/1998
Goldmine Gully	SN05	10	184	278	242	574	1/09/1991	2/06/1994
	SN02	96	110	283	248	2078	22/06/1981	8/09/1998
Eastern Trib 1	SN06	7	168	209	205	265	1/09/1991	18/10/1995
	SN03	86	77	205	192	653	22/06/1981	8/09/1998
Eastern Trib 2	SN04	45	59	173	109	728	1/07/1991	14/01/2020

Table H-2 Myara North surface water EC (uS/cm) – Alcoa sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	WG72	26	204	269	261	356	1/09/1991	18/11/1997
	WG67	9	206	284	237	434	1/01/1991	21/08/1996
	WG20	36	201	292	275	434	22/12/1975	20/10/1997
	WG16	8	239	409	409	542	22/12/1975	12/12/1978
	WG17	12	343	595	639	764	22/12/1975	12/12/1978
	WG19	20	272	524	559	638	24/08/1977	24/07/1991
	WG63	22	182	387	396	537	1/07/1991	18/08/2000
	WG61	27	170	341	352	522	1/01/1991	2/08/1999
	WG68	13	137	184	167	385	1/07/1991	18/08/2000
	WG14	33	258	437	460	582	27/07/1977	20/10/1993
	WG13	12	286	426	431	533	22/12/1975	12/12/1978
	WG54	14	290	448	451	564	25/01/1979	23/06/1994
	WG15	9	245	392	387	557	22/12/1975	12/12/1978
Gooralong Brook	GG08	14	182	327	331	459	19/01/1976	11/12/1978
	GG07	14	219	318	305	435	19/01/1976	11/12/1978
	GG06	9	194	241	233	300	19/12/1975	11/12/1978
	GG05	13	211	235	239	251	19/12/1975	11/12/1978
	GG03	52	155	278	281	468	19/12/1975	20/10/1993
39 Mile Brook	TN11	28	184	328	332	503	4/11/1975	21/06/1994
	TN30	13	239	342	355	435	4/11/1975	26/10/1993
	TN34	6	290	334	320	423	1/09/1991	18/10/1993
	TN33	17	330	483	506	583	22/11/1990	21/06/1994
	TN10	24	213	351	349	540	22/11/1990	21/06/1994
	TN09	20	223	474	472	684	18/10/1977	21/06/1994
	TN31	16	243	427	368	657	19/11/1975	12/10/1992
	TN01	60	209	484	495	806	30/10/1975	19/11/1993
	TN02	52	206	407	411	630	4/11/1975	19/11/1993
	TN13	9	203	398	407	533	18/10/1977	11/12/1978
	TN14	126	180	437	432	938	25/01/1979	13/02/1990
East of 1100mm isohyet								
Banksia Gully	SN01	86	142	432	394	1129	22/06/1981	8/09/1998
Goldmine Gully	SN05	10	342	528	457	1113	1/09/1991	2/06/1994
	SN02	96	197	537	469	3874	22/06/1981	8/09/1998
Eastern Trib 1	SN06	7	311	391	385	503	1/09/1991	18/10/1993
	SN03	86	133	384	359	1268	22/06/1981	8/09/1998
Eastern Trib 2	SN04	45	98	322	195	1415	1/07/1991	14/01/2020

Table H-3 Myara North surface water EC (uS/cm) – DWER sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	6161352	24	307	596	607	714	4/05/1976	9/07/1980
	616058[6]	4138	0	124	22	479	3/04/1992	8/07/2013
	616058[7]	525	210	554	536	1180	25/06/1992	22/10/1997
	6161353	18	238	454	470	649	6/07/1976	4/10/1979
	6161351	21	298	513	510	682	21/10/1975	4/10/1979
	6161338	25	286	409	386	588	3/11/1975	4/10/1979
	6161339	23	298	489	481	867	3/11/1975	4/10/1979
	6161340	23	298	497	500	691	4/05/1976	4/10/1979
	6161337	23	286	424	423	540	3/11/1975	1/06/1983
	6161341	106	161	358	365	531	4/05/1976	13/12/1984
	6161343	108	286	344	326	598	4/05/1976	13/12/1984
	6161342	107	105	408	403	761	3/11/1975	13/12/1984
	6161349	103	122	255	253	488	3/11/1975	13/12/1984
	6161348	90	111	215	219	313	3/11/1975	13/12/1984
	6161347	113	106	214	215	314	3/08/1976	13/12/1984
Gooralong Brook	6141622	119	175	270	274	390	21/10/1975	15/12/1986
Minor tributary	6141104	207	120	306	318	547	28/10/1975	7/09/1995
39 Mile Brook	6141118	110	173	410	403	762	22/01/1976	19/12/1984
	6141117	105	176	360	330	806	27/05/1976	14/11/1984
	6141116	16	398	529	527	667	21/10/1975	22/11/1977
	6141114	16	218	328	343	378	27/05/1976	25/07/1978
	6141115	17	341	429	417	561	21/10/1975	12/09/1977
	614031[8]	290	0	513	505	928	30/05/1985	23/09/1998
	6141113	24	242	397	371	800	17/10/1979	17/09/1980
East of 1100mm isohyet								
Banksia Gully	6141120	84	23	365	352	833	10/08/1976	14/11/1984
	6141121	150	18	535	537	1216	28/10/1975	10/10/1994
Goldmine Gully	6141126	83	16	340	330	761	10/08/1976	7/09/1995
	6141125	114	28	468	437	1857	2/12/1975	10/10/1994
Eastern Trib 1	6141128	83	16	340	330	761	10/08/1976	10/10/1994
	6141127	22	171	387	384	689	17/10/1979	5/11/1980
Serpentine River	6141138	112	103	438	425	889	9/07/1980	7/09/1995
	614035[9]	269	152	579	557	1388	26/07/1982	14/10/1998
	6141142	84	130	441	390	1009	4/06/1981	11/11/1985
	6141141	86	130	431	441	840	4/06/1981	18/11/1985
	6141140	94	140	390.85	360	724	28/05/1981	18/11/1985
	6141147	104	120	511.09	447	1889	22/06/1976	1/10/1985

[6] Wungong Cobiac gauging station continuous EC logging – summary of maximum EC values with 0 value representing no flow.
[7] Wungong Cobiac gauging station discrete monitoring. Single sample recorded 24/01/2000.
[8] 39 Mile Brook Jack Rocks gauging station location discrete monitoring.
[9] Serpentine River River Road gauging station location discrete monitoring.

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
	6141148	117	41	401.48	370	833	9/10/1975	11/11/1985

Table H-4 Myara North surface water turbidity (NTU) – Alcoa sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	WG16	8	0.2	0.5	0.5	0.6	22/12/1975	12/12/1978
	WG17	12	0.1	0.4	0.3	1	22/12/1975	12/12/1978
	WG19	19	0.1	0.4	0.2	3.8	24/08/1977	24/07/1991
	WG14	20	0.1	0.3	0.2	0.9	27/07/1977	20/10/1993
	WG13	12	0.2	0.5	0.3	1.9	22/12/1975	12/12/1978
	WG54	5	0.2	0.2	0.2	0.3	25/01/1979	23/06/1994
	WG15	9	0.1	0.3	0.3	0.6	22/12/1975	12/12/1978
Gooralong Brook	GG08	7	0.4	1.0	0.9	1.8	19/01/1976	11/12/1978
	GG07	9	0.3	0.5	0.3	0.9	19/01/1976	11/12/1978
	GG06	5	0.2	0.3	0.3	0.5	19/12/1975	11/12/1978
	GG05	6	0.1	0.3	0.2	0.6	19/12/1975	11/12/1978
	GG03	32	0.2	0.7	0.5	5.4	19/12/1975	20/10/1993
39 Mile Brook	TN11	8	0.2	0.4	0.3	1	4/11/1975	21/06/1994
	TN09	9	0.1	1.9	0.9	10	18/10/1977	21/06/1994
	TN01	19	0.2	0.7	0.5	1.9	30/10/1975	19/11/1993
	TN02	12	0.2	0.9	0.3	3.2	4/11/1975	19/11/1993
	TN13	9	0.2	0.6	0.3	2.5	18/10/1977	11/12/1978
	TN14	126	0.2	1.8	0.9	45	25/01/1979	13/02/1990
Banksia Gully	SN01	47	0.3	1.7	1.2	8.8	22/06/1981	8/09/1998
Goldmine Gully	SN02	51	0.3	1.1	0.9	3.2	22/06/1981	8/09/1998
Eastern Trib 1	SN03	49	0.3	1.3	1.1	4.8	22/06/1981	8/09/1998

Table H-5 Myara North surface water turbidity (NTU) – DWER sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	6161352	17	0.2	1.1	0.5	10.0	4/05/1976	9/07/1980
	616058[10]	432	0.1	1.0	0.5	31.0	25/06/1992	22/10/1997
	6161353	14	0.2	0.6	0.5	1.4	6/07/1976	4/10/1979
	6161351	12	0.3	0.8	0.6	4.0	21/10/1975	4/10/1979
	6161338	16	0.3	0.9	0.7	5.0	3/11/1975	4/10/1979
	6161339	17	0.2	0.7	0.6	1.4	3/11/1975	4/10/1979
	6161340	17	0.2	0.6	0.5	2.4	4/05/1976	4/10/1979
	6161337	16	0.3	0.7	0.5	2.5	3/11/1975	1/06/1983
	6161341	99	0.1	0.8	0.6	8.8	4/05/1976	13/12/1984
	6161343	101	0.2	0.9	0.7	5.5	4/05/1976	13/12/1984
	6161342	101	0.2	1.3	1.0	21.0	3/11/1975	13/12/1984
	6161349	101	0.2	0.8	0.7	1.9	3/11/1975	13/12/1984
	6161348	84	0.2	1.1	0.9	7.2	3/11/1975	13/12/1984
	6161347	112	0.2	0.8	0.7	2.4	3/08/1976	13/12/1984
Gooralong Brook	6141621	139	0.2	2.1	1.1	35.0	21/10/1975	13/12/1984
	6141622	124	0.3	1.1	0.7	13.0	21/10/1975	15/12/1986
Minor tributary	6141104	206	0.3	1.4	1.2	6.2	7/06/1977	7/09/1995
39 Mile Brook	6141118	103	0.3	0.9	0.7	3.2	22/01/1976	19/12/1984
	6141117	99	0.3	0.9	0.7	8.0	27/05/1976	14/11/1984
	6141116	5	0.3	0.7	0.5	1.8	21/10/1975	22/11/1977
	6141114	7	0.3	0.5	0.6	0.8	27/05/1976	25/07/1978
	614031[11]	243	0.2	0.8	0.5	4.3	30/05/1985	23/09/1998
	6141113	23	0.4	2.1	0.8	23.0	17/10/1979	17/09/1980
Banksia Gully	6141120	83	0.5	3.0	1.3	55.0	10/08/1976	14/11/1984
	6141121	175	0.2	2.3	1.2	54.0	28/10/1975	10/10/1994
Goldmine Gully	6141126	134	0.4	1.7	1.4	10.0	10/08/1976	7/09/1995
	6141125	274	0.4	1.6	1.3	14.0	2/12/1975	10/10/1994
Eastern Trib 1	6141128	110	0.3	1.4	1.1	10.0	10/08/1976	10/10/1994
	6141127	21	0.5	1.6	1.4	4.0	17/10/1979	5/11/1980
Serpentine River	6141138	148	0.3	2.4	2.0	7.9	9/07/1980	7/09/1995
	614035[12]	220	0.5	2.3	1.7	18.0	26/07/1982	14/10/1998
	6141142	84	0.6	2.4	2.0	8.6	4/06/1981	11/11/1985
	6141141	86	0.8	2.3	2.1	7.1	4/06/1981	18/11/1985
	6141140	94	0.6	2.0	1.7	7.0	28/05/1981	18/11/1985
	6141147	102	0.1	3.3	2.6	14.0	22/06/1976	1/10/1985
	6141148	113	0.4	2.0	1.6	7.0	9/10/1975	11/11/1985

[10] Wungong Cobiac gauging station discrete monitoring. Single sample recorded 24/01/2000.
[11] 39 Mile Brook Jack Rocks gauging station location discrete monitoring.

Table H-6 Myara North surface water pH – Alcoa sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	WG17	5	6.2	6.4	6.4	6.7	22/12/1975	12/12/1978
	WG19	7	6.1	6.3	6.2	6.7	24/08/1977	24/07/1991
	WG14	7	6.1	6.4	6.3	6.8	27/07/1977	20/10/1993
	WG13	5	6.3	6.5	6.4	6.9	22/12/1975	12/12/1978
	WG15	5	6.2	6.5	6.4	6.8	22/12/1975	12/12/1978
Gooralong Brook	GG08	11	5.9	6.4	6.5	6.8	19/01/1976	11/12/1978
	GG07	10	5	6.2	6.05	6.8	19/01/1976	11/12/1978
	GG06	6	6.2	6.6	6.6	6.9	19/12/1975	11/12/1978
	GG05	9	5.6	6.2	6.2	6.9	19/12/1975	11/12/1978
	GG03	20	5.8	6.4	6.4	7.4	19/12/1975	20/10/1993
39 Mile Brook	TN01	30	5.4	6.3	6.4	7.3	30/10/1975	19/11/1993
	TN02	25	5.1	6.2	6.2	7.2	4/11/1975	19/11/1993
	TN14	19	6.2	7.1	7.1	8.5	25/01/1979	13/02/1990
Banksia Gully	SN01	6.0	5.2	6.1	6.2	6.6	22/06/1981	8/09/1998
Goldmine Gully	SN02	6.0	5.6	6.1	6.1	6.5	22/06/1981	8/09/1998
Eastern Trib 1	SN03	6.0	5.9	6.2	6.2	6.7	22/06/1981	8/09/1998
Eastern Trib 2	SN04	29	5.6	6.2	6.2	6.8	1/07/1991	14/01/2020

Table H-7 Myara North surface water pH – DWER sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Wungong Brook	616058[13]	62	6.30	6.82	6.90	7.00	30/06/1992	22/10/1997
	614031[14]	237	5.40	6.58	6.60	8.50	30/05/1985	23/09/1998
	614035[15]	240	5.60	6.49	6.40	8.60	26/07/1982	14/10/1998

[13] Wungong Cobiac gauging station discrete monitoring. Single sample recorded 24/01/2000.
[14] 39 Mile Brook Jack Rocks gauging station location discrete monitoring.
[15] Serpentine River River Road gauging station discrete monitoring.

Holyoake

Table H-8 Holyoake surface water EC (uS/cm) – Alcoa sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Davis Brook	DV04	22	352	672	646	914	4/02/1976	29/11/1979

Table H-9 Holyoake surface water EC (uS/cm) – DWER sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
South Dandalup	614060[16]	226	122	175	169	789	21/06/1988	15/08/2000
	6141360	47	150	310	240	978	11/08/1976	27/09/1984
	6141352	67	151	307	265	1100	22/10/1975	20/09/1984
	6141349	10	278	489	308	2000	3/11/1975	14/10/1980
	6141350	65	142	309	263	950	22/10/1975	20/09/1984
	6141345	31	17	259	240	1064	6/10/1976	20/09/1984
	6141344	51	22	331	322	870	15/09/1976	20/09/1984
	6141342	55	19	209	216	479	11/08/1976	20/09/1984
	6141005	7	296	641	699	923	13/07/1972	25/09/1975
	6141333	7	150	342	316	682	22/10/1975	4/10/1984
	6141337	76	124	199	189	426	11/08/1976	4/10/1984
	6141336	56	17	210	216	272	25/06/1980	30/08/1984
	614043[17]	930	61	346	351	547	5/06/1984	26/09/1994
	6141340	86	26	350	335	681	22/10/1975	4/10/1984
Swamp Oak Brook	6141021	23	511	751	763	941	20/06/1972	22/11/1976

Table H-10 Holyoake surface water turbidity (NTU) – Alcoa sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
Davis Brook	DV04	16	0.7	1.8	1.8	3.5	4/04/1977	24/10/1979

Table H-11 Holyoake surface water turbidity (NTU) – DWER sites

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
South Dandalup	614060[12]	112	0.3	1.4	1.0	6.7	21/06/1988	15/08/2000
	6141360	44	0.8	4.5	2.6	23.0	24/08/1977	27/09/1984
	6141352	65	0.7	2.8	2.0	12.0	19/07/1978	20/09/1984
	6141349	37	0.5	3.4	2.2	9.8	11/08/1980	7/08/1995
	6141350	79	1.0	2.7	2.3	6.4	24/08/1977	13/09/1994
	6141345	30	0.1	1.7	1.6	5.0	19/07/1978	20/09/1984
	6141344	51	0.7	7.8	7.3	18.0	24/08/1977	20/09/1984
	6141342	55	1.1	3.7	2.5	41.0	19/07/1978	20/09/1984

[16] South Dandalup Gordon Catchment gauging station discrete monitoring.
[17] South Dandalup Pindalup gauging station discrete monitoring.

Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
	6141333	101	0.8	3.1	2.6	12.0	27/07/1977	4/10/1984
	6141337	74	0.6	1.9	1.5	6.6	19/07/1978	4/10/1984
	6141336	56	0.7	1.9	1.6	8.2	25/06/1980	30/08/1984
	614043[14]	176	0.1	1.6	1.0	65.0	5/06/1984	26/09/1994
	6141340	106	0.3	1.1	0.9	12	24/08/1977	12/10/1994
Davis Brook	6141465	5	1.6	5.8	5.0	12.0	18/07/1978	17/07/1979

Table H-12 Holyoake surface water pH – DWER sites

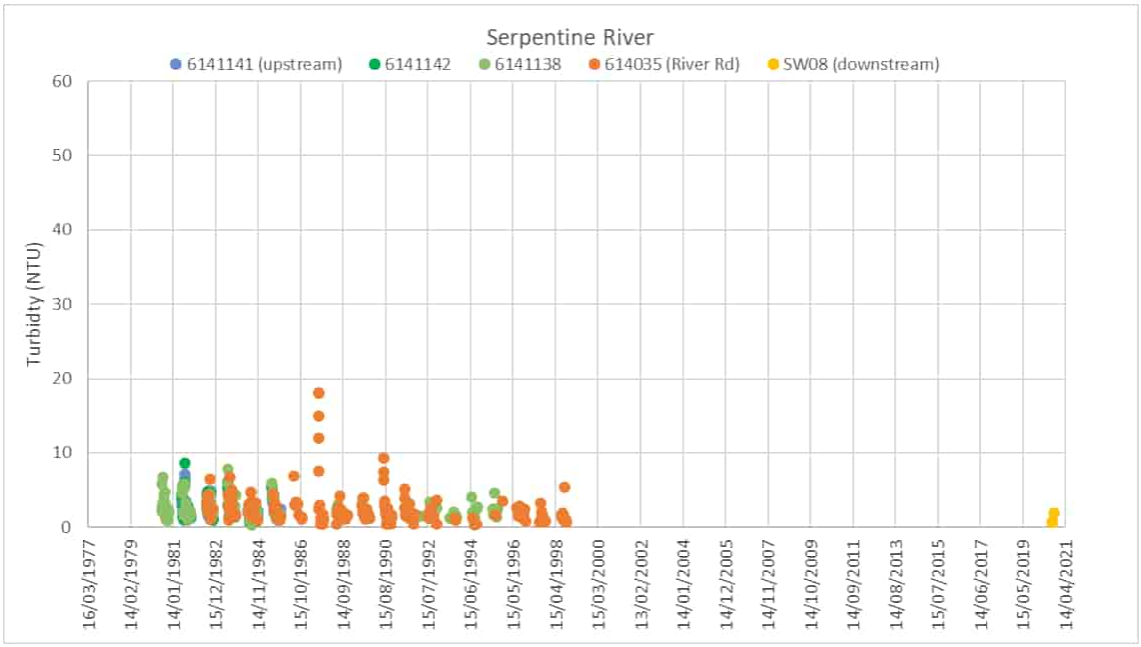
Tributary	Site ID	Count	Min	Average	Median	Max	Start record	End record
South Dandalup	614060[18]	115	6.0	6.9	6.9	8.3	21/06/1988	26/09/2014
	614043[19]	223	6.1	7.1	7.1	8.2	6/06/1984	26/09/1994

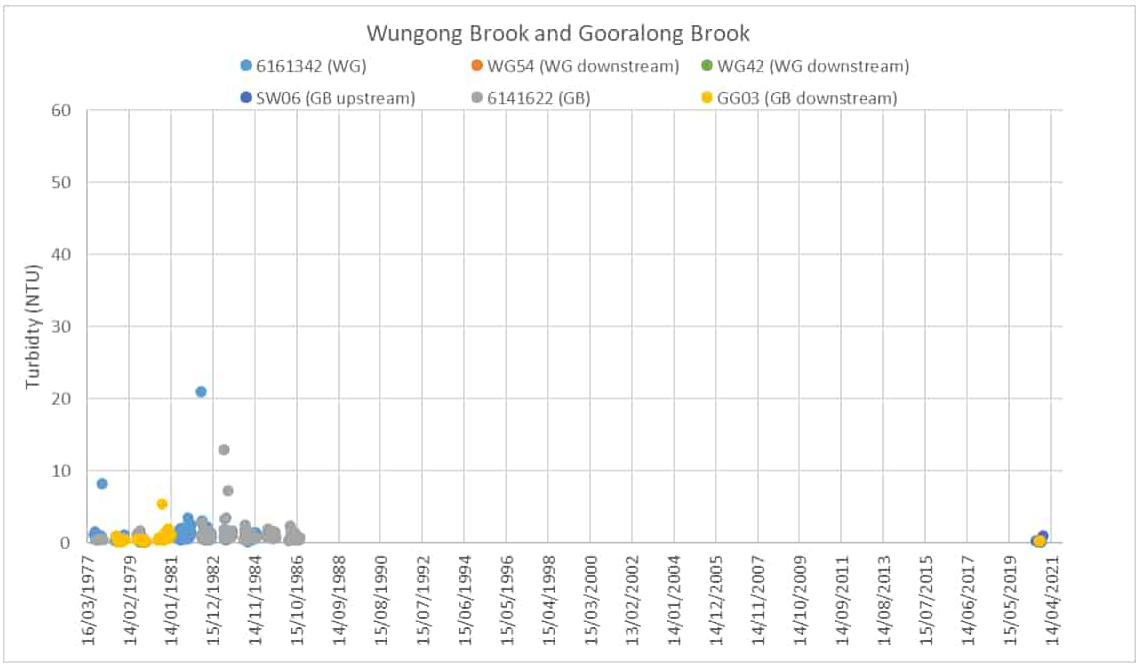
[18] South Dandalup Gordon Catchment gauging station discrete monitoring.
[19] South Dandalup Pindalup gauging station discrete monitoring.

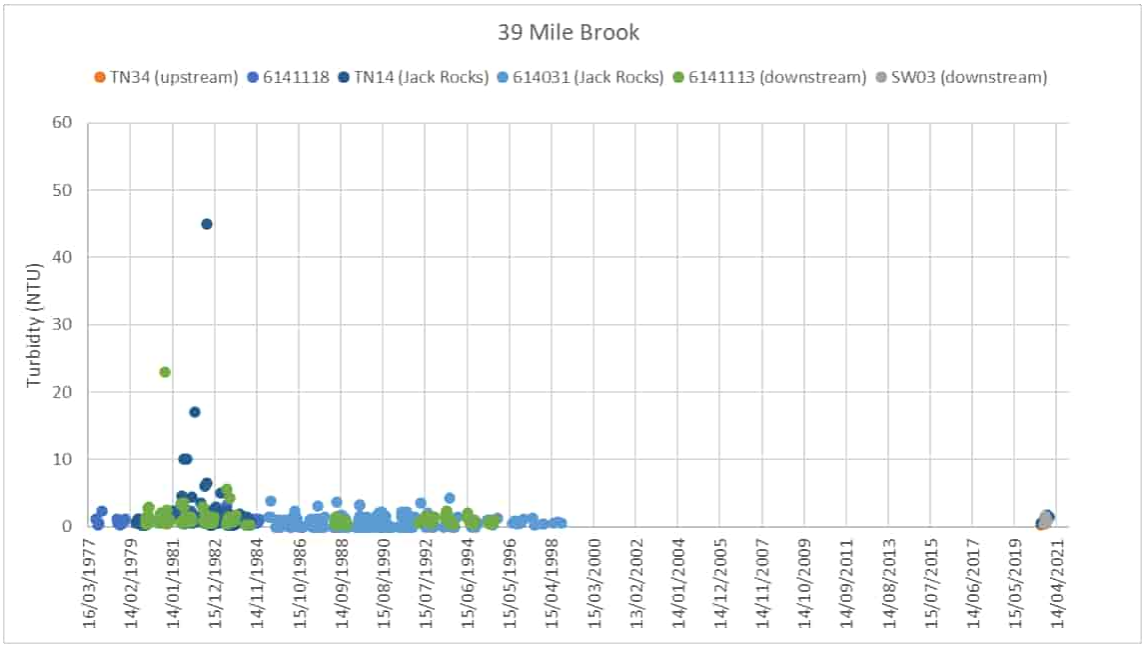
Appendix I

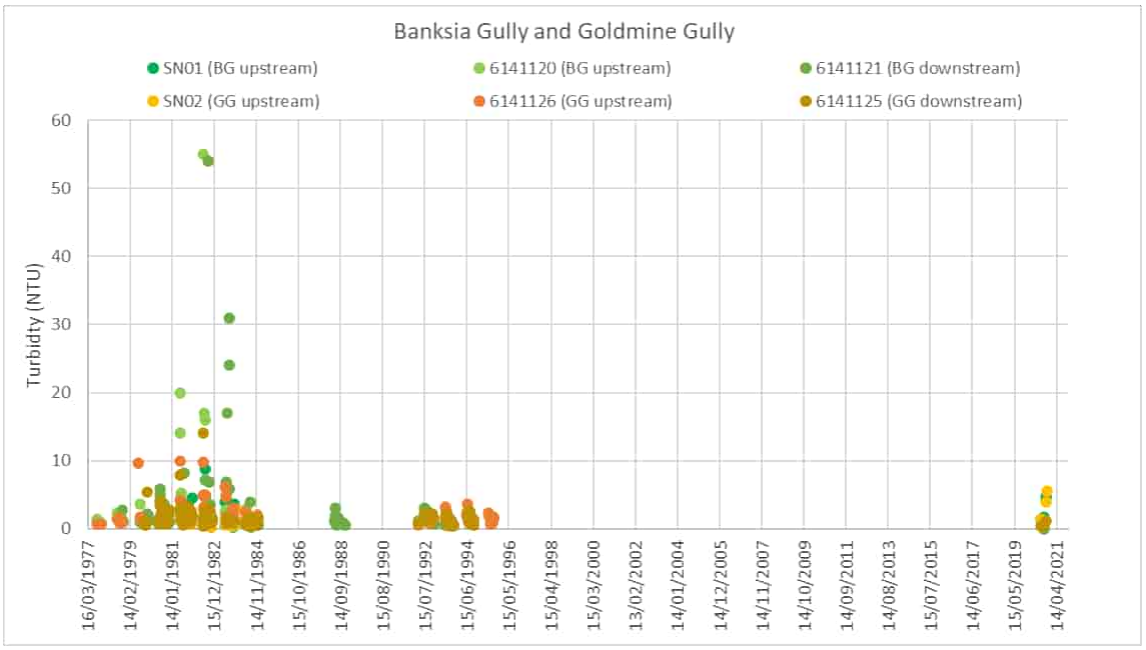
Surface water turbidity plots - long term monitoring sites

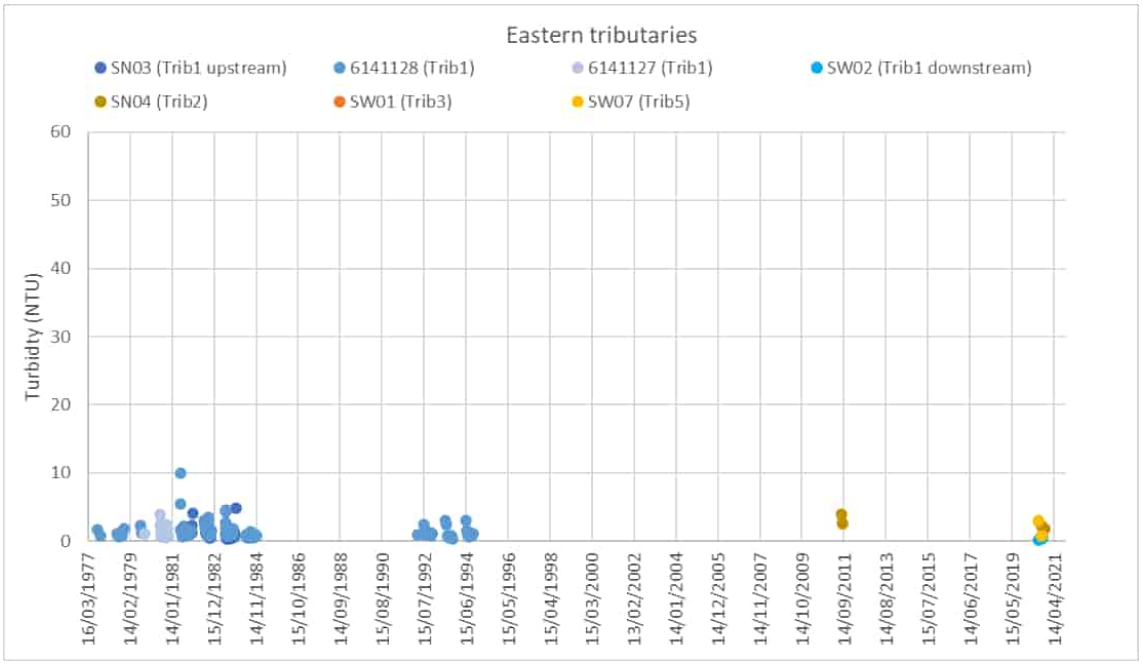
Myara North long term monitoring sites





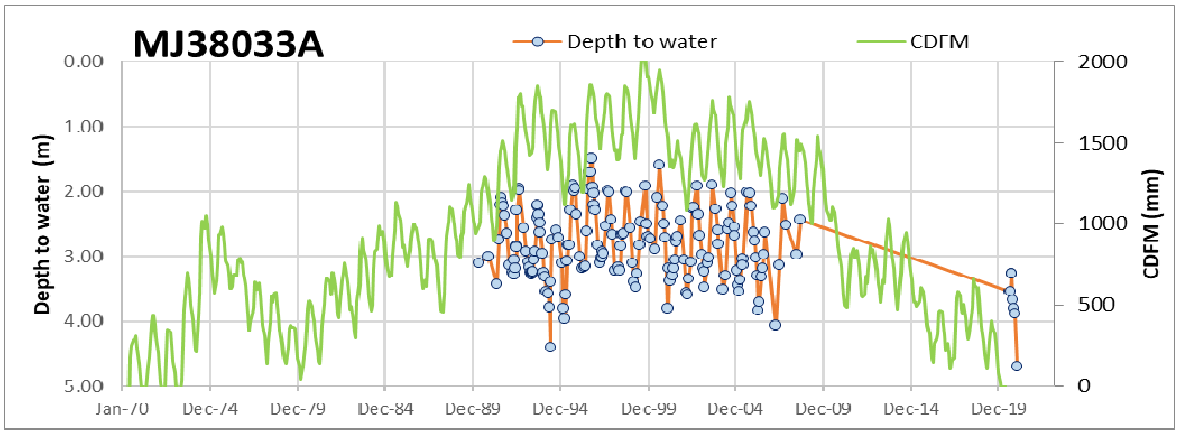

39 Mile Brook
TN34 (upstream)
6141118
TN14 (Jack Rocks)
614031 (Jack Rocks)
6141113 (downstream)
SW03 (downstream)
Turbidty (NTU)
60
50
40
30
20
10
0
16/03/1977
14/02/1979
14/01/1981
15/12/1982
14/11/1984
15/10/1986
14/09/1988
15/08/1990
15/07/1992
15/06/1994
15/05/1996
15/04/1998
15/03/2000
13/02/2002
14/01/2004
14/12/2005
14/11/2007
14/10/2009
14/09/2011
14/08/2013
15/07/2015
14/06/2017
15/05/2019
14/04/2021


Banksia Gully and Goldmine Gully
SN01 (BG upstream)
6141120 (BG upstream)
6141121 (BG downstream)
SN02 (GG upstream)
6141126 (GG upstream)
6141125 (GG downstream)
Turbidty (NTU)
60
50
40
30
20
10
0
16/03/1977
14/02/1979
14/01/1981
15/12/1982
14/11/1984
15/10/1986
14/09/1988
15/08/1990
15/07/1992
15/06/1994
15/05/1996
15/04/1998
15/03/2000
13/02/2002
14/01/2004
14/12/2005
14/11/2007
14/10/2009
14/09/2011
14/08/2013
15/07/2015
14/06/2017
15/05/2019
14/04/2021


Eastern tributaries
SN03 (Trib1 upstream)
6141128 (Trib1)
6141127 (Trib1)
SW02 (Trib1 downstream)
SN04 (Trib2)
SW01 (Trib3)
SW07 (Trib5)
Turbidty (NTU)
60
50
40
30
20
10
0
16/03/1977
14/02/1979
14/01/1981
15/12/1982
14/11/1984
15/10/1986
14/09/1988
15/08/1990
15/07/1992
15/06/1994
15/05/1996
15/04/1998
15/03/2000
13/02/2002
14/01/2004
14/12/2005
14/11/2007
14/10/2009
14/09/2011
14/08/2013
15/07/2015
14/06/2017
15/05/2019
14/04/2021

Appendix J

Groundwater data graphs - historical sites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CDFM
Depth to water (m)
CDFM (mm)
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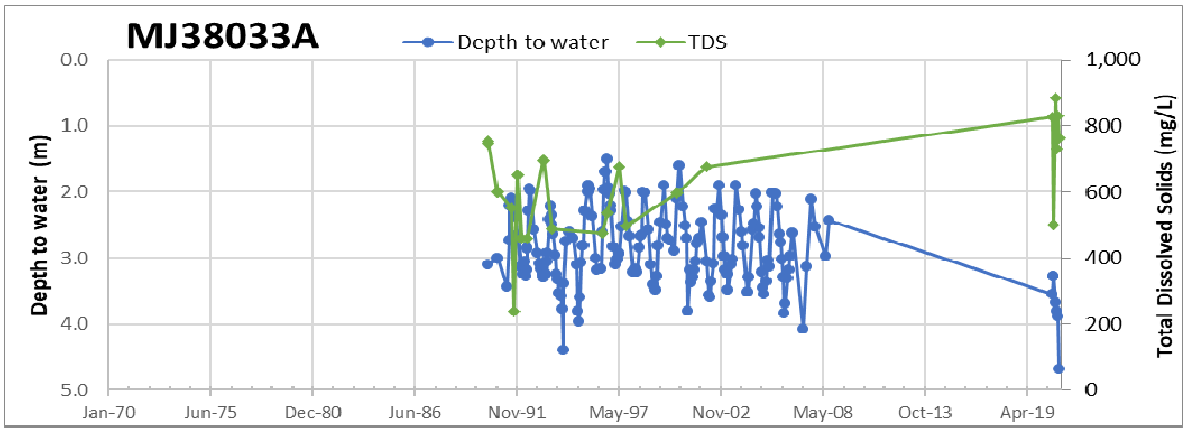
2.00
3.00
4.00
5.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19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TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
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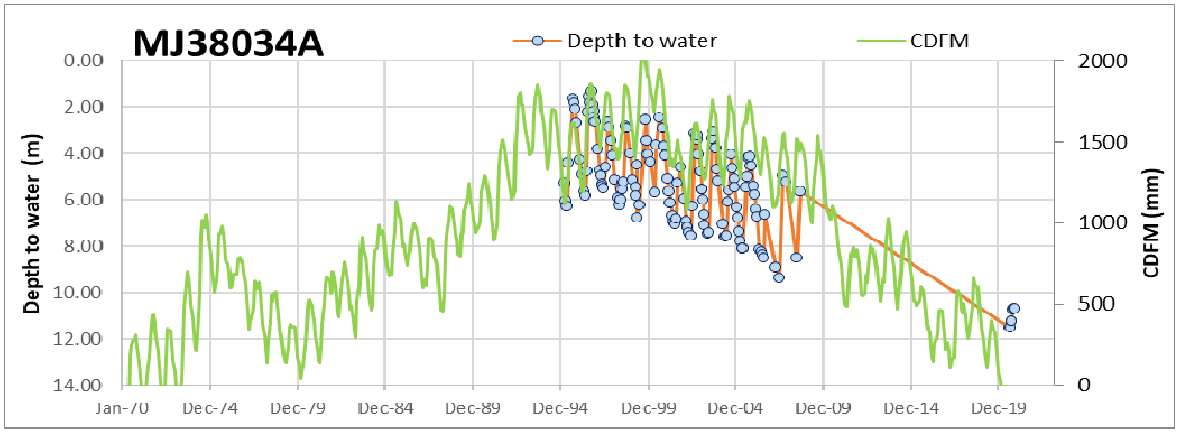
3.0
4.0
5.0
1,000
800
600
400
200
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19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CDFM
Depth to water (m)
CDFM (mm)
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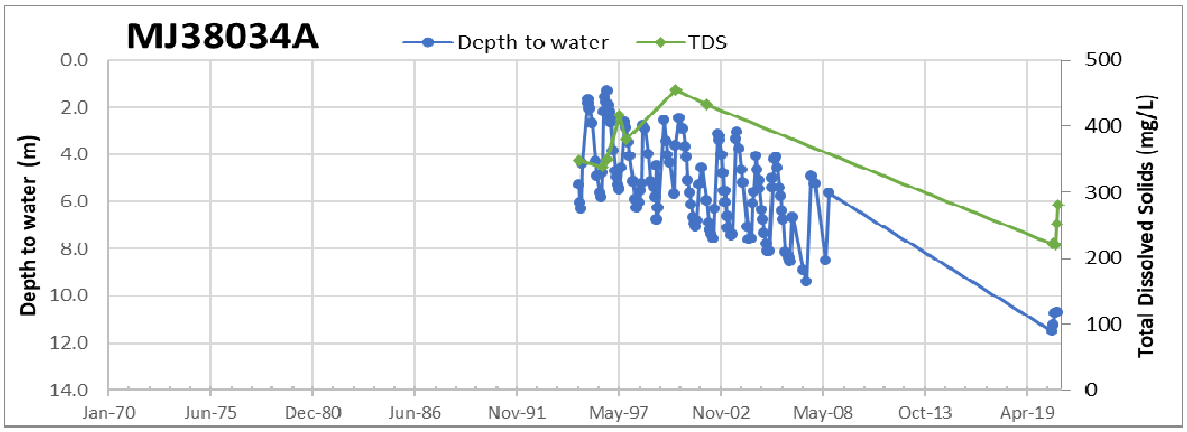
4.00
6.00
8.00
10.00
12.00
14.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19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TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
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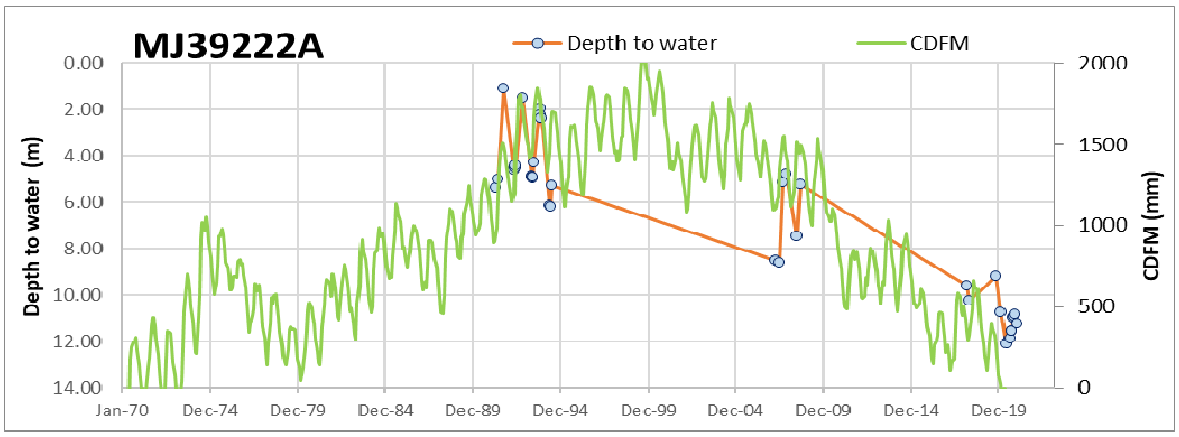
4.0
6.0
8.0
10.0
12.0
14.0
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19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CDFM (mm)
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6.00
8.00
10.00
12.00
14.00
2000
1500
1000
500
0
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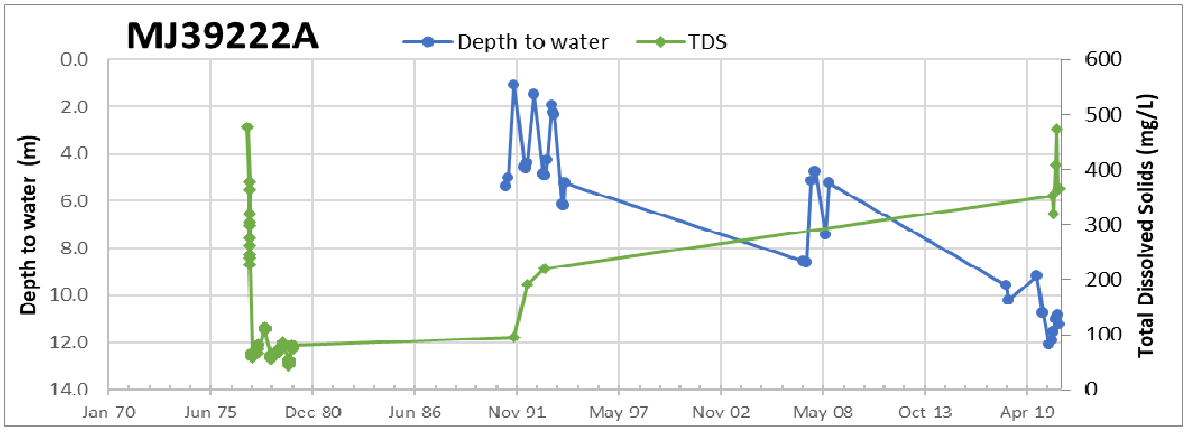
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19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TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
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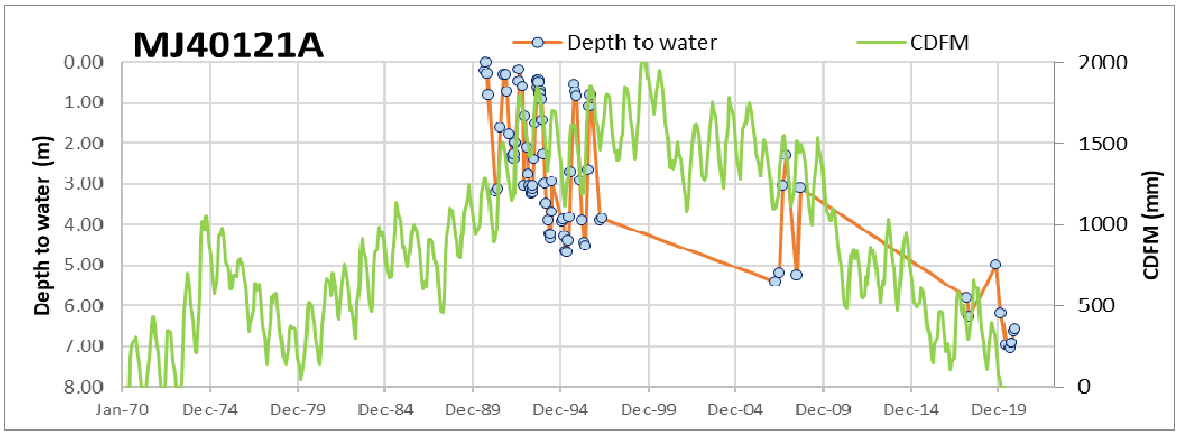
4.0
6.0
8.0
10.0
12.0
14.0
600
500
400
300
200
100
0
Jan 70
Jun 75
Dec 80
Jun 86
Nov 91
May 97
Nov 02
May 08
Oct 13
Apr 19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CDFM (mm)
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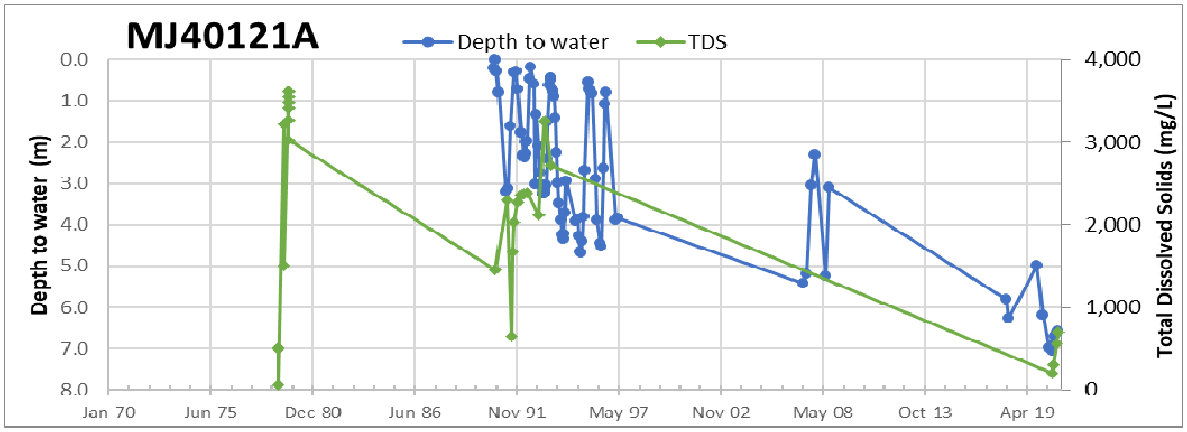
4.00
5.00
6.00
7.00
8.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19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Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
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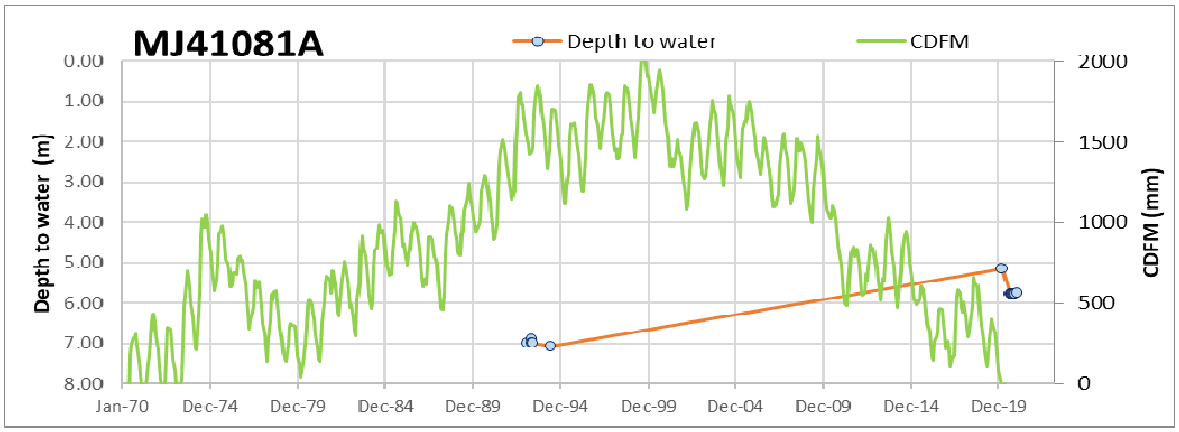
2.0
3.0
4.0
5.0
6.0
7.0
8.0
4,000
3,000
2,000
1,000
0
Jan 70
Jun 75
Dec 80
Jun 86
Nov 91
May 97
Nov 02
May 08
Oct 13
Apr 19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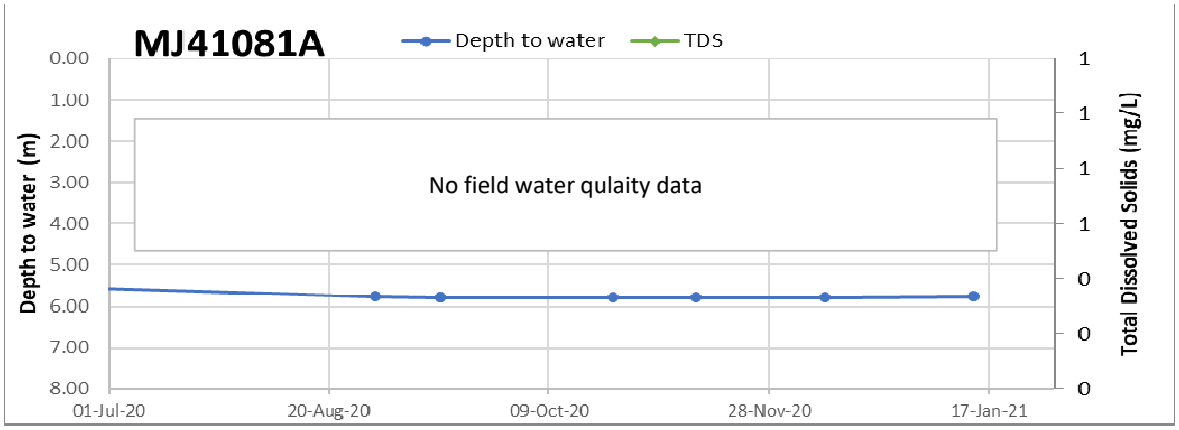
4.00
5.00
6.00
7.00
8.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19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TDS
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Depth to water (m)
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3.00
4.00
5.00
6.00
7.00
8.00
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1
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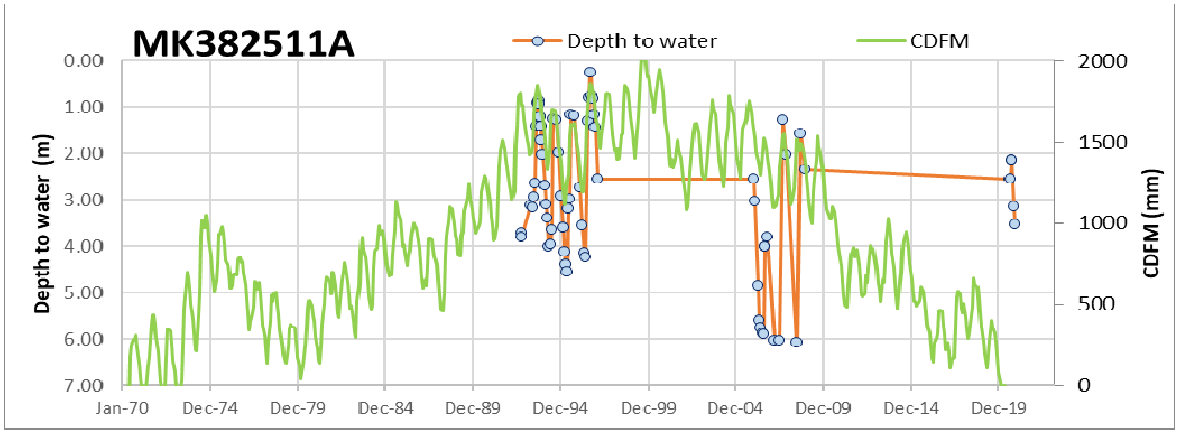
20-Aug-20
09-Oct-20
28-Nov-20
17-Jan-21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CDFM (mm)
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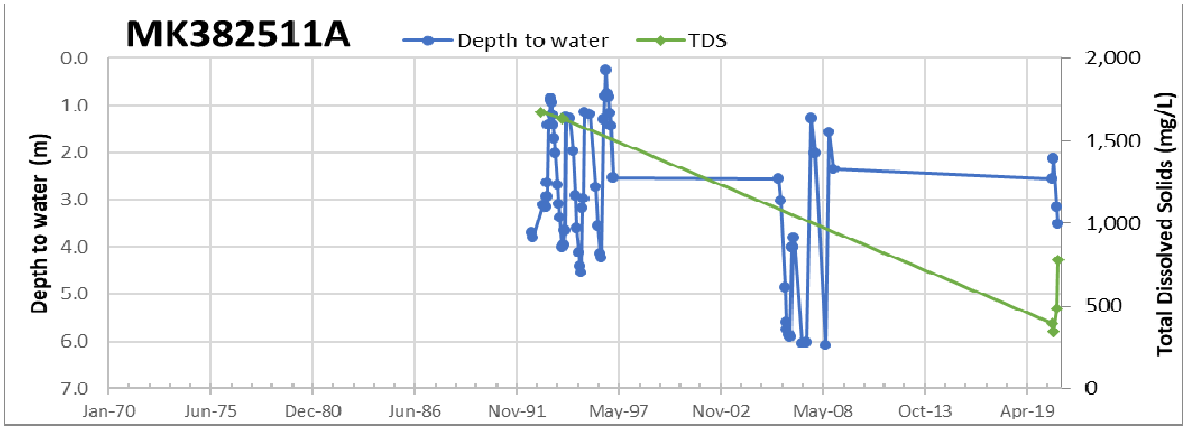
4.00
5.00
6.00
7.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19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Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
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2.0
3.0
4.0
5.0
6.0
7.0
2,000
1,500
1,000
500
0
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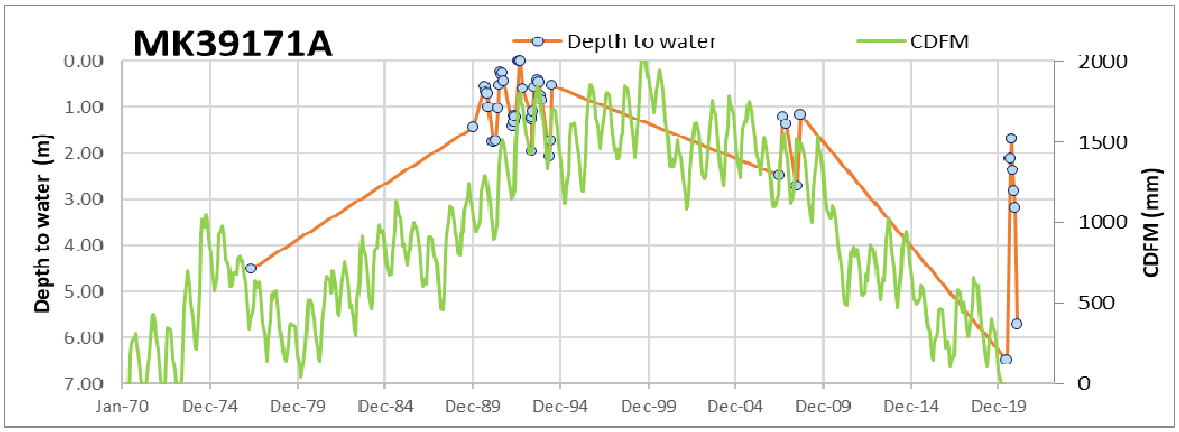
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19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Depth to water (m)
CDFM (mm)
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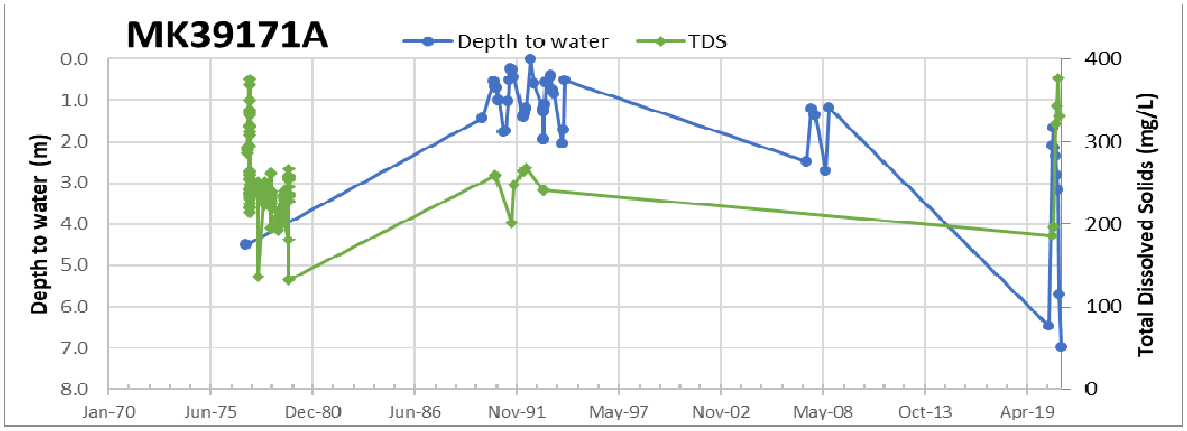
4.00
5.00
6.00
7.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19


MK39171A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
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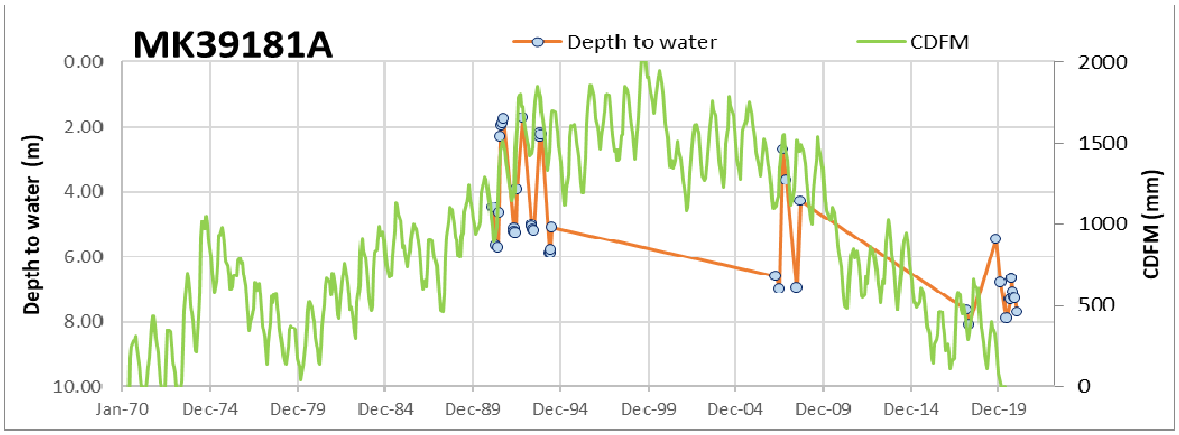
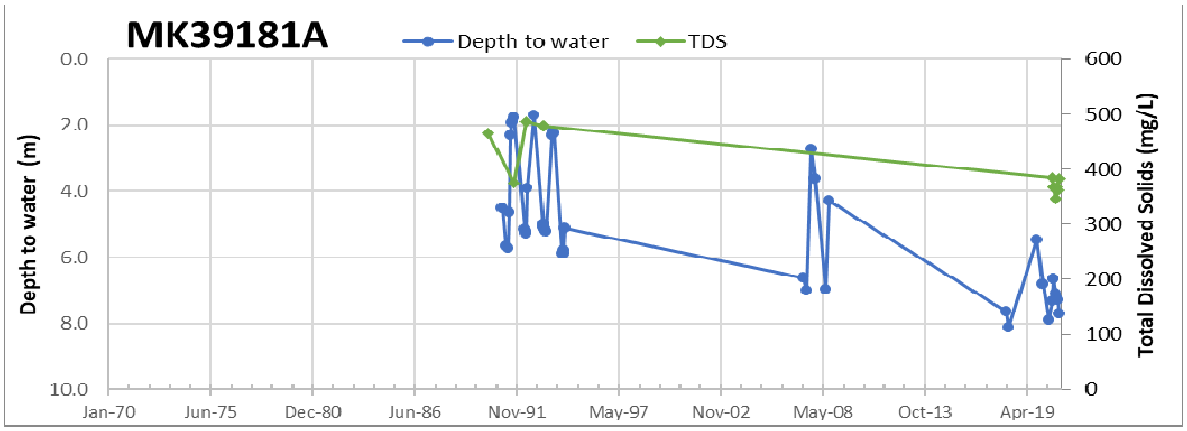
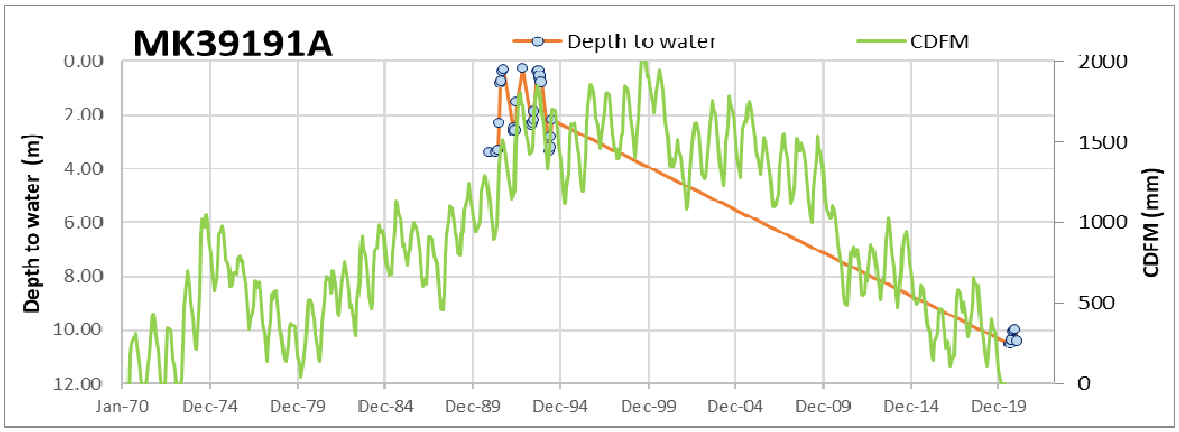
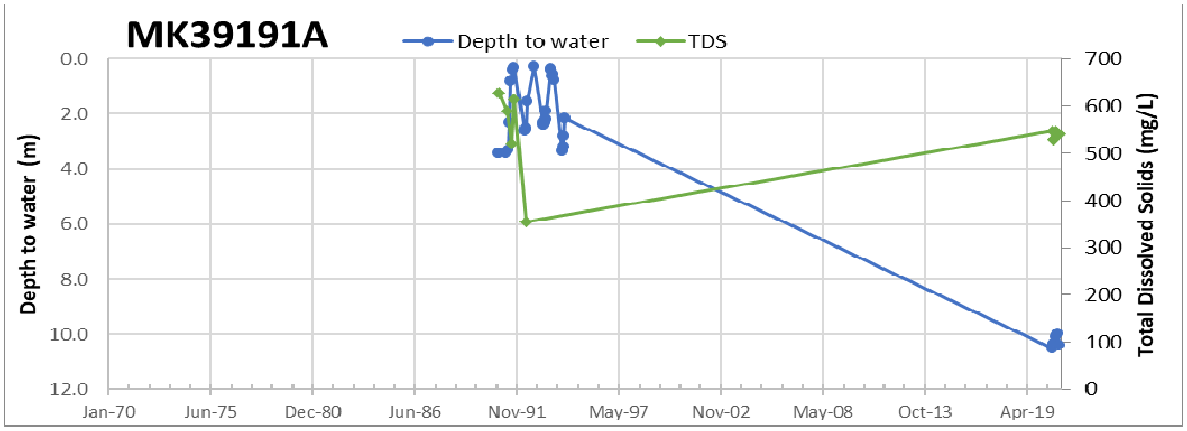
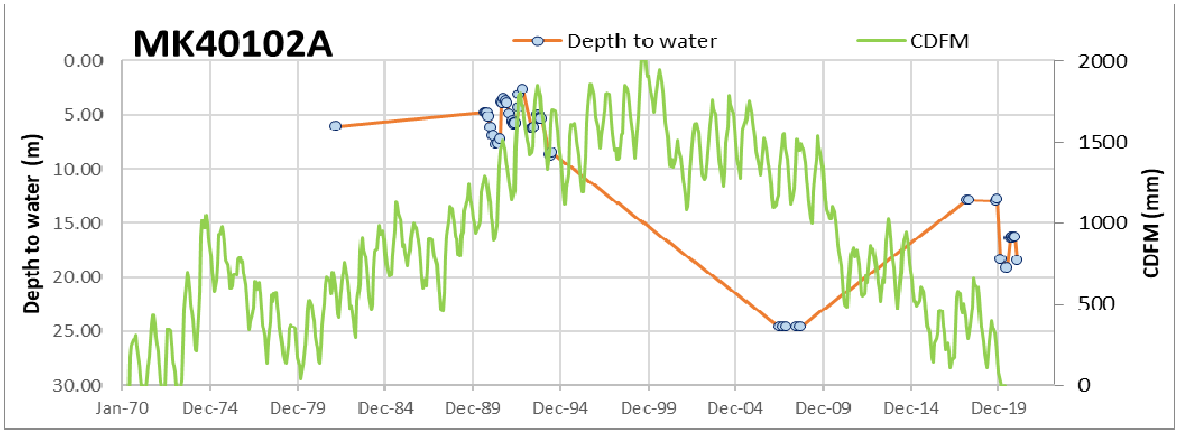
2.0
3.0
4.0
5.0
6.0
7.0
8.0
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

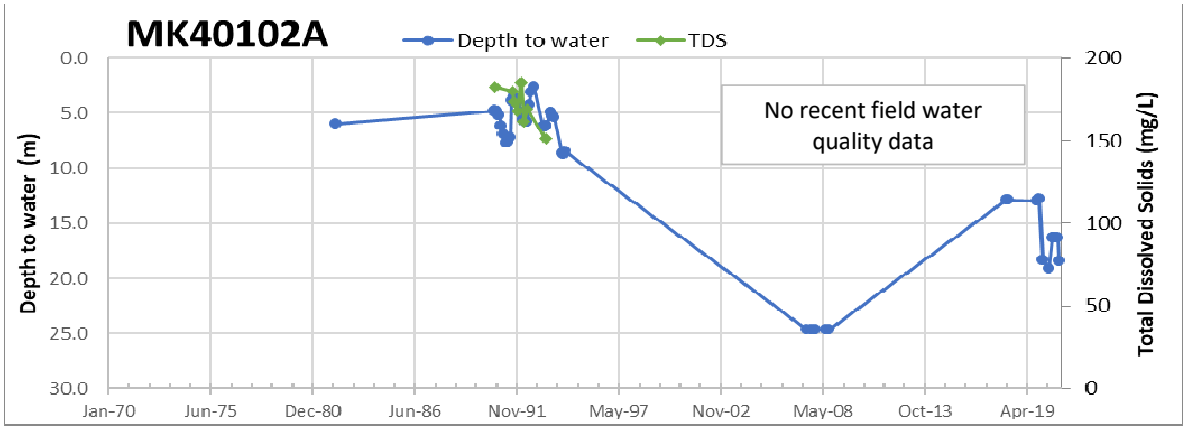

MK39181A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

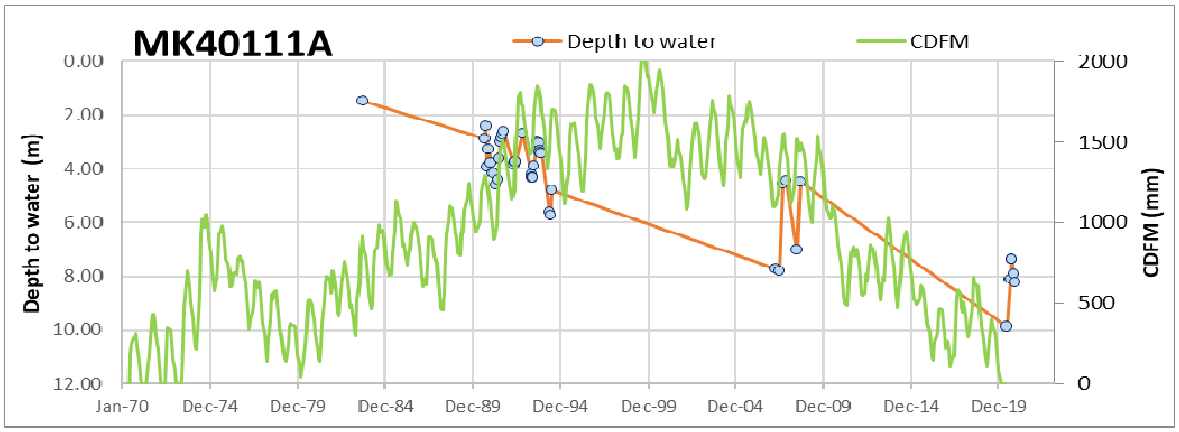

MK39181A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
600
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

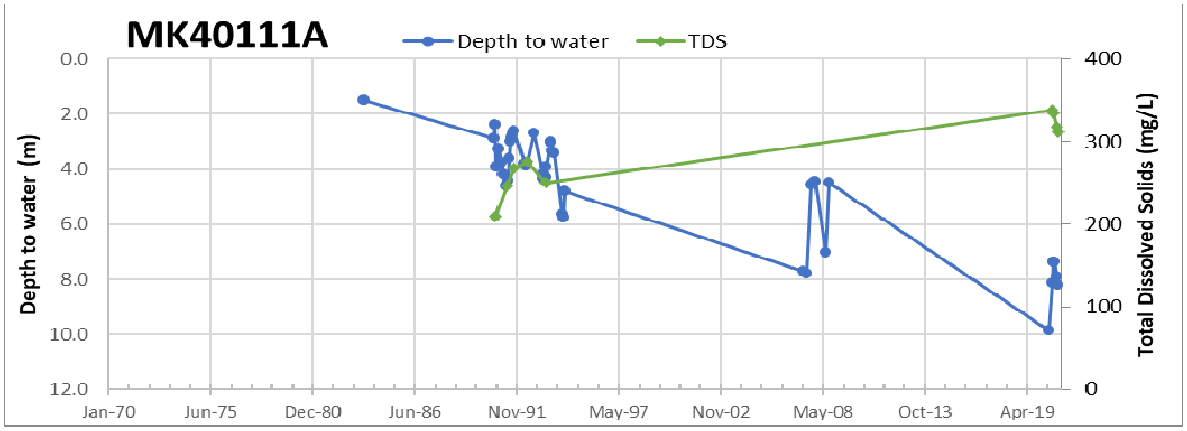

MK39191A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

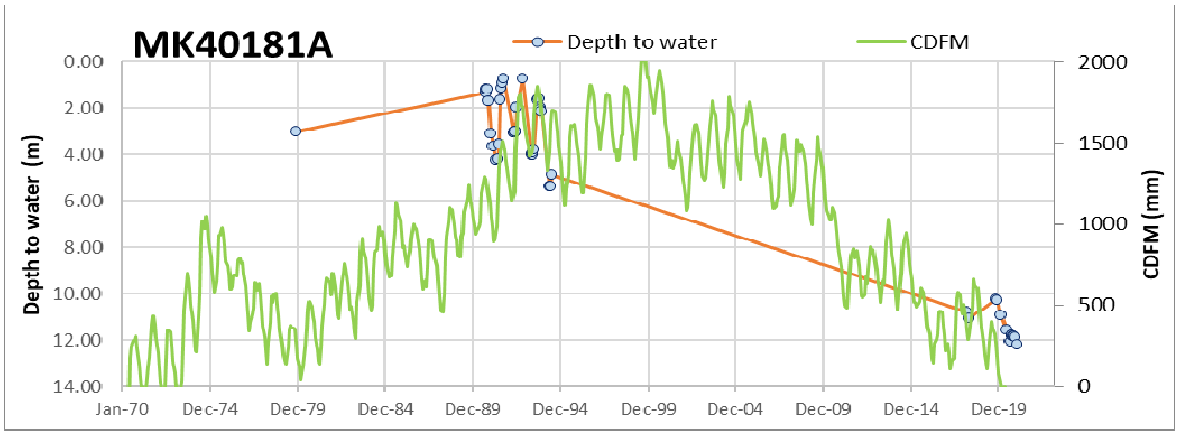

MK39191A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
700
600
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

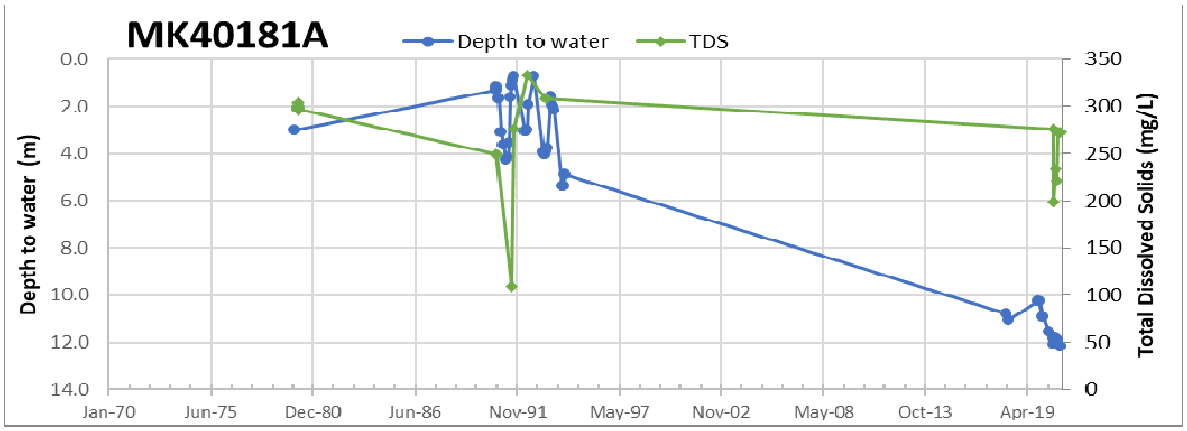

MK40102A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

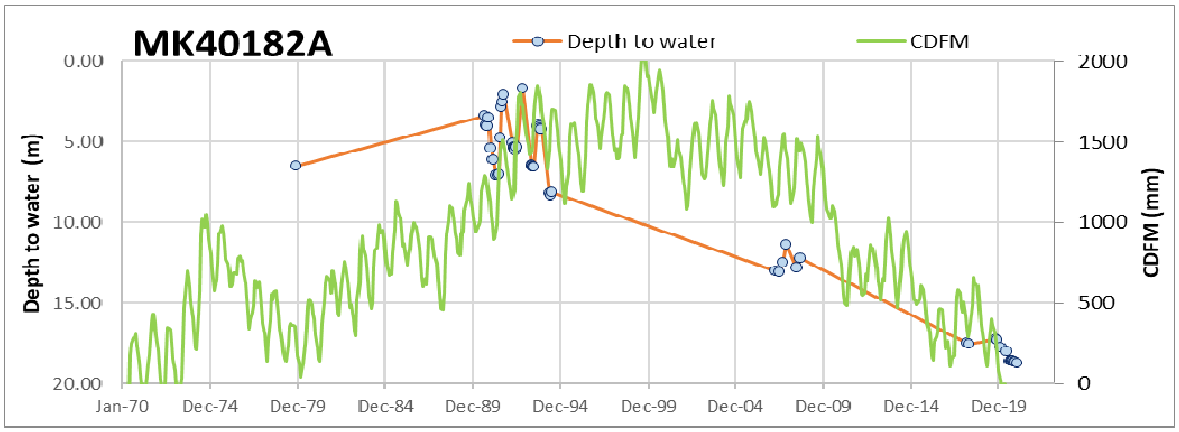

MK40102A
Depth to water
TDS
No recent field water quality data
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

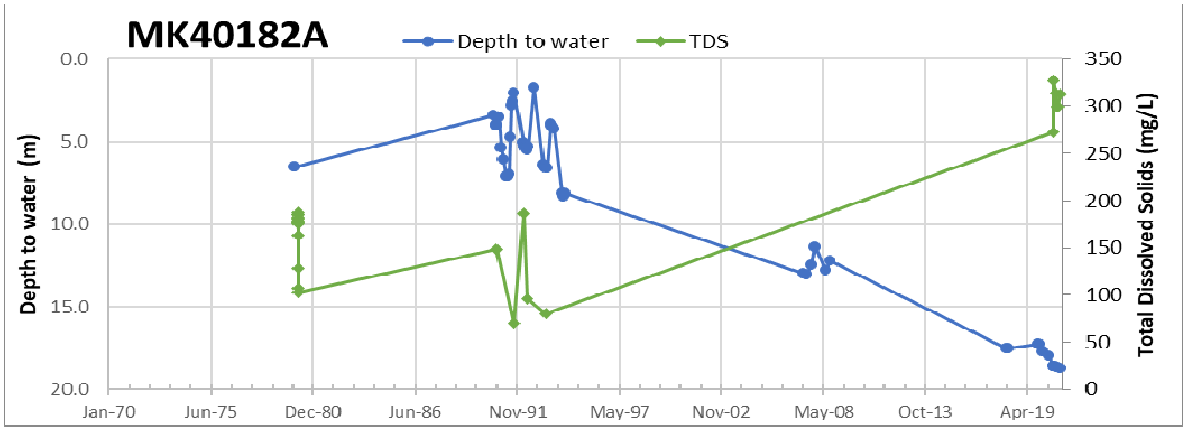

MK40111A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

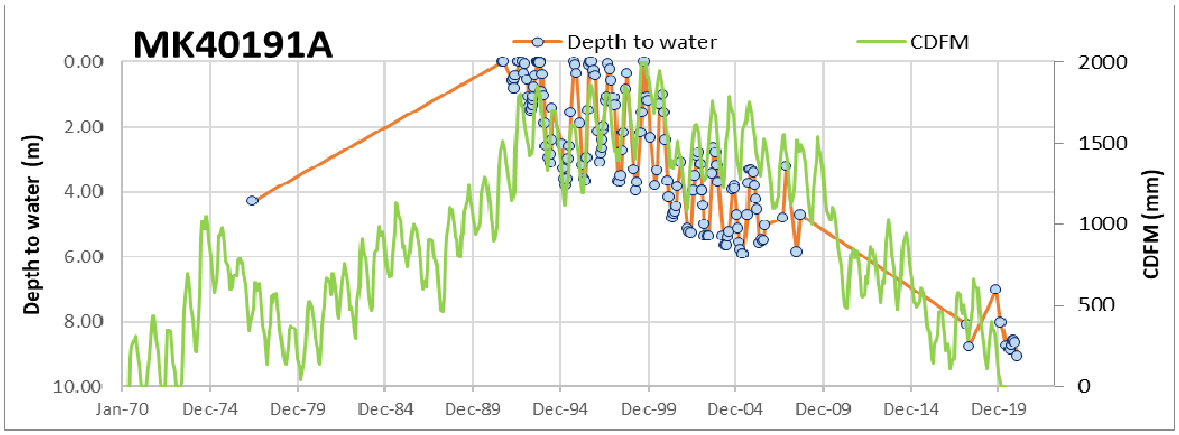

MK40111A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

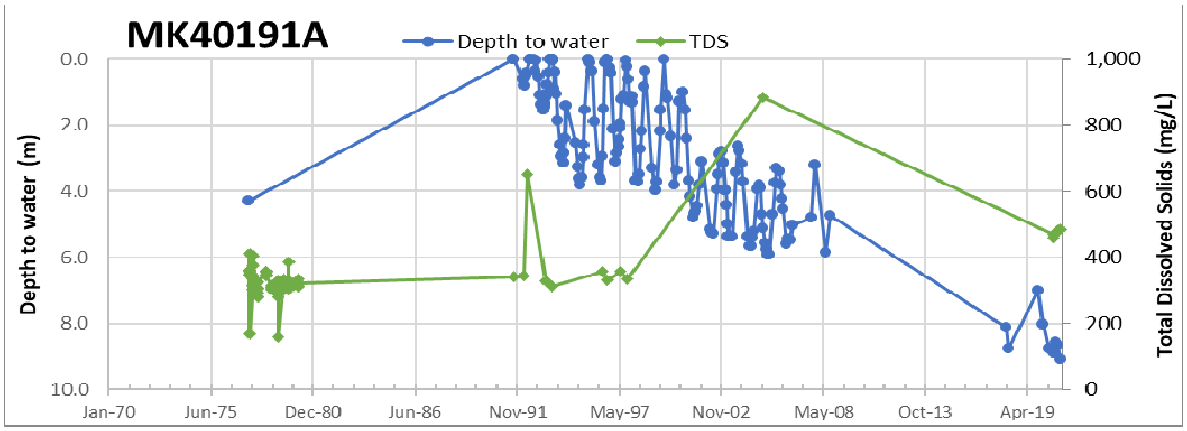

MK40181A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

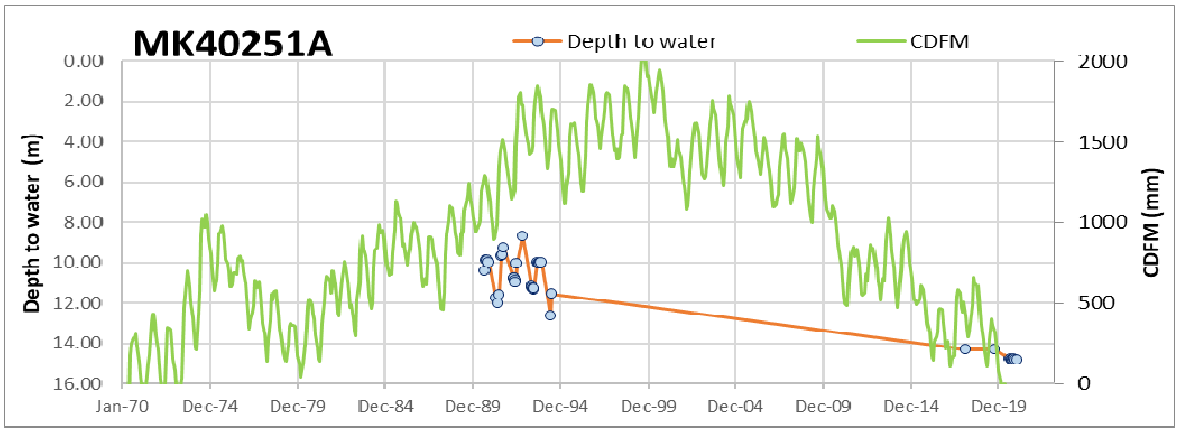

MK40181A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
350
300
250
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

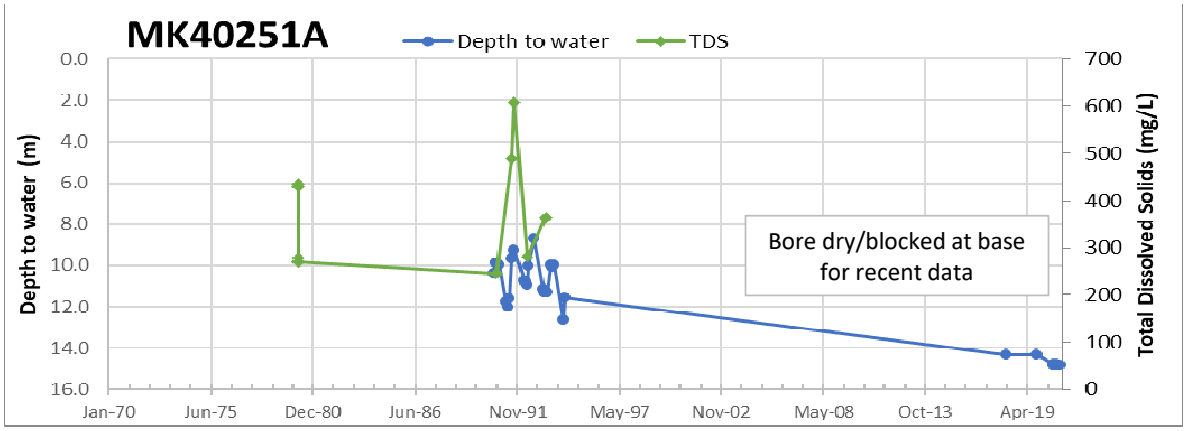

MK40182A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

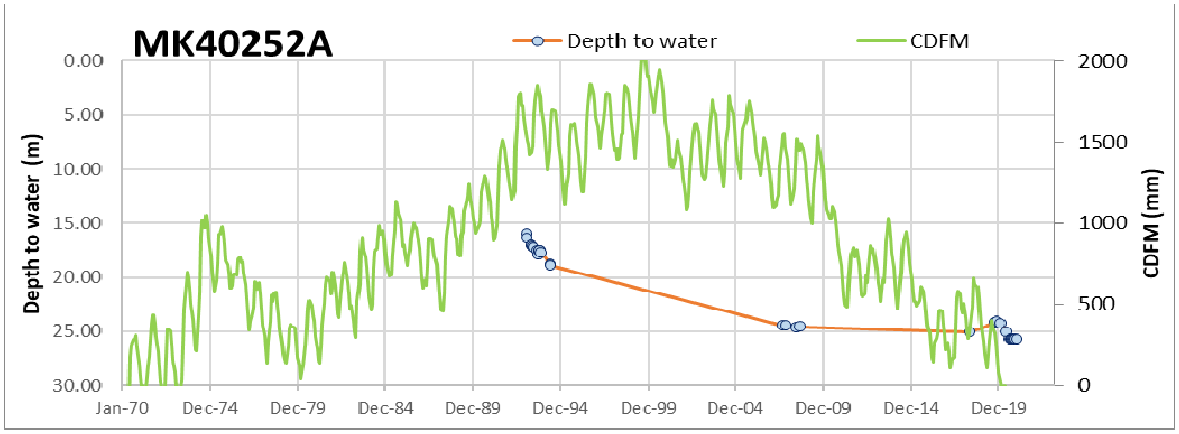

MK40182A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
350
300
250
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

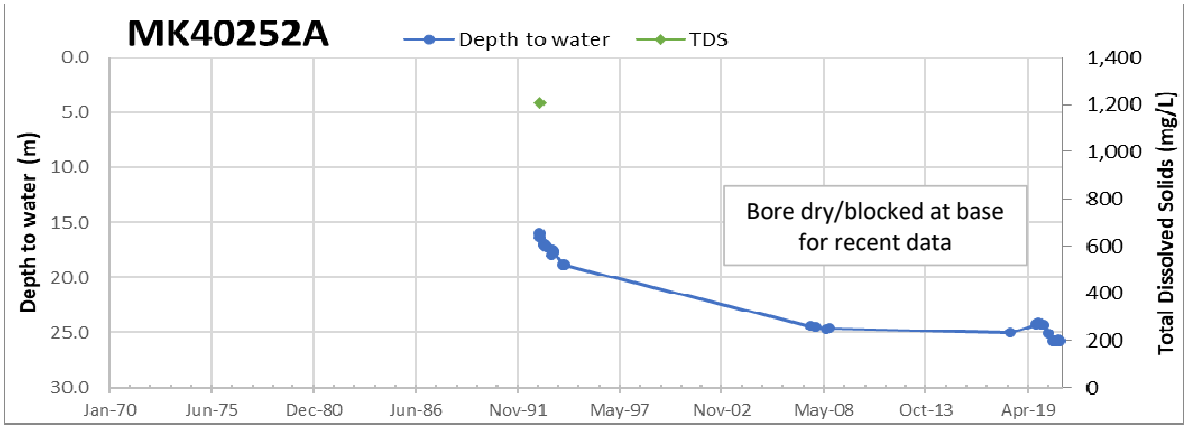

MK40191A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

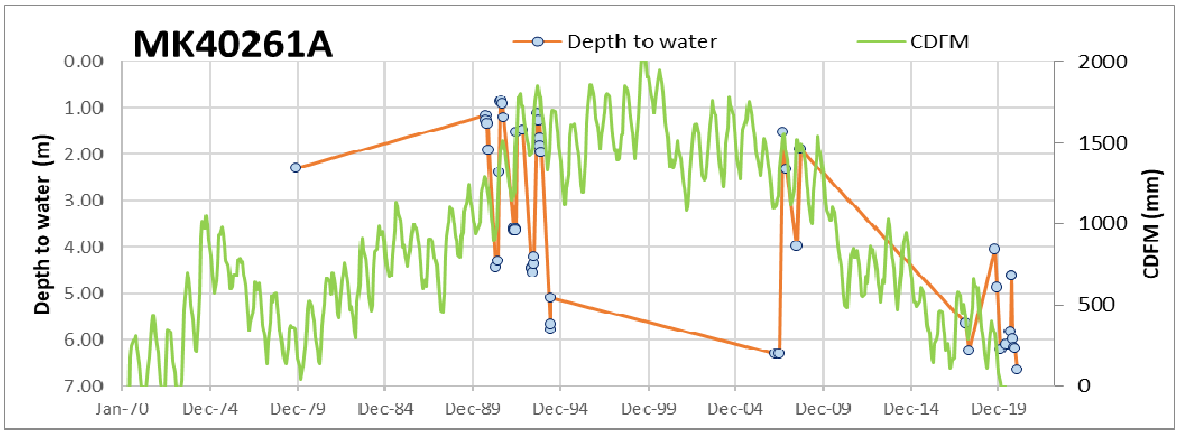

MK40191A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
1,000
800
600
400
200
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

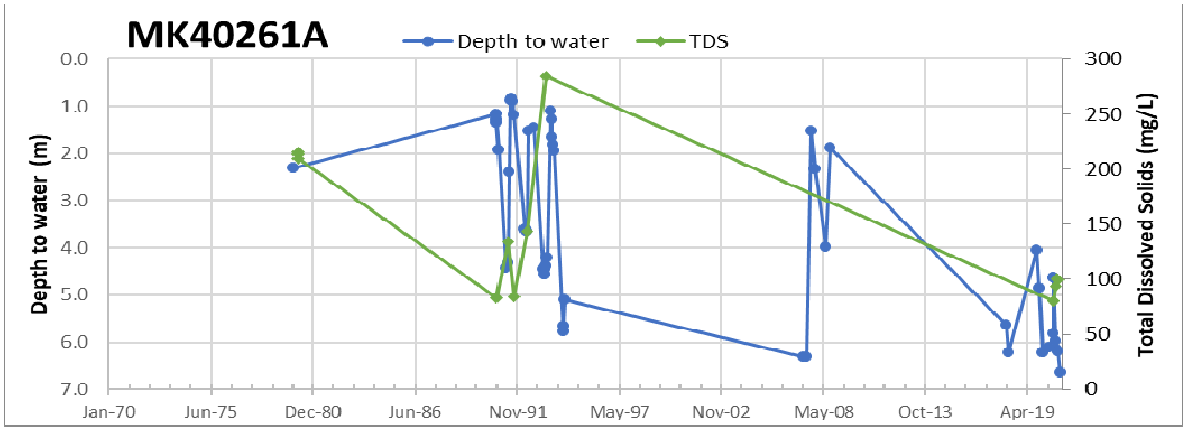

MK40251A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

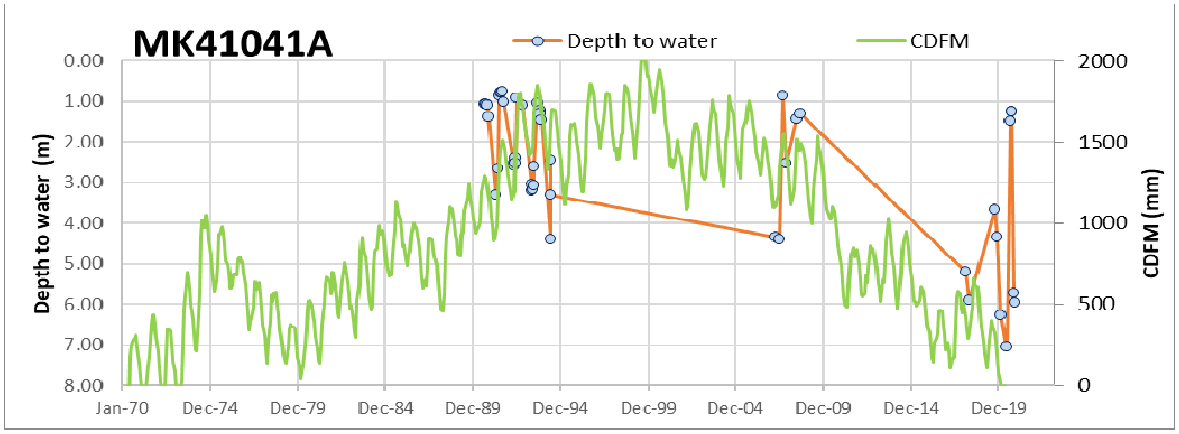

MK40251A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
Bore dry/blocked at base for recent data
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
700
600
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

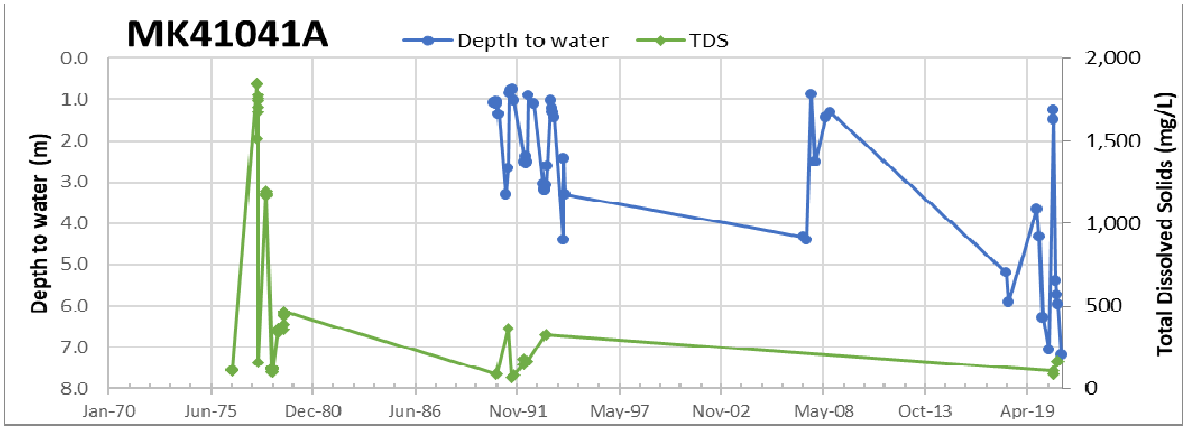

MK40252A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

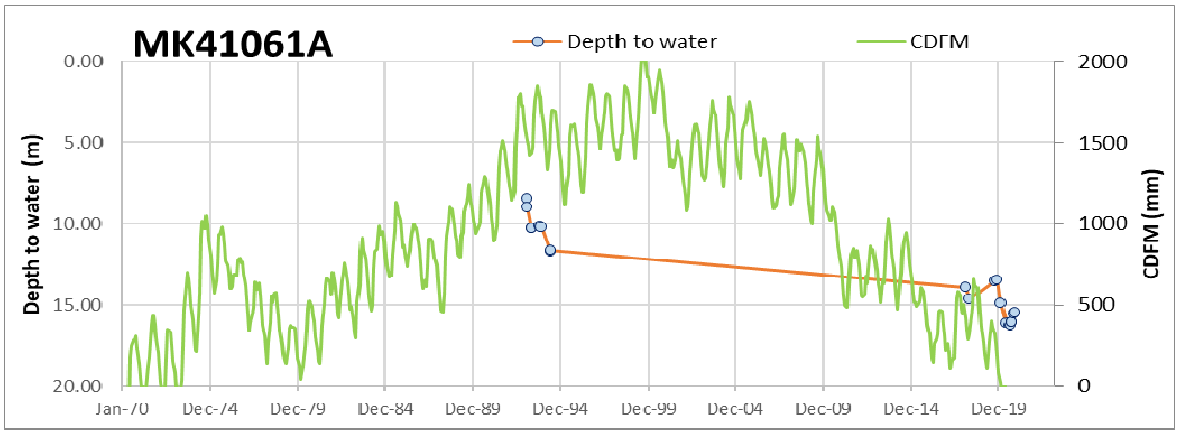

MK40252A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
Bore dry/blocked at base for recent data
0.0
5.0
10.0
15.0
20.0
25.0
30.0
1,400
1,200
1,000
800
600
400
200
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

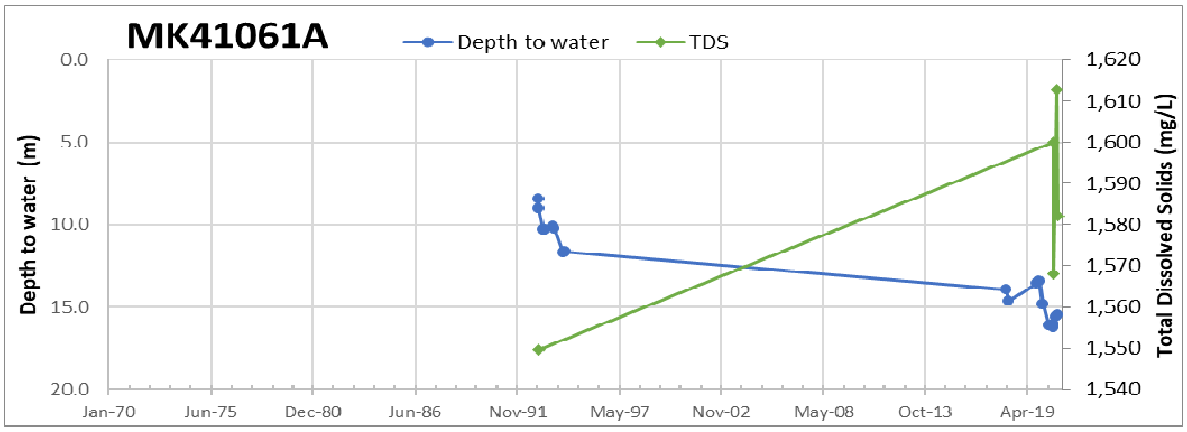

MK40261A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

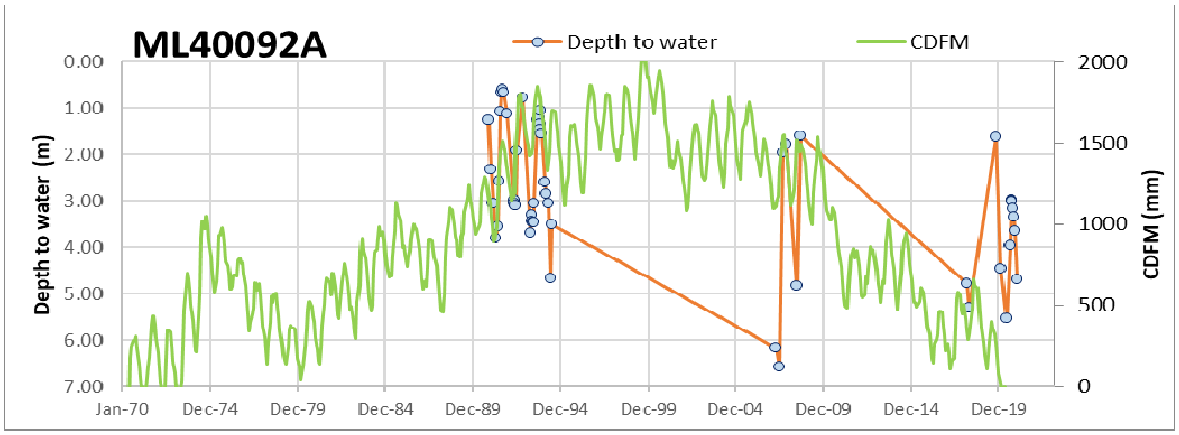

MK40261A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
300
250
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

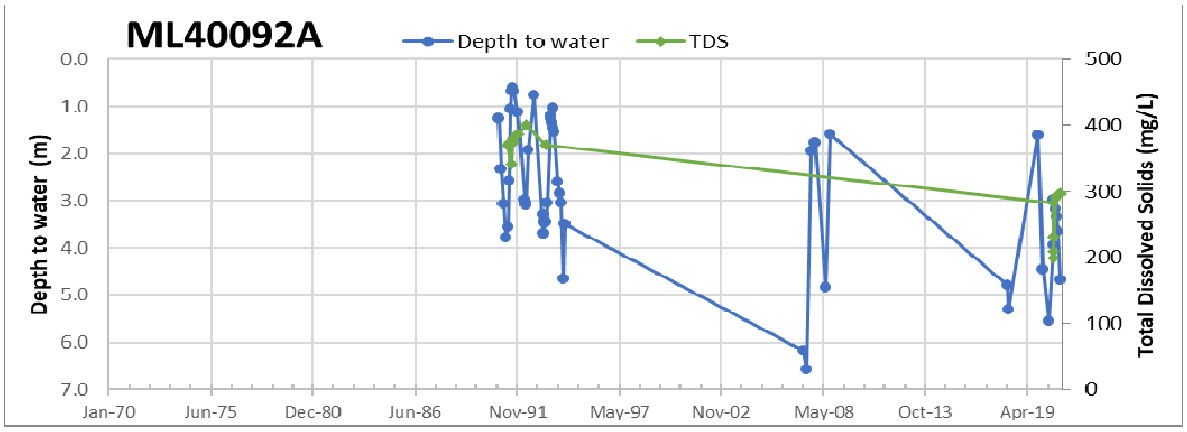

MK41041A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

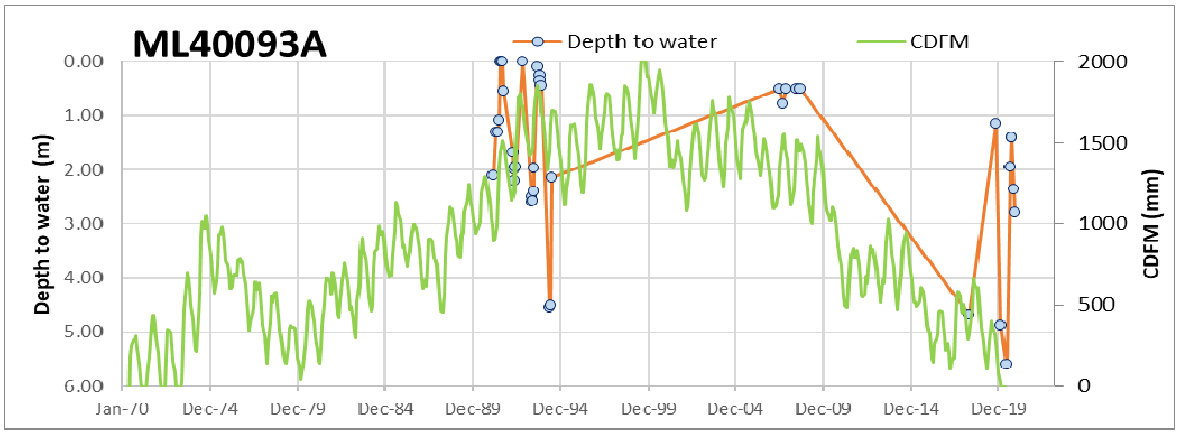

MK41041A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
2,000
1,500
1,000
500
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

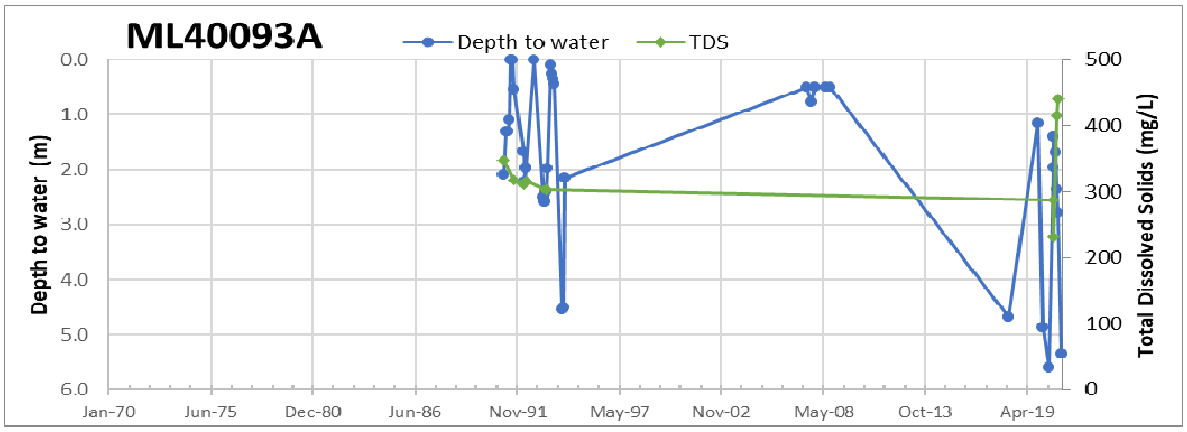

MK41061A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

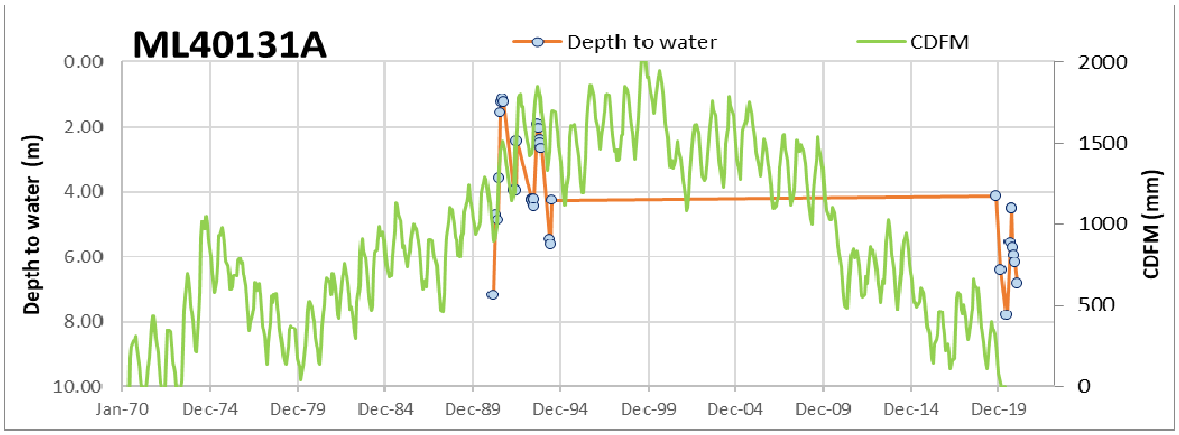

MK41061A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
1,620
1,610
1,600
1,590
1,580
1,570
1,560
1,550
1,540
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

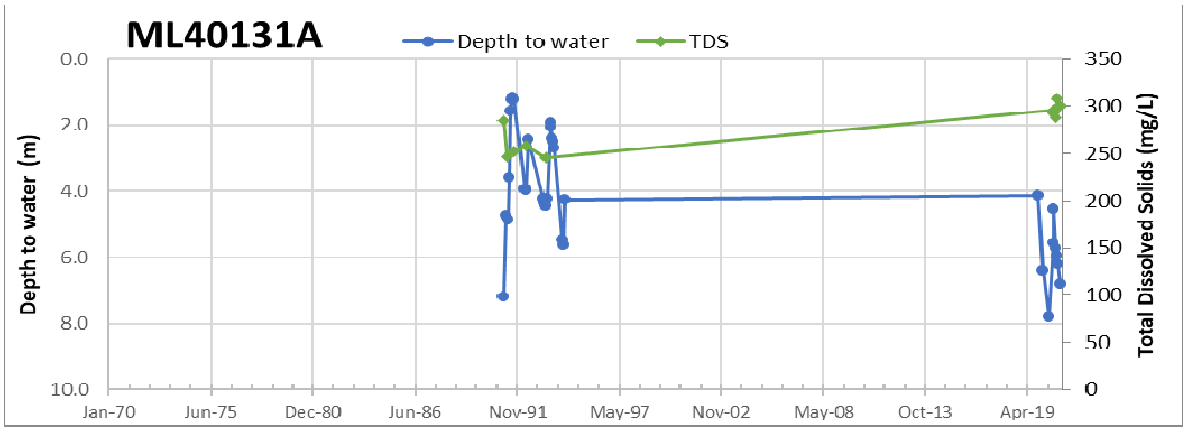

ML40092A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

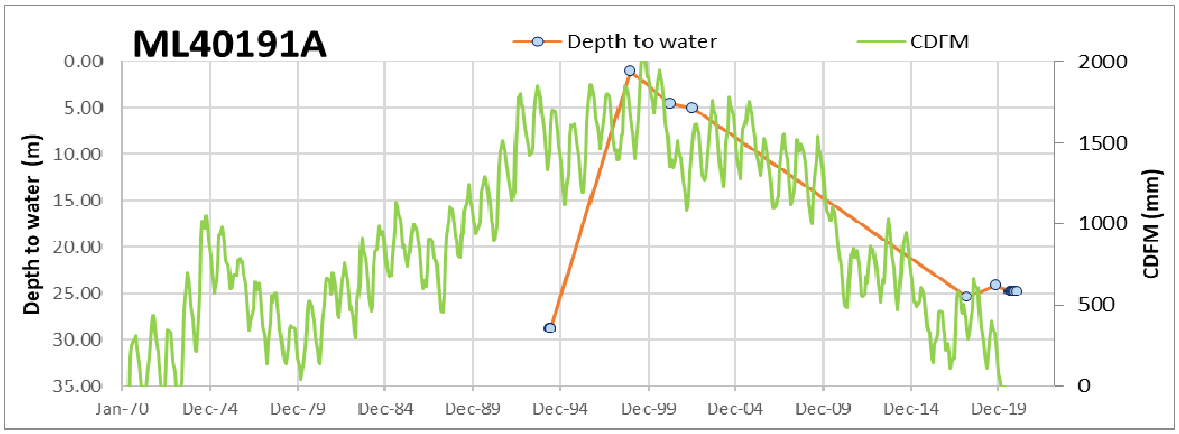

ML40092A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

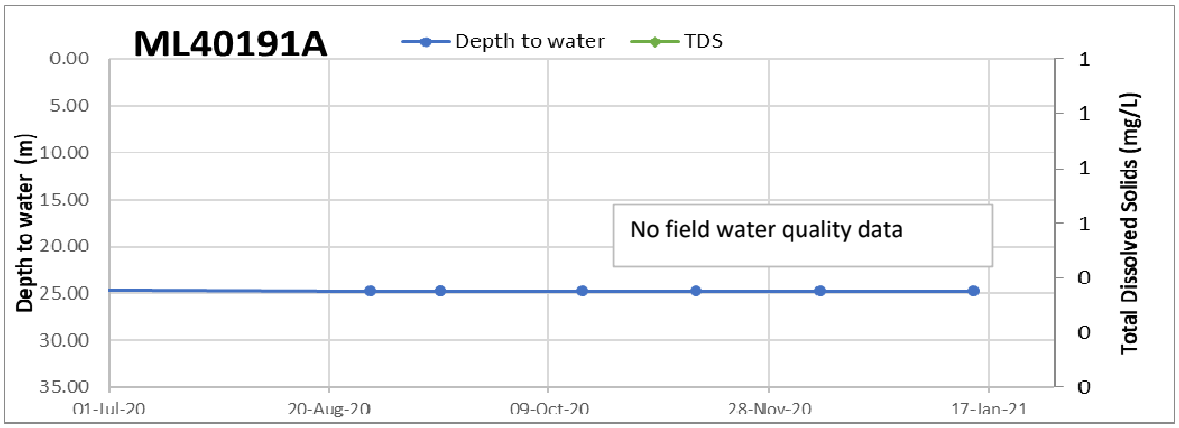

ML40093A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

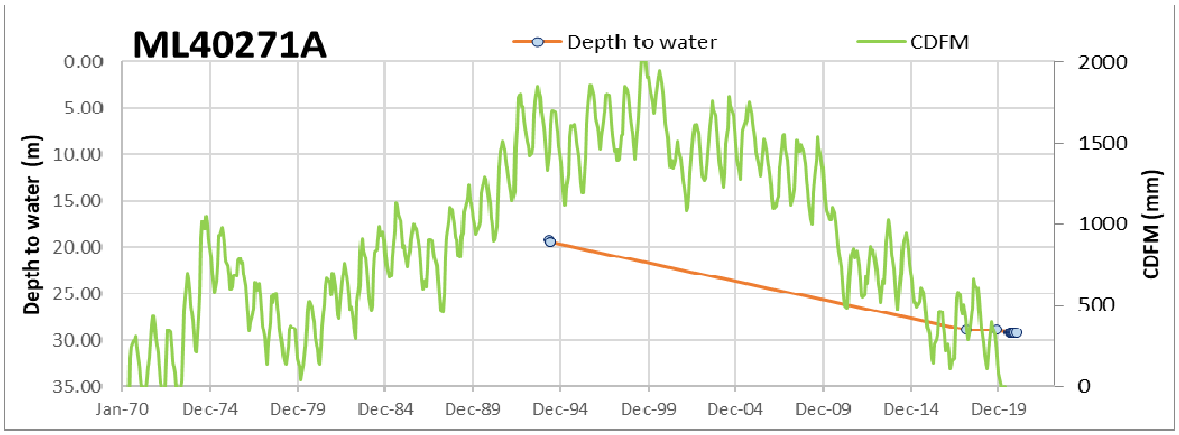

ML40093A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

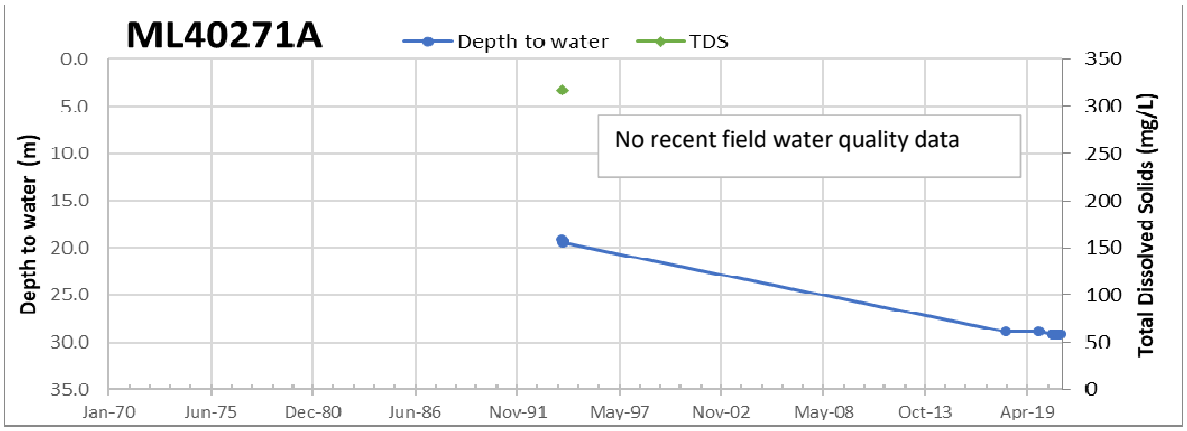

ML40131A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
2.00
4.00
6.00
8.00
10.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

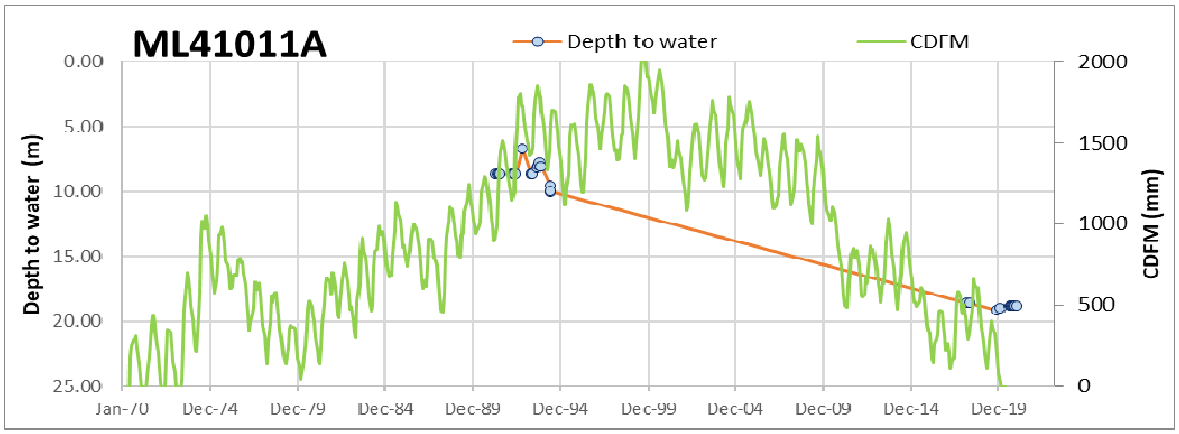

ML40131A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
350
300
250
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

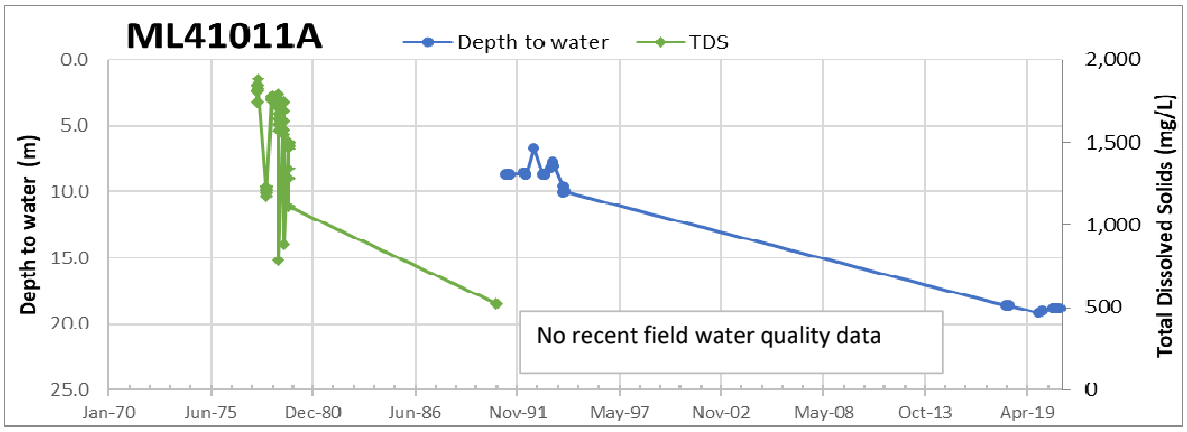

ML40191A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

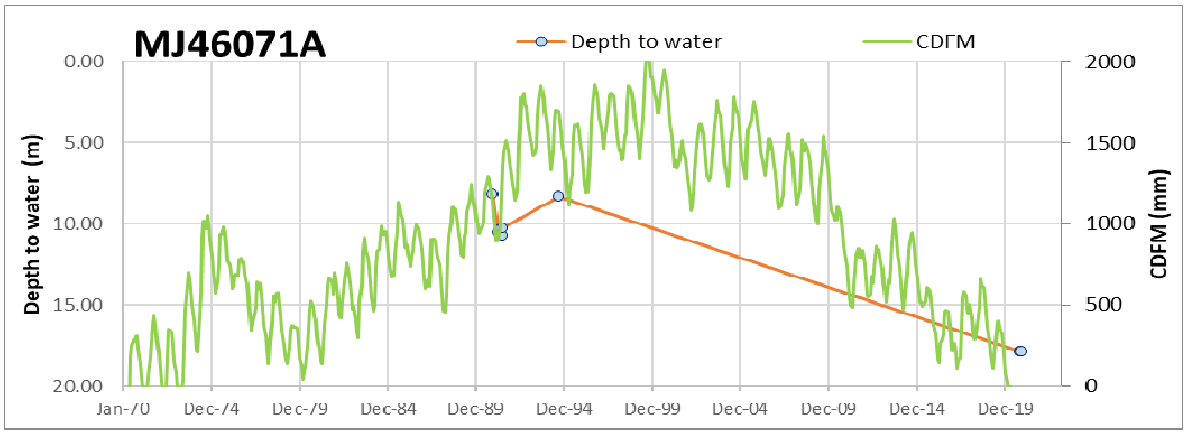

ML40191A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
No field water quality data
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
1
1
1
1
0
0
0
01-Jul-20
20-Aug-20
09-Oct-20
28-Nov-20
17-Jan-21

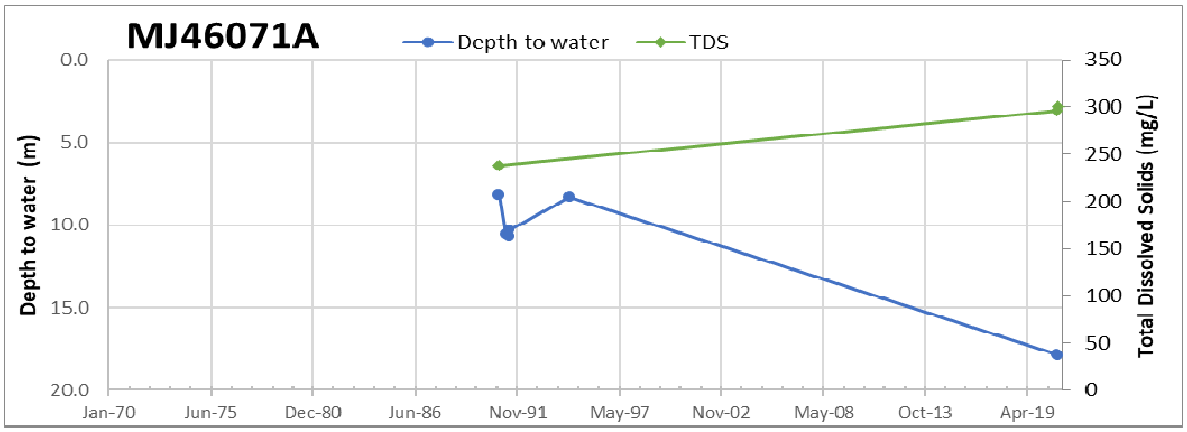

ML40271A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

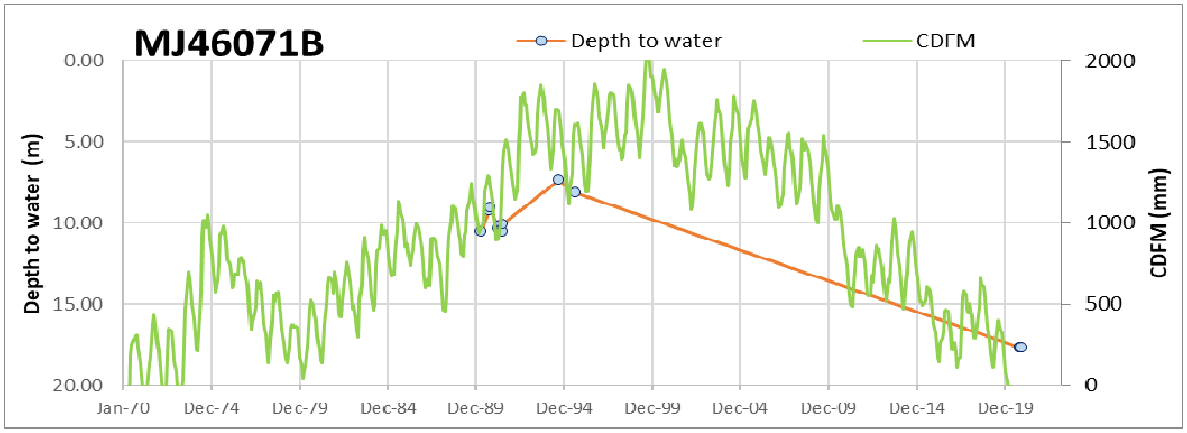

ML40271A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
No recent field water quality data
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
350
300
250
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

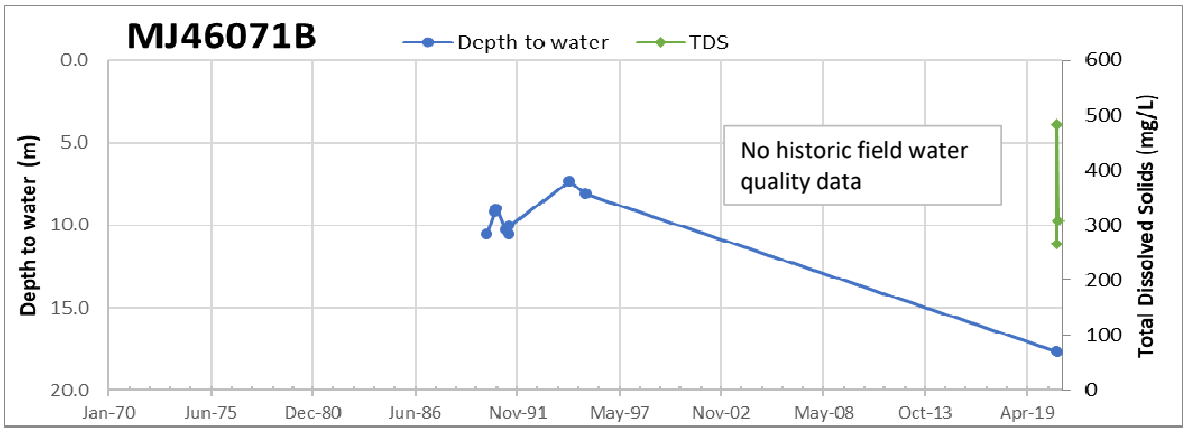

ML41011A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

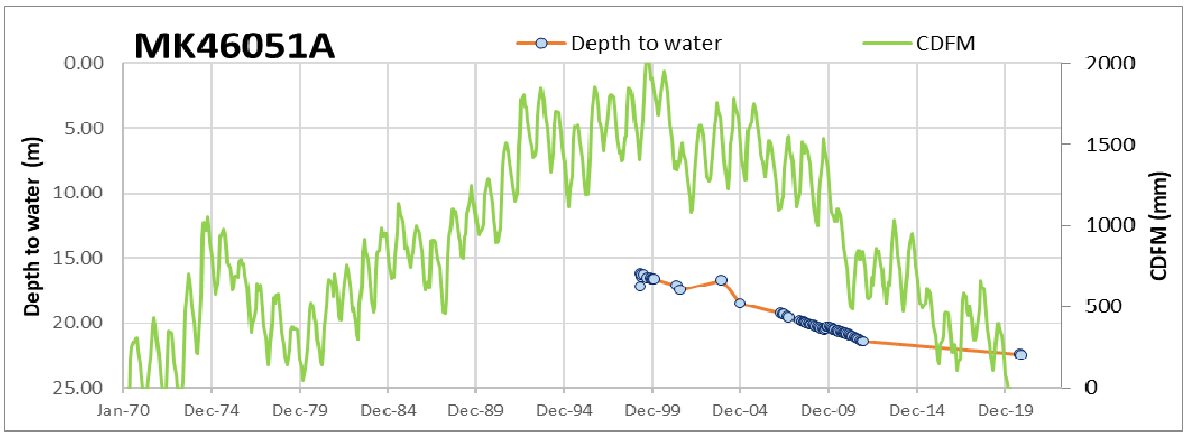

ML41011A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
2,000
1,500
1,000
500
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19
No recent field water quality data

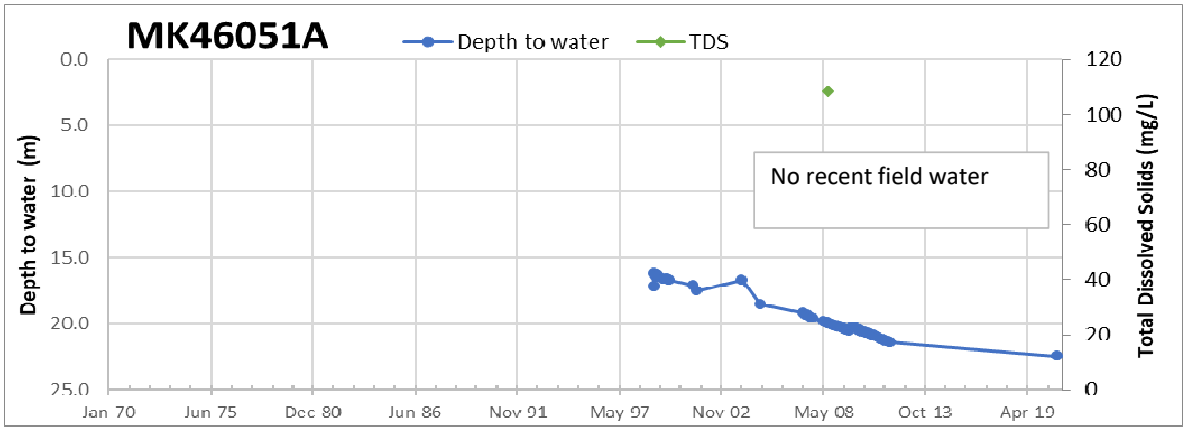

MJ46071A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

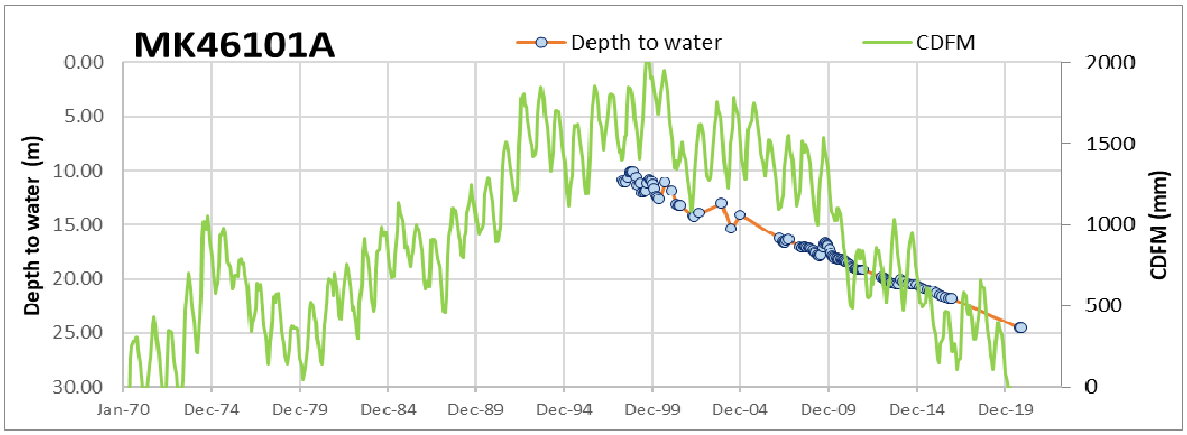

MJ46071A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
350
300
250
200
150
100
50
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

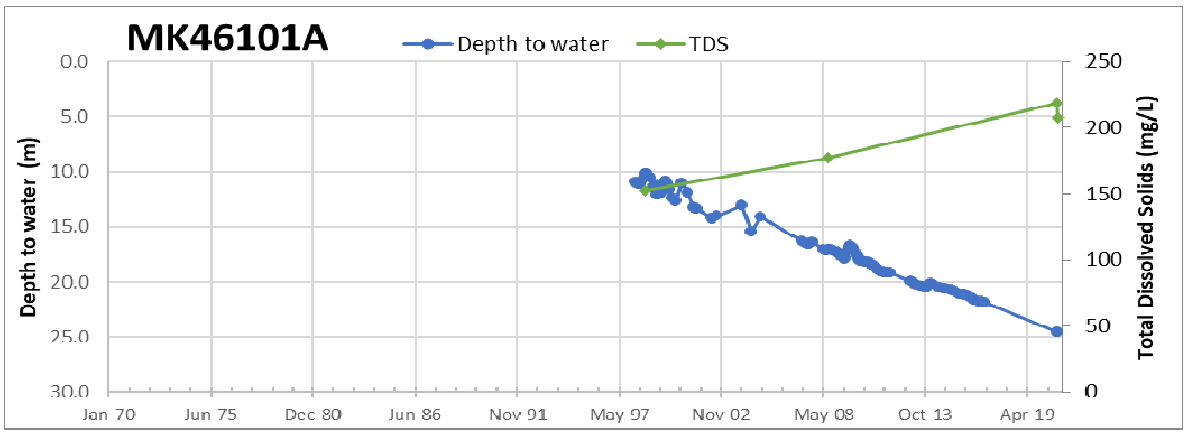

MJ46071B
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

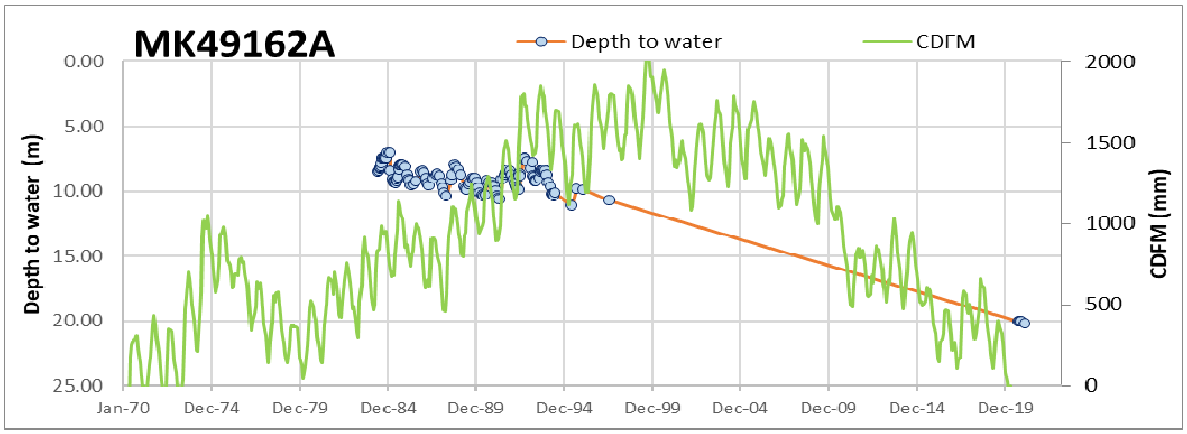

MJ46071B
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
No historic field water quality data
0.0
5.0
10.0
15.0
20.0
600
500
400
300
200
100
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

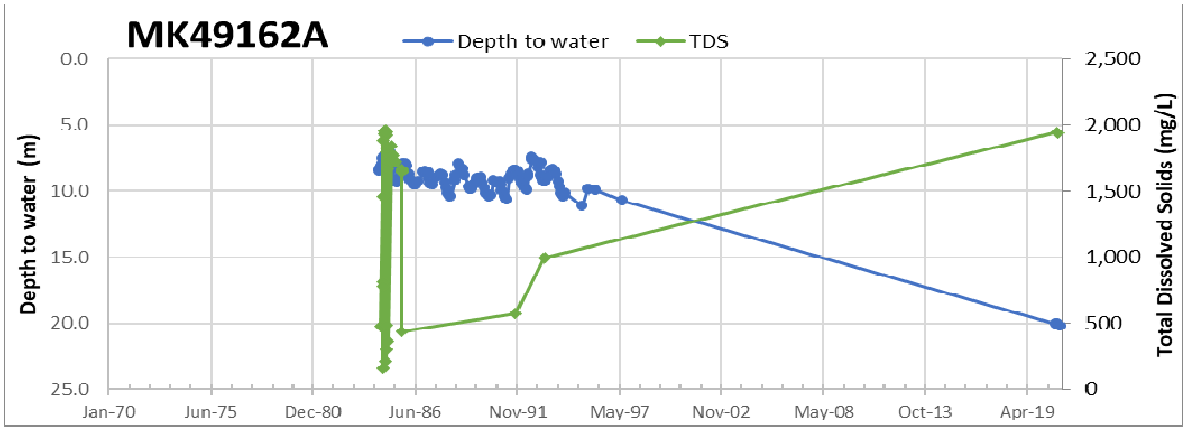

MK46051A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

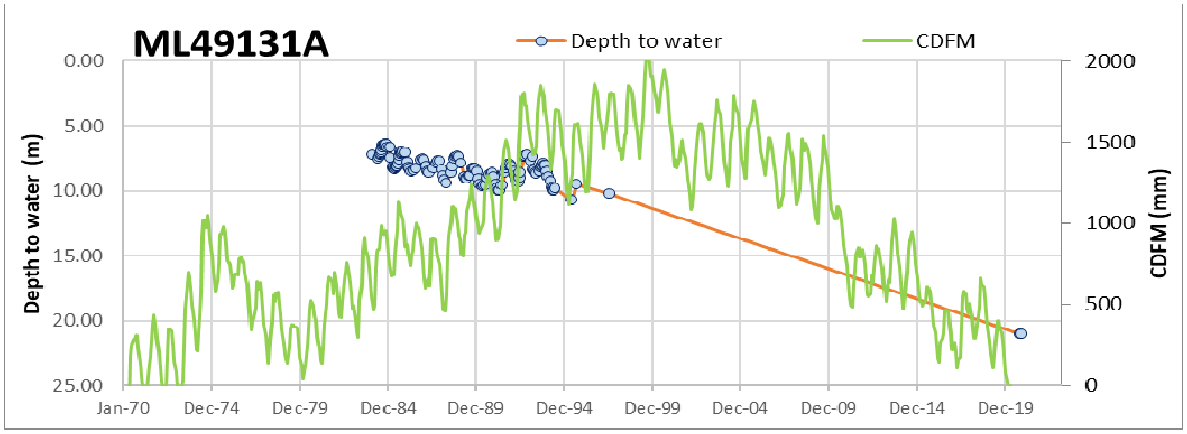

MK46051A
Depth to water
TDS
No recent field water
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
120
100
80
60
40
20
0
Jan 70
Jun 75
Dec 80
Jun 86
Nov 91
May 97
Nov 02
May 08
Oct 13
Apr 19

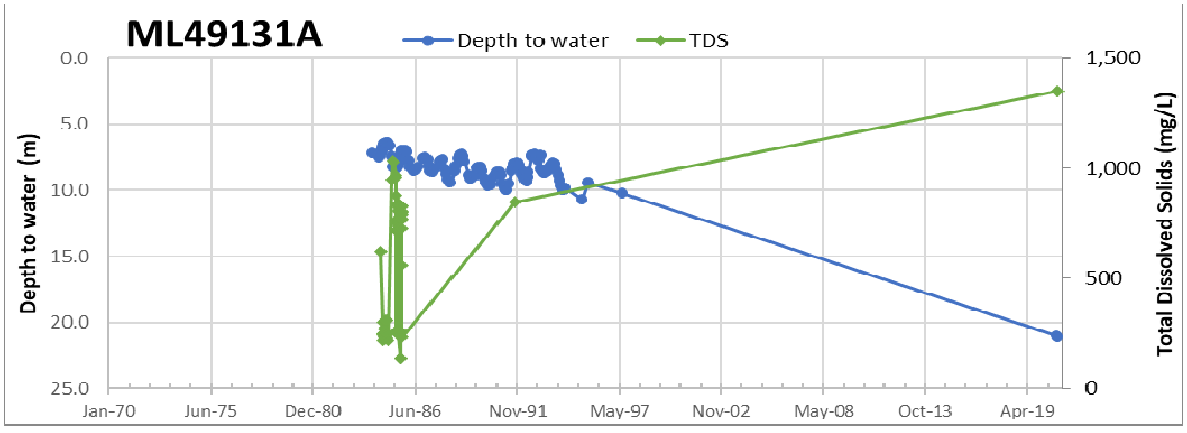

MK46101A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19


MK46101A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
250
200
150
100
50
0
Jan 70
Jun 75
Dec 80
Jun 86
Nov 91
May 97
Nov 02
May 08
Oct 13
Apr 19


MK49162A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19


MK49162A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
2,500
2,000
1,500
1,000
500
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

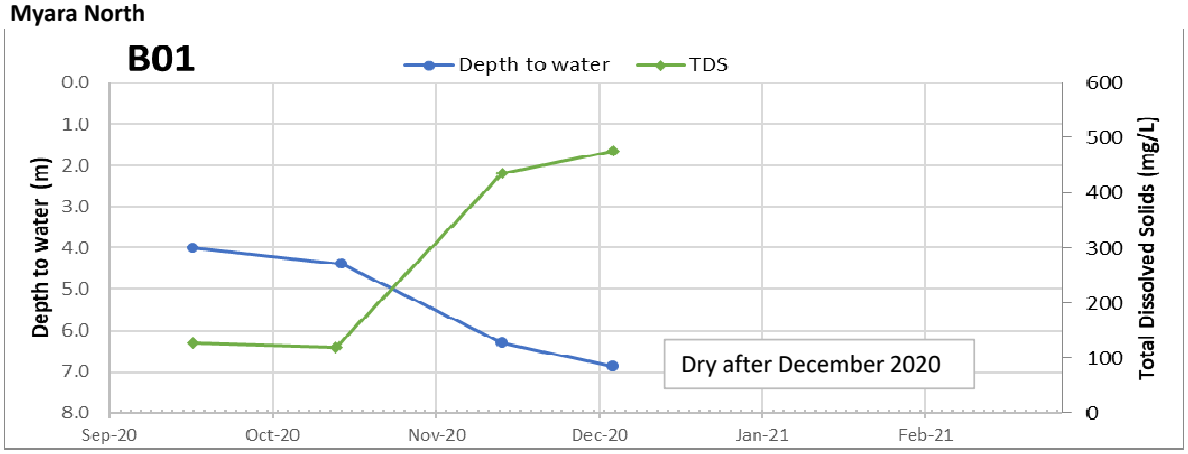

ML49131A
Depth to water
CDFM
Depth to water (m)
CDFM (mm)
0.00
5.00
10.00
15.00
20.00
25.00
2000
1500
1000
500
0
Jan-70
Dec-74
Dec-79
Dec-84
Dec-89
Dec-94
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19

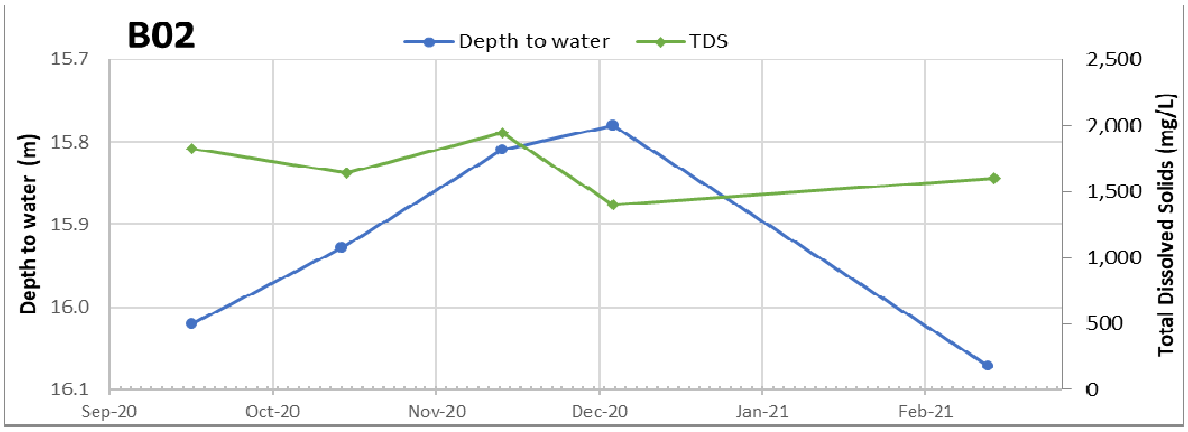

ML49131A
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
5.0
10.0
15.0
20.0
25.0
1,500
1,000
500
0
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08
Oct-13
Apr-19

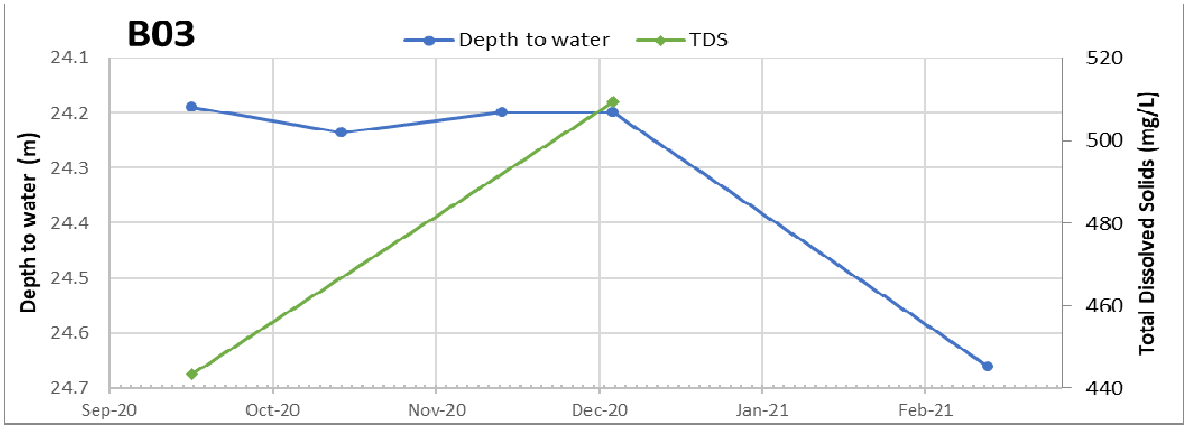
Appendix K

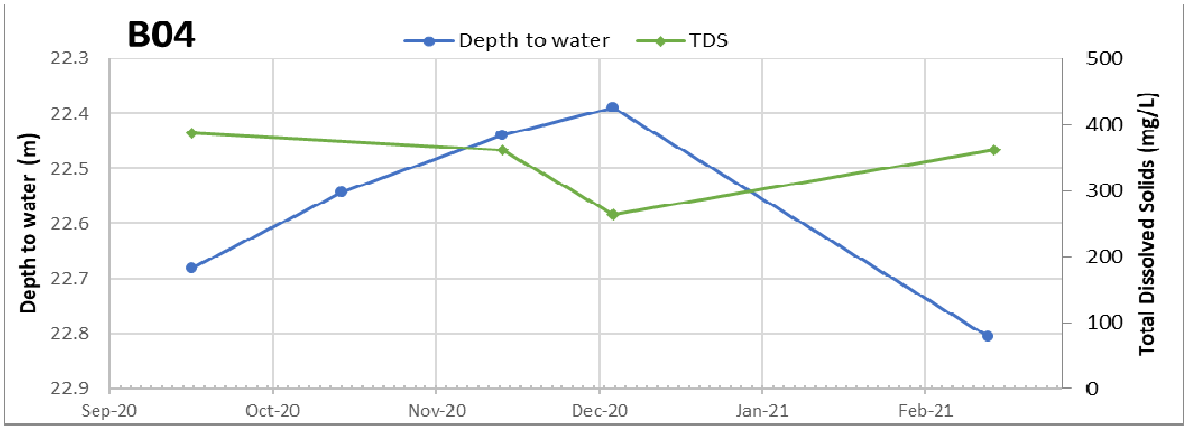
Groundwater data graphs – New sites

Myara North

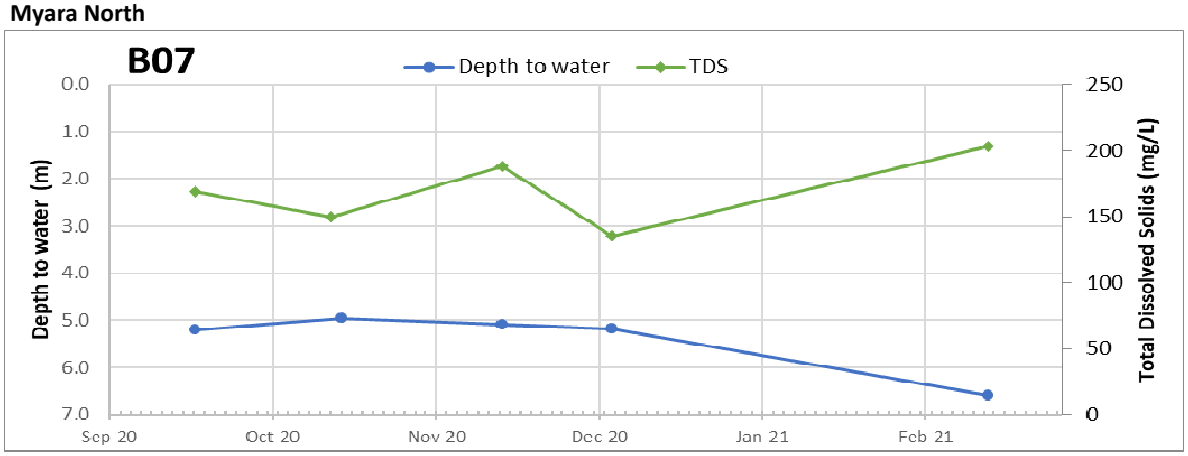

B01
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
600
500
400
300
200
100
0
Dry after December 2020
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

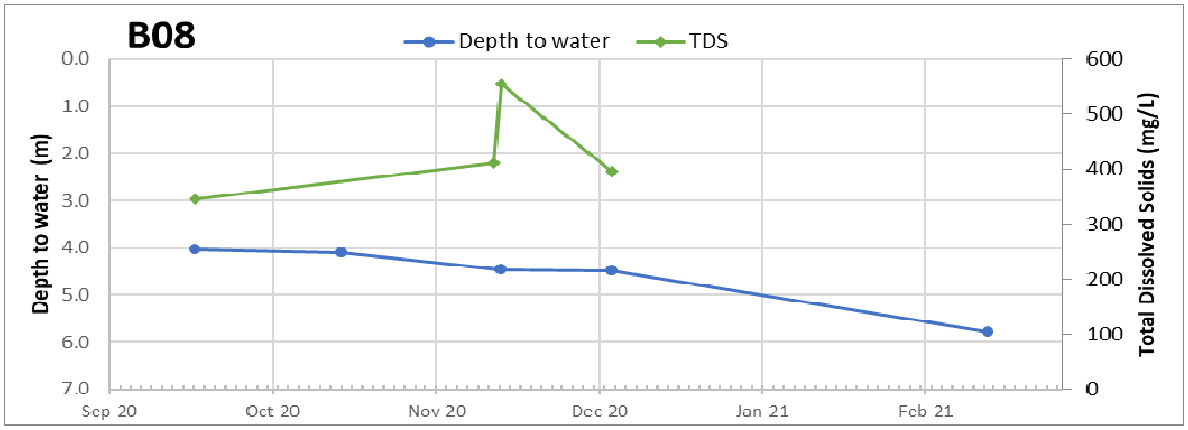

B02
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
15.7
15.8
15.9
16.0
16.1
2,500
2,000
1,500
1,000
500
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

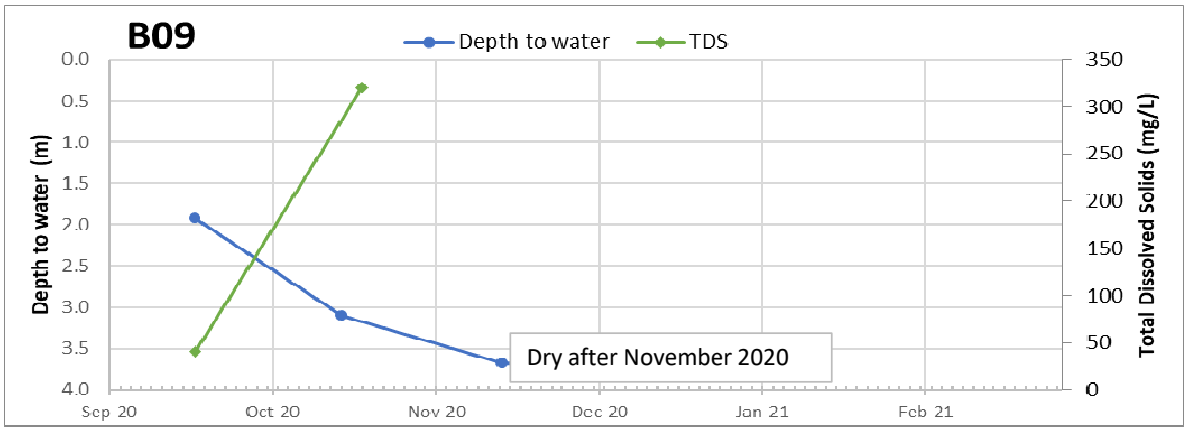

B03
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
24.1
24.2
24.3
24.4
24.5
24.6
24.7
520
500
480
460
440
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

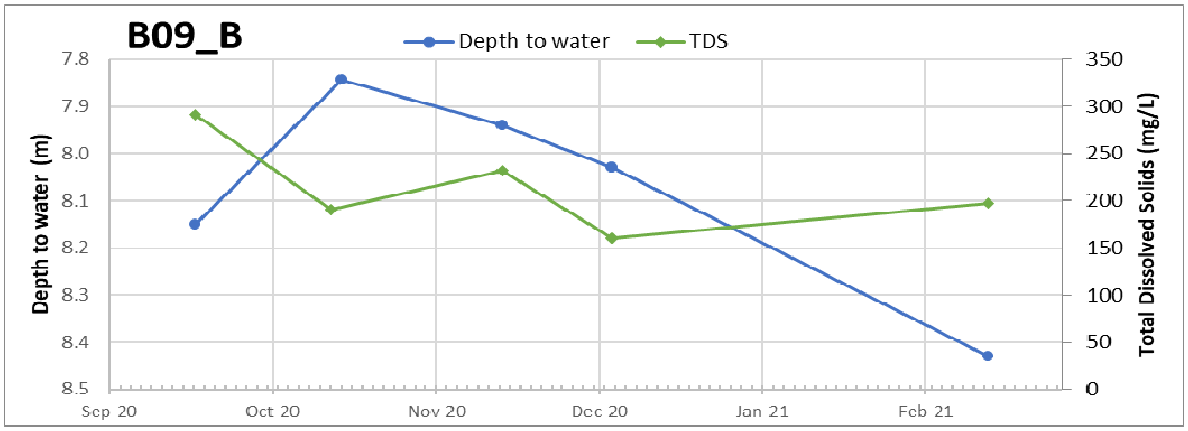

B04
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
22.3
22.4
22.5
22.6
22.7
22.8
22.9
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

Myara North

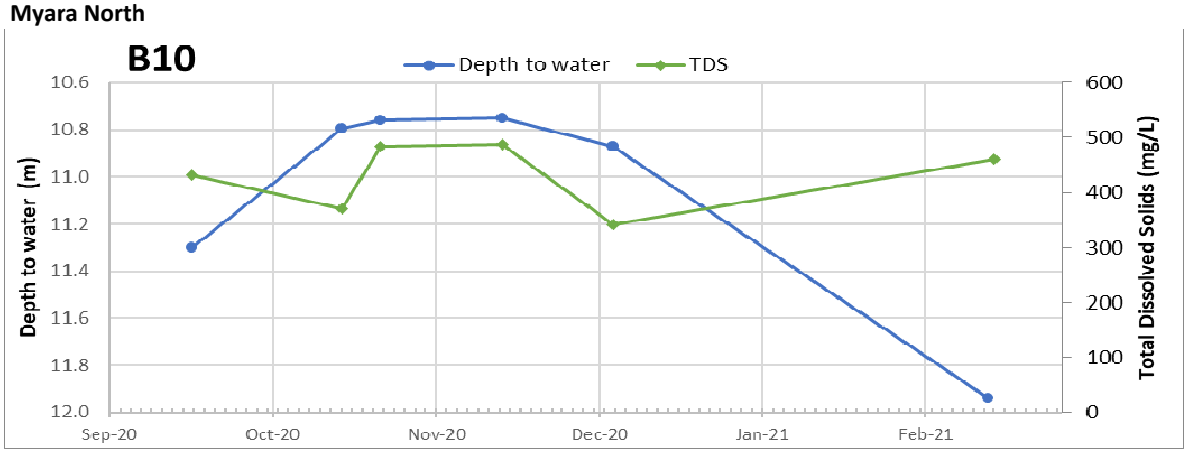

B07
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
250
200
150
100
50
0
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21

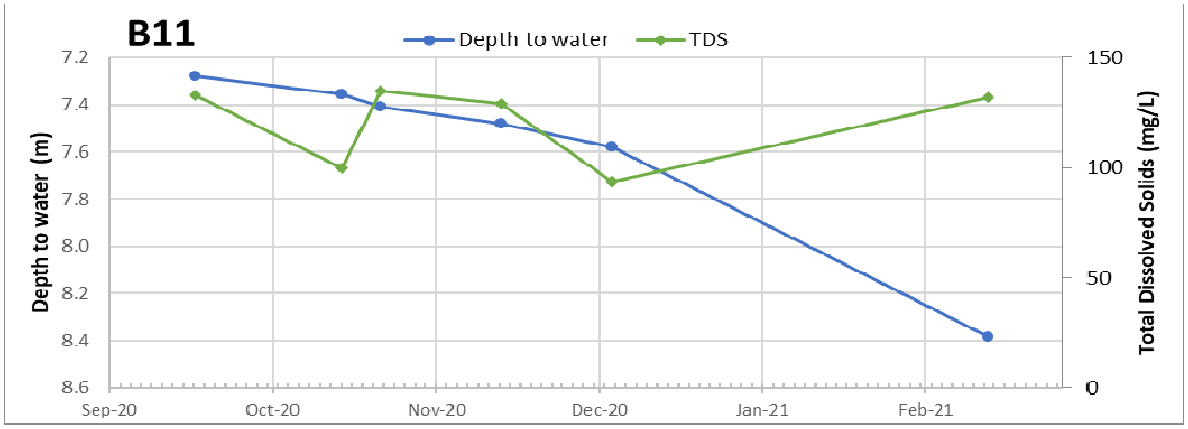

B08
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
600
500
400
300
200
100
0
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21

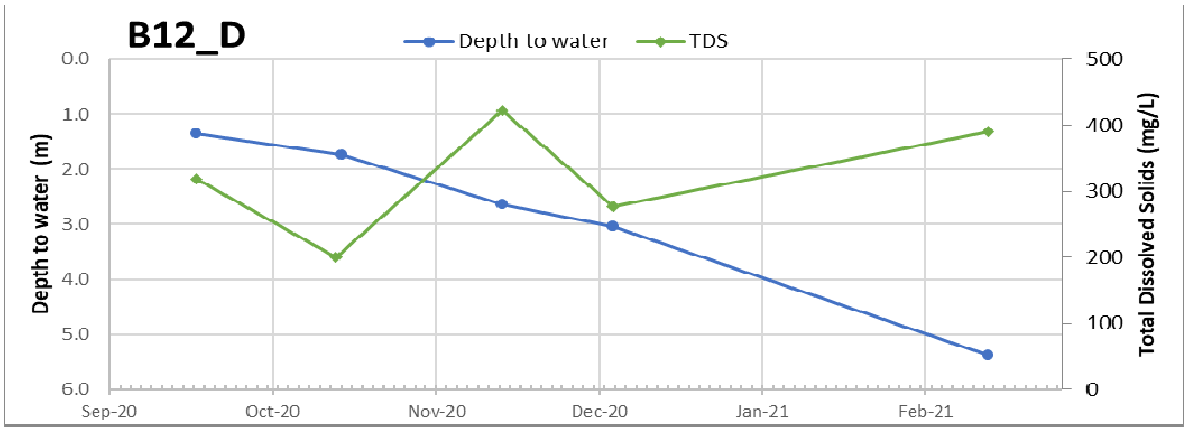

B09
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
350
300
250
200
150
100
50
0
Dry after November 2020
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21

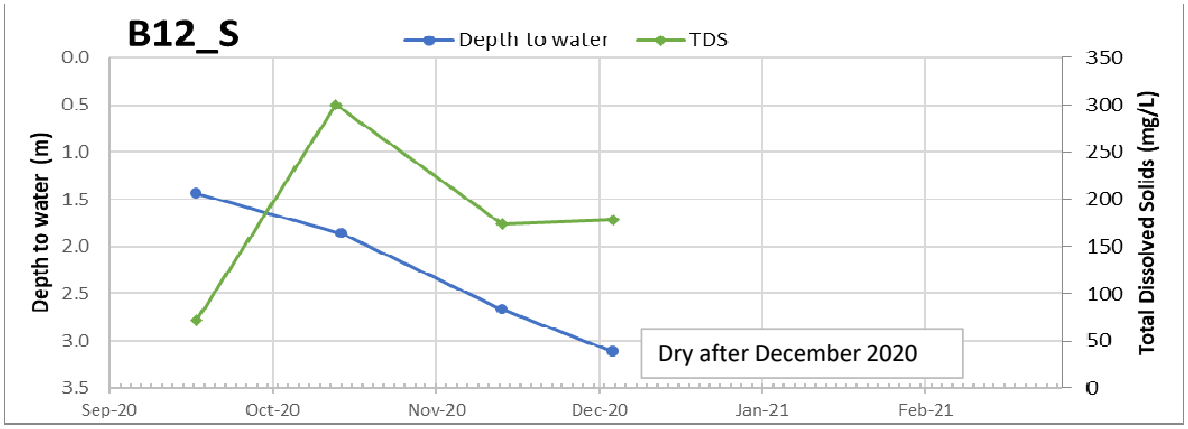

B09_B
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
7.8
7.9
8.0
8.1
8.2
8.3
8.4
8.5
350
300
250
200
150
100
50
0
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21

Myara North

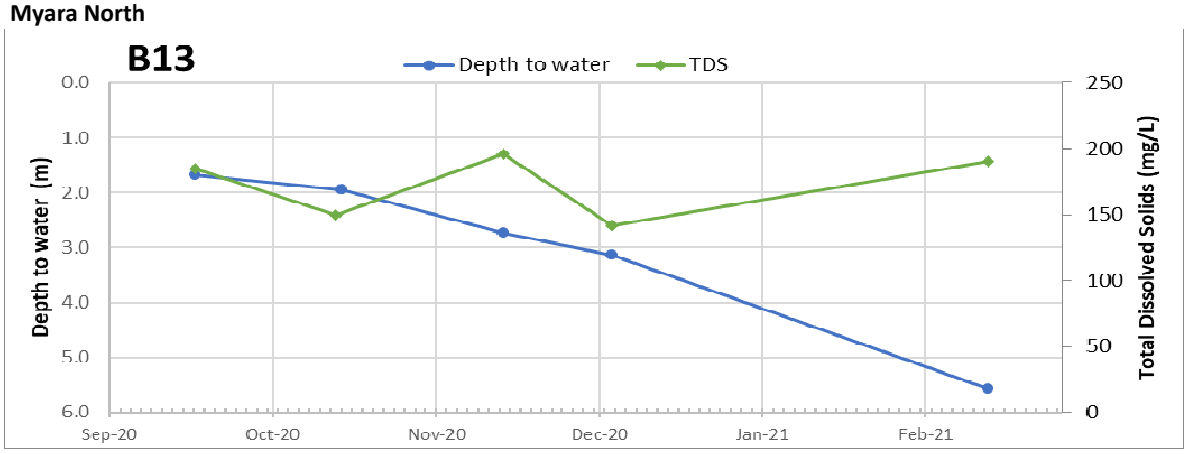

B10
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
10.6
10.8
11.0
11.2
11.4
11.6
11.8
12.0
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

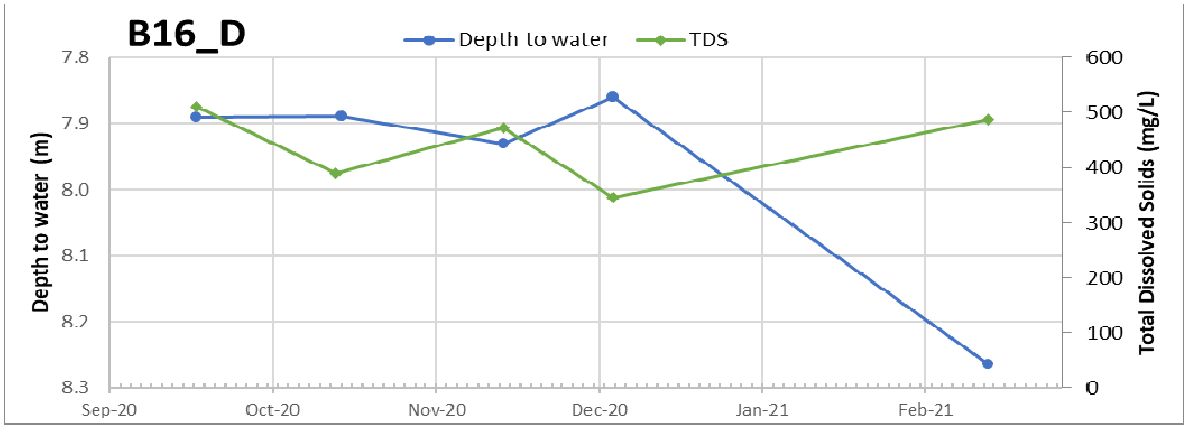

B11
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
150
100
50
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

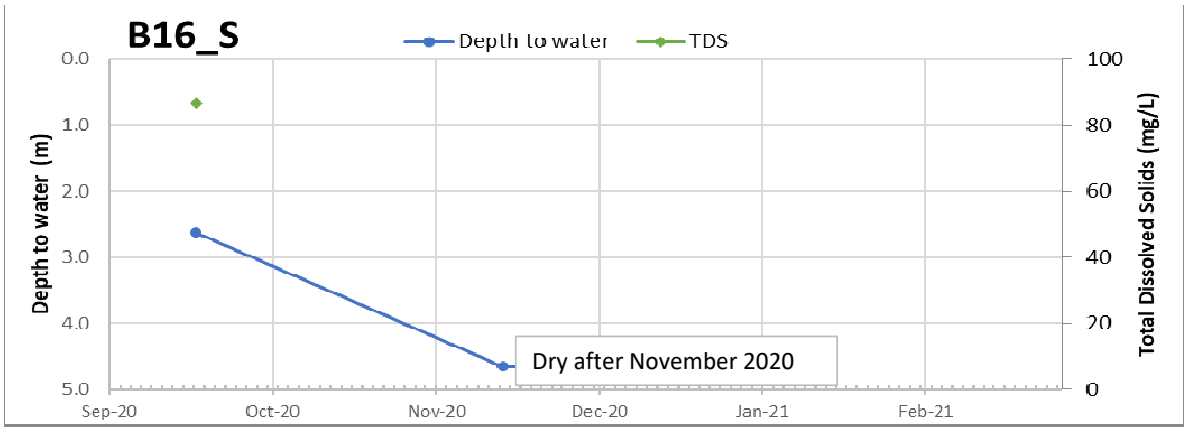

B12_D
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

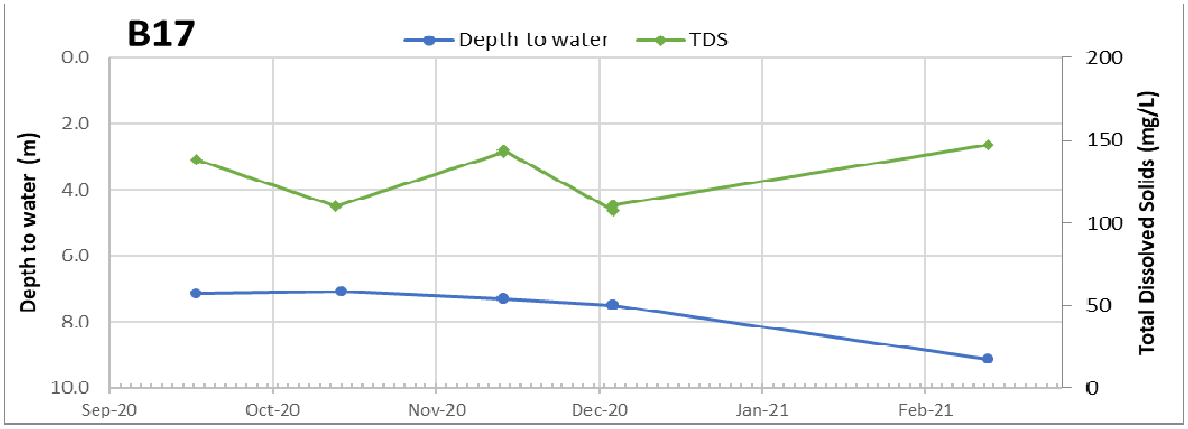

B12_S
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
350
300
250
200
150
100
50
0
Dry after December 2020
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

Myara North

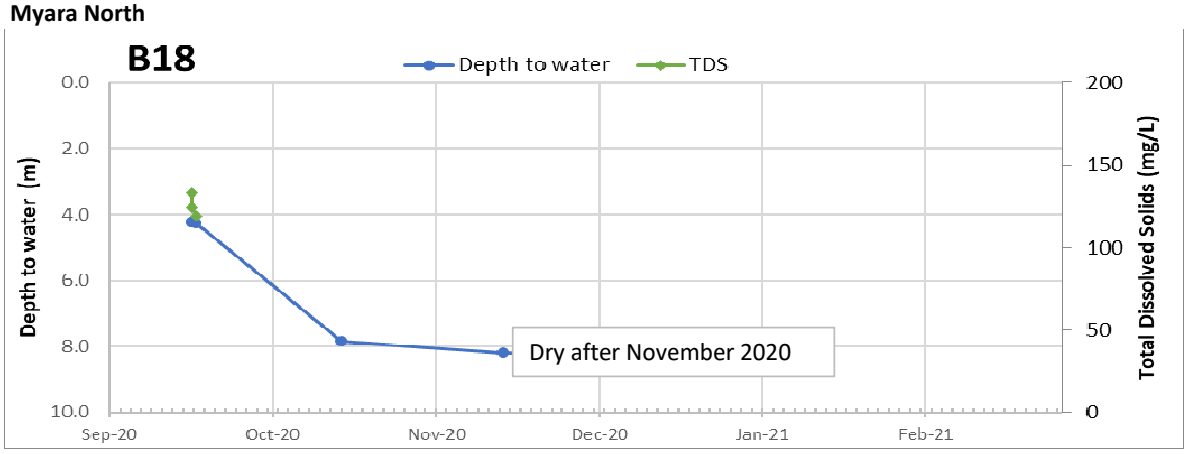

B13
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
250
200
150
100
50
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

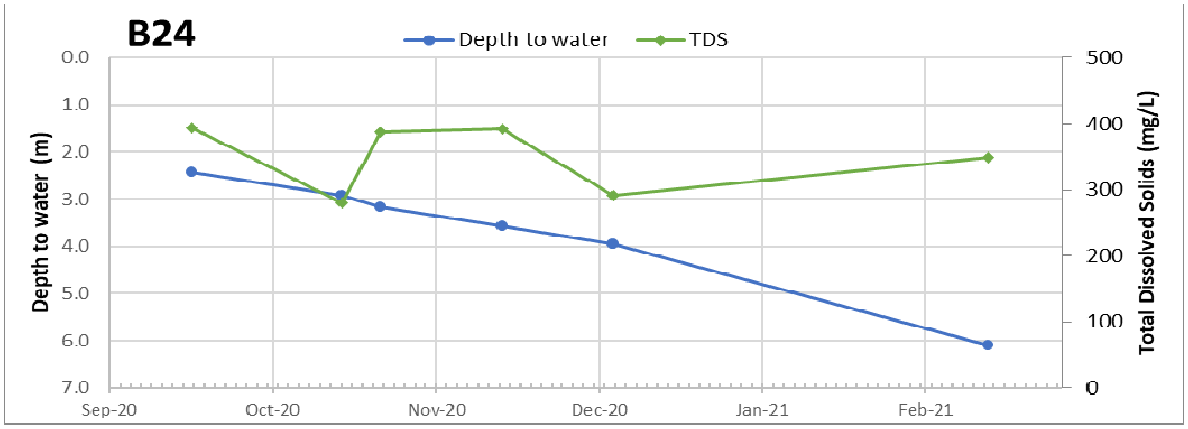

B16_D
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
7.8
7.9
8.0
8.1
8.2
8.3
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


B16_S
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
100
80
60
40
20
0
Dry after November 2020
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


B17
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
200
150
100
50
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

Myara North


B18
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
200
150
100
50
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Dry after November 2020


B24
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

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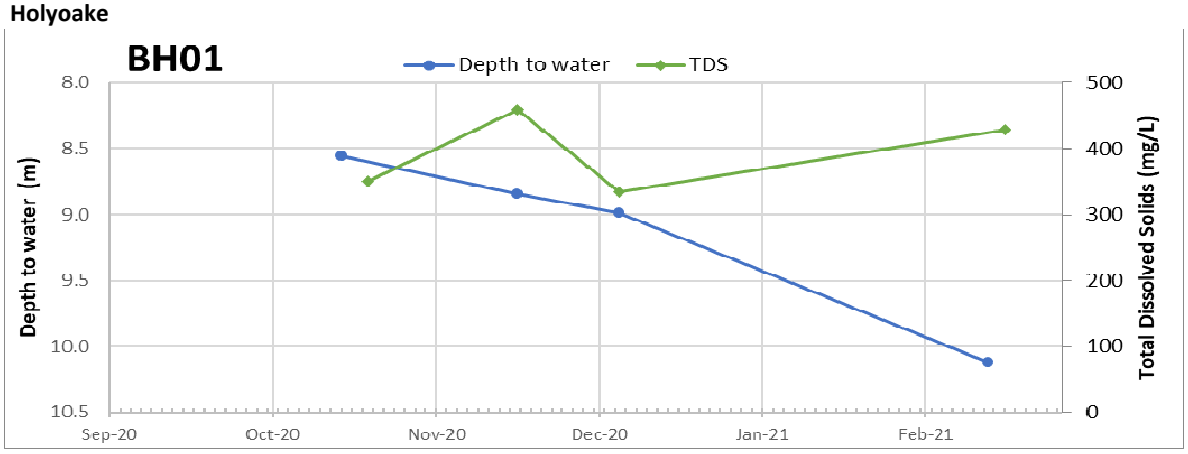
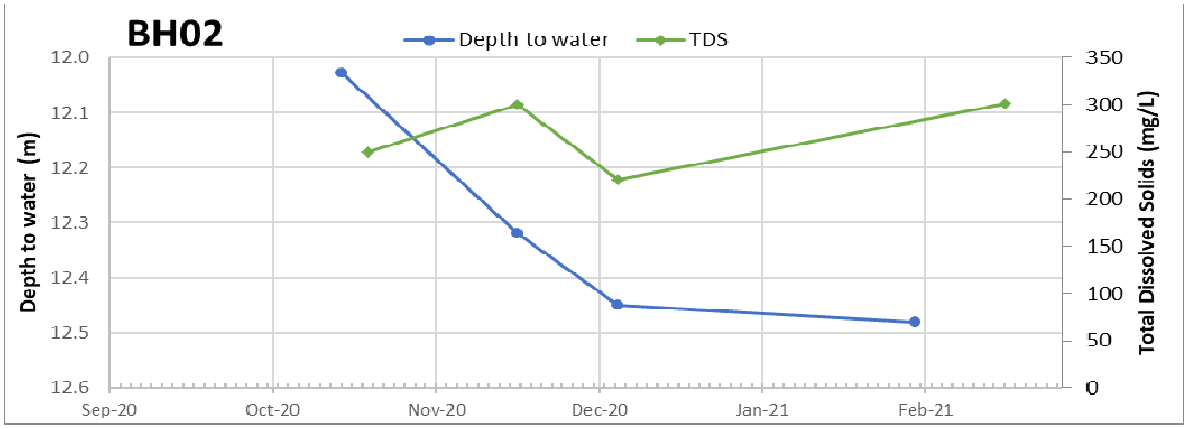
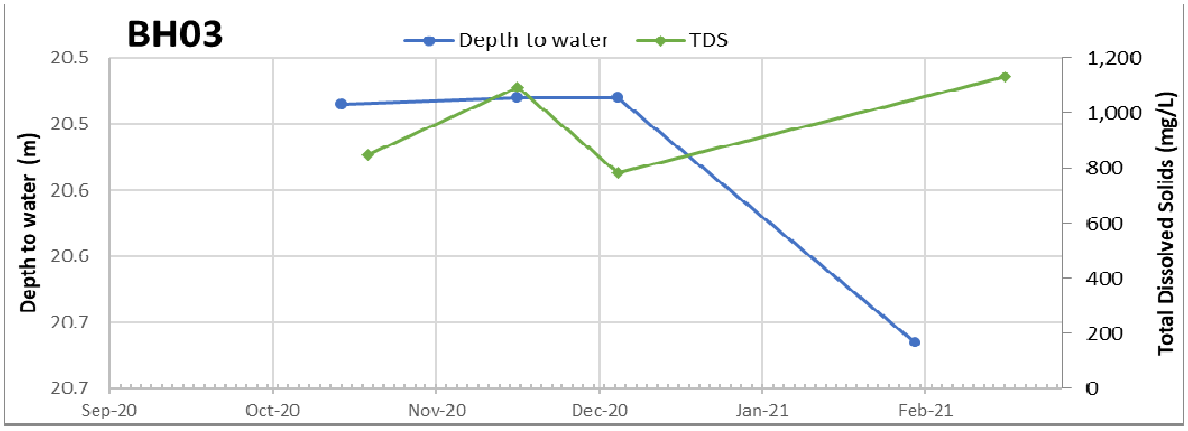
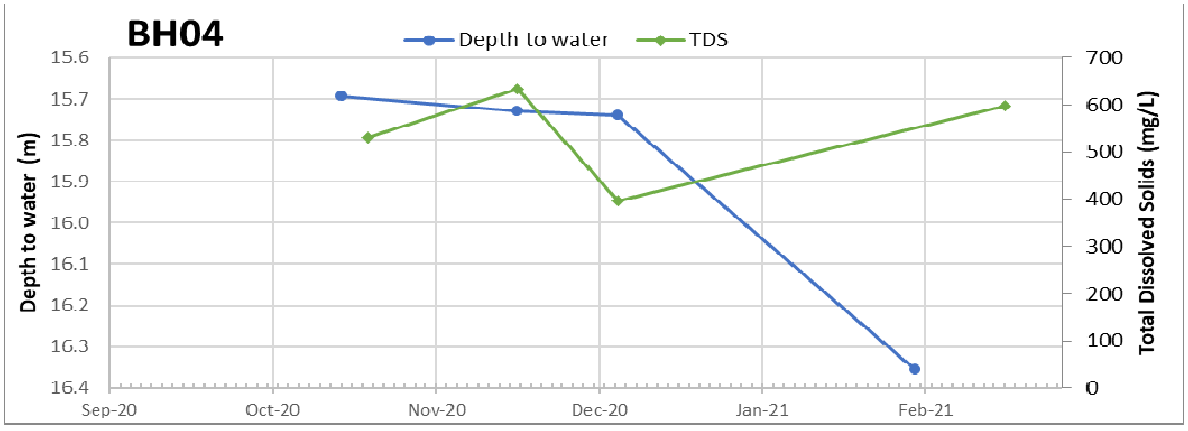

BH01
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
8.0
8.5
9.0
9.5
10.0
10.5
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH02
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
12.0
12.1
12.2
12.3
12.4
12.5
12.6
350
300
250
200
150
100
50
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH03
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
20.5
20.5
20.6
20.6
20.7
20.7
1,200
1,000
800
600
400
200
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH04
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
15.6
15.7
15.8
15.9
16.0
16.1
16.2
16.3
16.4
700
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

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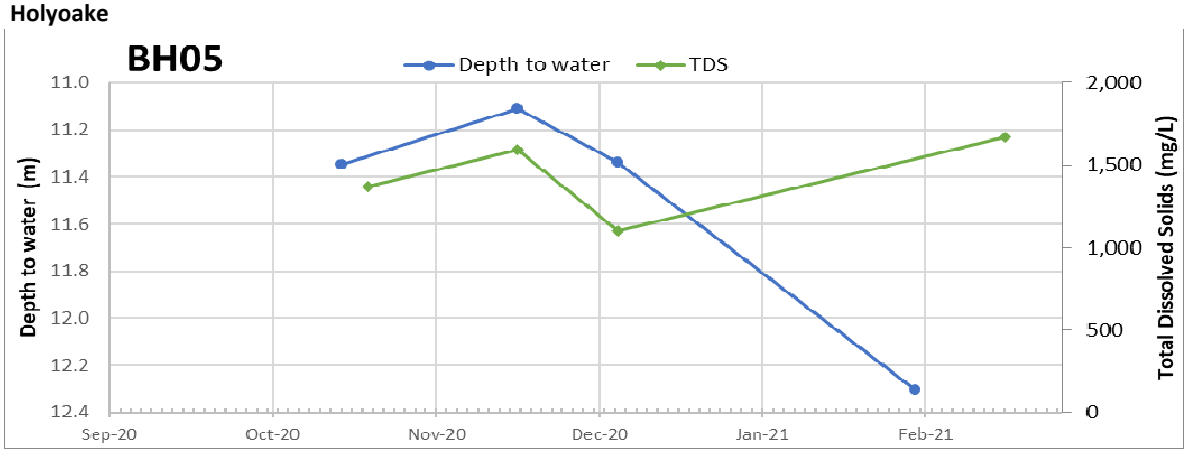
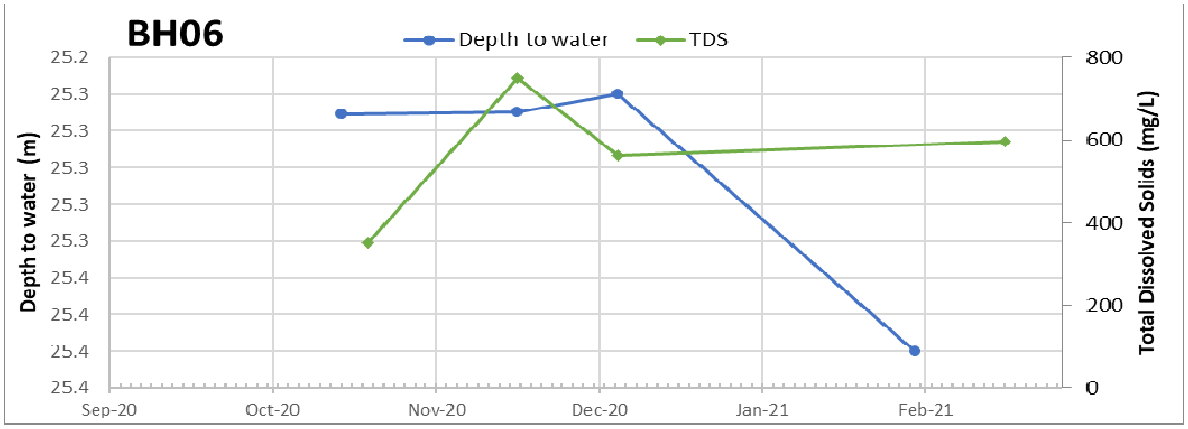
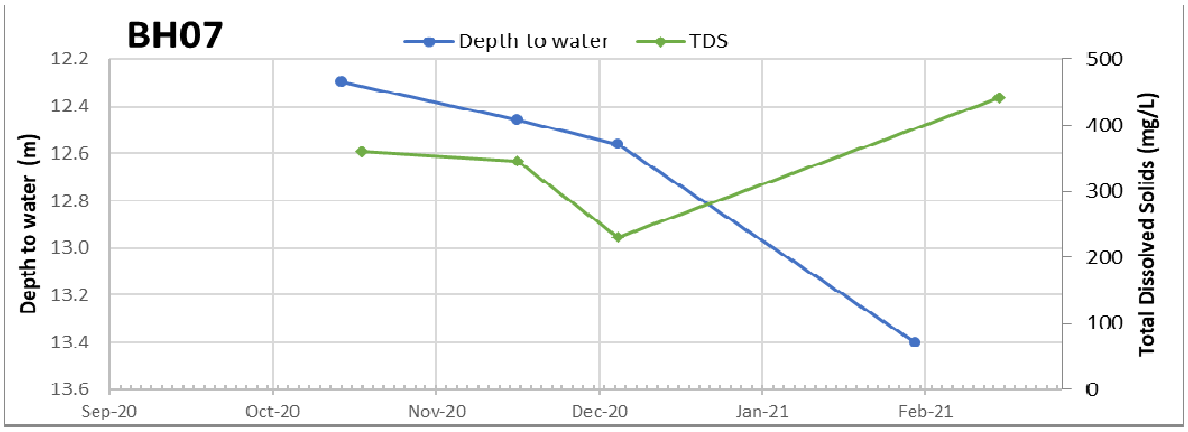
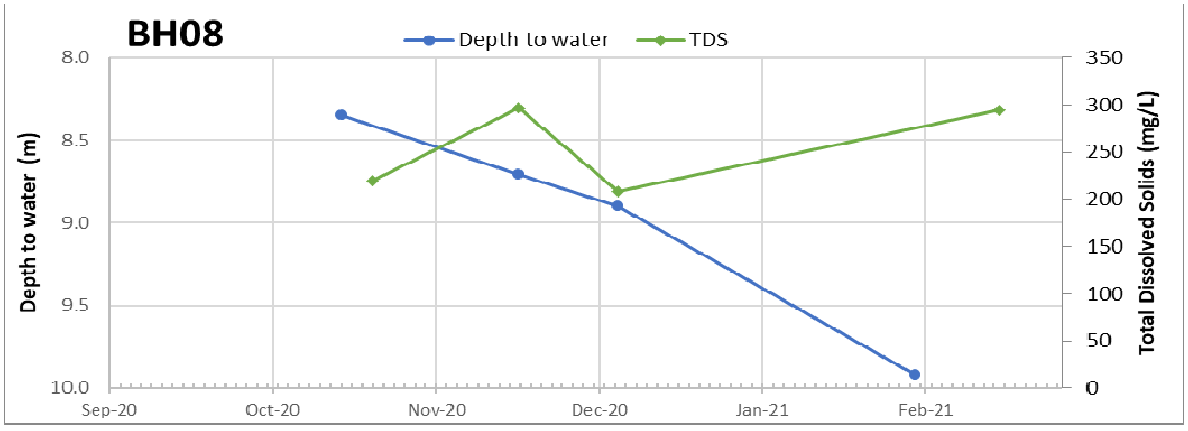

BH05
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
11.0
11.2
11.4
11.6
11.8
12.0
12.2
12.4
2,000
1,500
1,000
500
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH06
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
25.2
25.3
25.3
25.3
25.3
25.3
25.4
25.4
25.4
25.4
800
600
400
200
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH07
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
12.2
12.4
12.6
12.8
13.0
13.2
13.4
13.6
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH08
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
8.0
8.5
9.0
9.5
10.0
350
300
250
200
150
100
50
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

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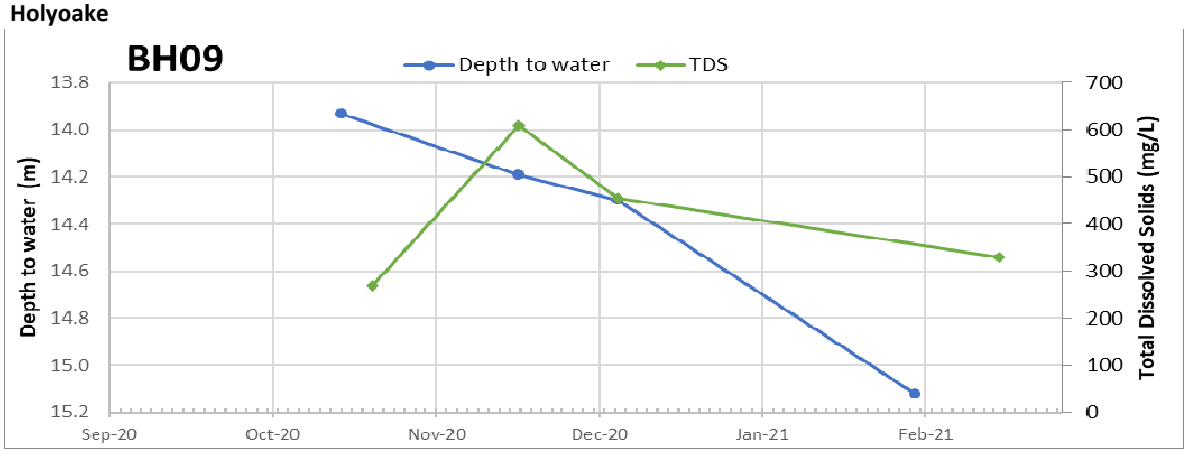
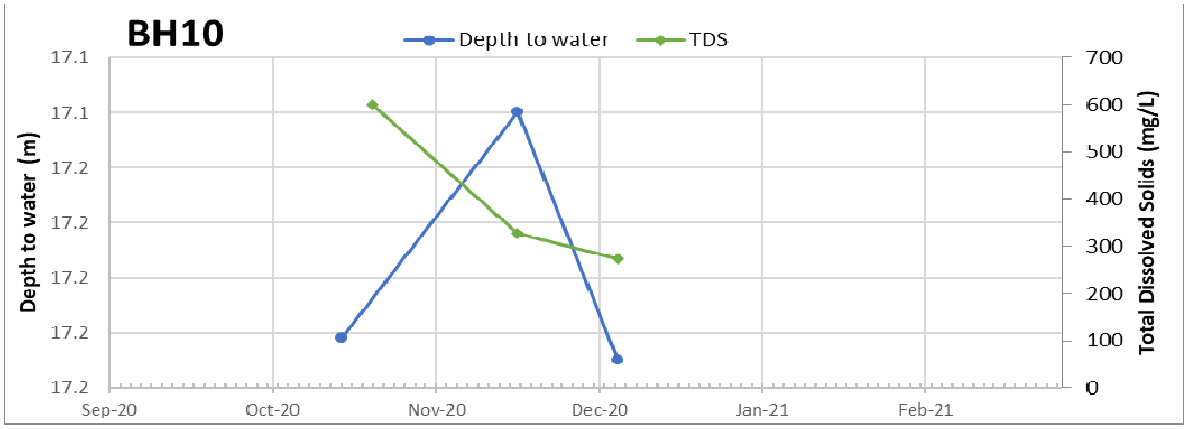
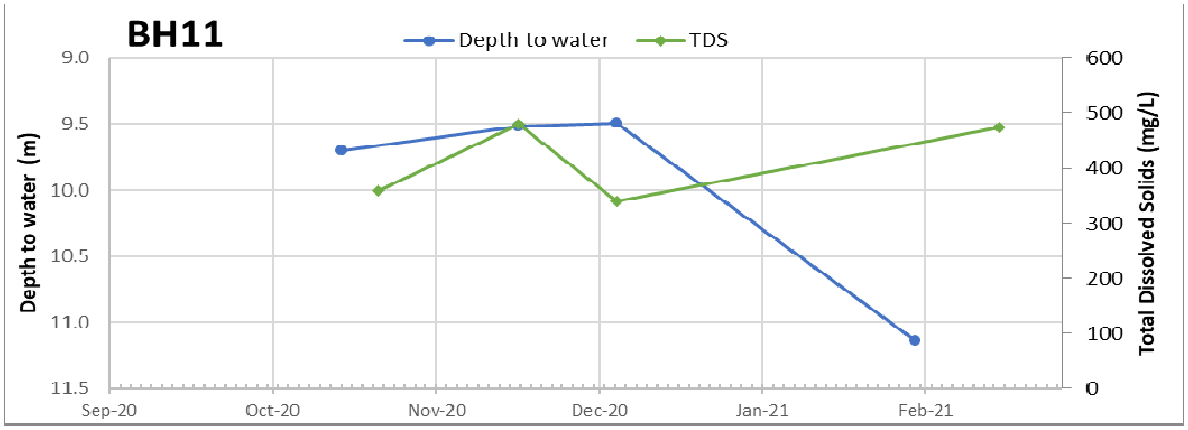
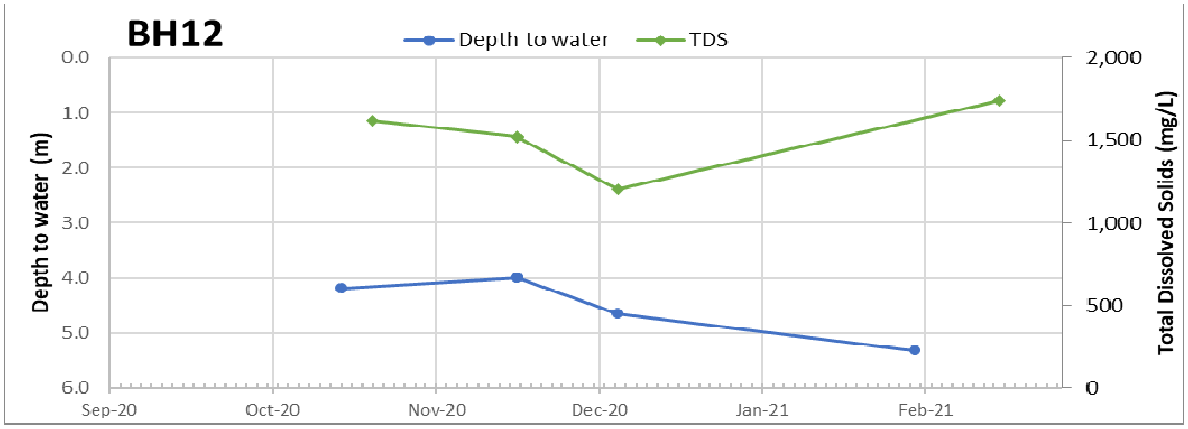

BH09
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
13.8
14.0
14.2
14.4
14.6
14.8
15.0
15.2
700
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH10
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
17.1
17.1
17.2
17.2
17.2
17.2
17.2
700
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH11
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
9.0
9.5
10.0
10.5
11.0
11.5
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH12
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
2,000
1,500
1,000
500
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

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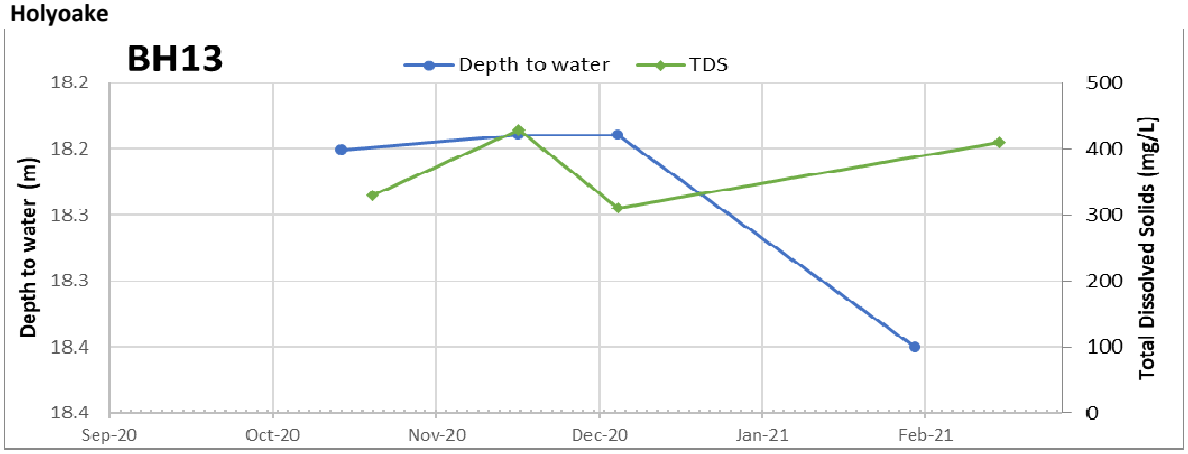
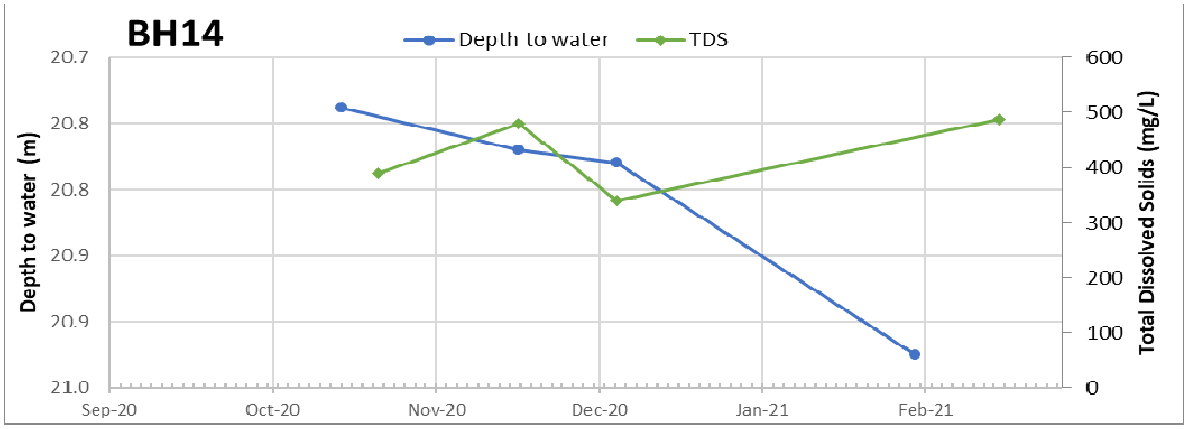
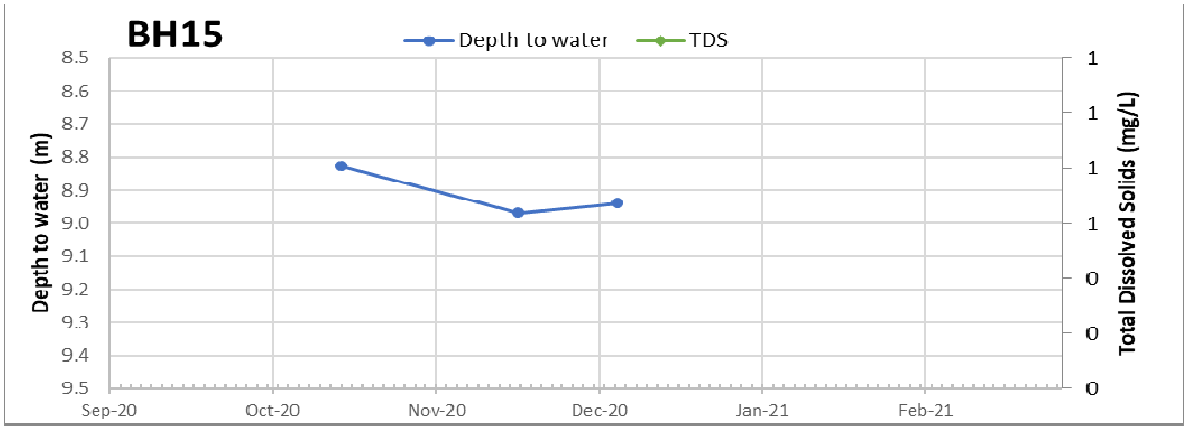
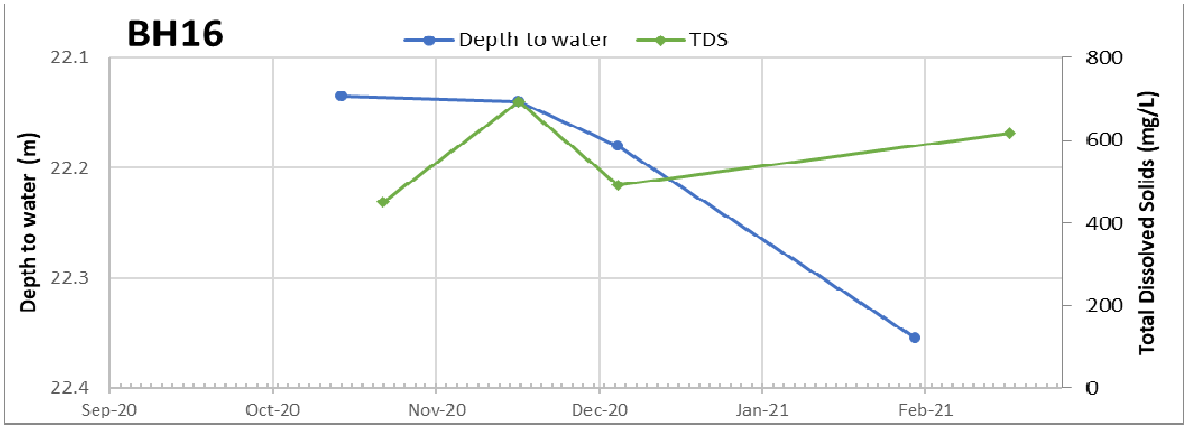

BH13
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
18.2
18.2
18.3
18.3
18.4
18.4
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH14
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
20.7
20.8
20.8
20.9
20.9
21.0
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH15
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
8.5
8.6
8.7
8.8
8.9
9.0
9.1
9.2
9.3
9.4
9.5
1
1
1
1
0
0
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21


BH16
Depth to water
TDS
Depth to water (m)
Total Dissolved Solids (mg/L)
22.1
22.2
22.3
22.4
800
600
400
200
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

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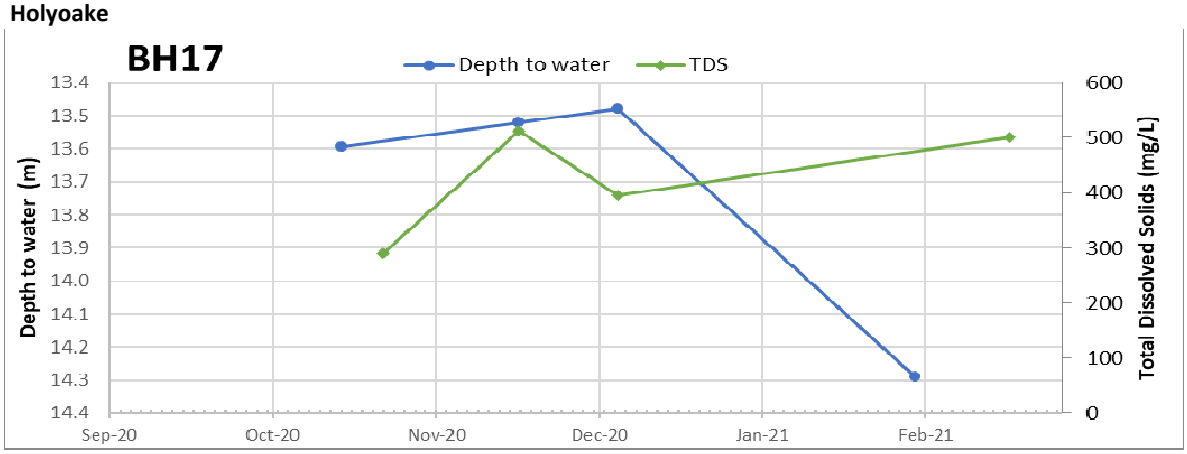
BH17
Depth to water
TDS
Depth to water (m)
13.4
13.5
13.6
13.7
13.8
13.9
14.0
14.1
14.2
14.3
14.4
Total Dissolved Solids (mg/L)
600
500
400
300
200
100
0
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21

Appendix L

Laboratory Results Summary – Groundwater and Surface Water

	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	B01	B02		B04		B07			B08			B09	B09_B		B10			B11			B12_D	
								16/10/20	16/10/20	16/2/21	16/10/20	16/2/21	13/10/20	15/10/20	15/2/21	13/10/20	15/10/20	15/2/21	19/10/20	13/10/20	15/2/21	15/10/20	22/10/20	16/2/21	15/10/20	22/10/20	15/2/21	14/10/20	15/2/21
Inorganics																													
pH (Lab)	pH units	0.01		6.5-8				6.14	7.21	6.97	6.13	5.81	5.77	-	5.51	6.21	-	6.05	5.49	5.79	5.67	-	6.16	6.35	-	5.4	5.48	6.73	6.63
Electrical conductivity (lab)	µS/cm	1						236	2720	2920	568	548	296	-	285	760	-	876	95	371	326	-	713	704	-	194	197	563	575
Turbidity	NTU	0.1						519	144	-	12.2	-	79.4	-	-	8.3	-	-	1930	831	-	-	-	-	-	-	-	0.1	-
Total Suspended Solids	mg/L	5						597	287	-	28	-	74	-	-	14	-	-	-	1110	-	-	-	-	-	-	-	<5	-
Salinity	mg/L	0.00001						0.00013	0.00153	0.0017	0.00031	0.0003	0.00016	-	0.00015	0.00042	-	0.00048	0.00052	0.0002	0.00017	-	0.00037	0.00038	-	0.00009	0.00011	0.0003	0.00031
Acidity & Alkalinity																													
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						24	184	135	42	20	12	-	6	48	-	40	4	23	12	-	47	27	-	8	8	37	48
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						24	184	135	42	20	12	-	6	48	-	40	4	23	12	-	47	27	-	8	8	37	48
Hardness as CaCO3 (Filtered)	mg/L	1						24	519	494	81	59	28	-	26	108	-	127	17	33	21	-	94	78	-	17	17	79	99
Major Ions																													
Calcium (Filtered)	mg/L	1						3	127	104	11	7	3	-	2	17	-	18	2	5	2	-	18	13	-	2	2	12	15
Magnesium (Filtered)	mg/L	1						4	49	57	13	10	5	-	5	16	-	20	3	5	4	-	12	11	-	3	3	12	15
Potassium (Filtered)	mg/L	1						<1	9	8	4	4	2	-	2	4	-	4	<1	2	1	-	3	2	-	1	1	2	2
Sodium (Filtered)	mg/L	1						35	388	395	74	76	50	-	45	108	-	129	36	62	58	-	105	101	-	31	27	76	81
Chloride	mg/L	1						49	780	806	148	154	86	-	74	217	-	239	26	97	76	-	194	190	-	54	45	155	151
Sulfate (Filtered)	mg/L	1	500					12	89	96	16	14	24	-	7	30	-	54	<1	21	22	-	30	25	-	7	7	15	16
Cations Total	meq/L	0.01						2	27.5	27.3	4.94	4.58	2.79	-	2.52	6.96	-	8.26	1.91	3.41	2.98	-	6.53	6	-	1.72	1.55	4.94	5.56
Anions Total	meq/L	0.01						2.11	27.5	27.4	5.35	5.04	3.16	-	2.35	7.7	-	8.66	0.81	3.63	2.84	-	7.04	6.42	-	1.83	1.57	5.42	5.55
Ionic Balance	%	0.01						2.68	0.1	0.3	3.96	4.73	6.35	-	3.42	5.04	-	2.41	-	3.18	2.33	-	3.73	3.39	-	3.05	0.9	4.64	0.05
Nutrients																													
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		0.03	0.06	<0.01	0.04	<0.01	0.01	-	<0.01	0.02	-	<0.01	<0.01	0.02	<0.01	0.02	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	11.29					0.02	<0.01	0.02	0.17	<0.01	0.13	-	0.09	<0.01	-	<0.01	<0.01	0.01	<0.01	0.04	-	0.02	0.05	-	0.04	0.04	0.42
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				0.02	<0.01	0.02	0.17	<0.01	0.13	-	0.09	<0.01	-	<0.01	<0.01	0.01	<0.01	0.04	-	0.02	0.05	-	0.04	0.04	0.42
Nitrogen (Total)	mg/L	0.1		0.45				0.6	<0.1	<0.1	0.2	<0.1	0.2	-	0.4	<0.1	-	<0.1	5.1	<0.2	0.7	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	0.4
Kjeldahl Nitrogen Total	mg/L	0.1						0.6	<0.1	<0.1	<0.1	<0.1	0.1	-	0.3	<0.1	-	<0.1	5.1	<0.2	0.7	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	<0.1
Reactive Phosphorus as P	mg/L	0.01						<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Phosphorus (Total)	mg/L	0.01		0.02				0.23	0.02	0.03	0.02	0.01	0.04	-	0.45	0.02	-	0.01	1.08	0.63	1.85	0.01	-	<0.01	0.01	-	0.01	0.01	0.01
Metals																													
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	2					0.006	0.083	0.07	0.091	0.082	-	0.035	0.029	0.159	0.151	0.213	0.035	0.063	0.05	0.052	-	0.044	0.022	-	0.015	0.043	0.053
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	0.09	0.06	0.06	<0.05	-	<0.05	0.06	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	0.05
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		0.001	0.004	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Cobalt (Filtered)	mg/L	0.001						<0.001	0.005	0.007	0.001	0.001	-	0.002	0.002	0.005	0.006	0.011	0.001	0.002	0.002	0.002	-	0.001	<0.001	-	<0.001	<0.001	<0.001
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	0.002	0.002	0.001	0.023	0.031	<0.001	<0.001	<0.001	-	0.001	<0.001	-	<0.001	<0.001	<0.001
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.041	0.968	1.31	0.228	0.223	-	0.052	0.026	0.282	0.328	0.221	0.063	0.181	0.084	0.119	-	0.1	0.028	-	0.009	0.074	0.112
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		0.001	0.002	0.004	0.004	0.003	-	0.002	0.01	0.002	0.003	0.002	0.009	0.003	0.004	0.002	-	0.002	<0.001	-	<0.001	0.001	0.001
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005			0.008	0.0024		0.012	0.007	0.007	0.008	0.007	-	0.006	0.007	0.016	0.025	0.024	0.05	0.009	0.008	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	<0.005
BTEXN																													
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2
Xylene Total	µg/L	2	600					<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
TRH - NEPM 2013																													
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	<100	<100	<100	800	-	1380	<100	-	<100	180	700	590	<100	-	<100	<100	-	<100	<100	<100
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	-	160	<100	-	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	<100	<100	<100	800	-	1540	<100	-	<100	180	700	590	<100	-	<100	<100	-	<100	<100	<100

	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	B01	B02		B04		B07			B08			B09	B09_B		B10			B11			B12_D	
								16/10/20	16/10/20	16/2/21	16/10/20	16/2/21	13/10/20	15/10/20	15/2/21	13/10/20	15/10/20	15/2/21	19/10/20	13/10/20	15/2/21	15/10/20	22/10/20	16/2/21	15/10/20	22/10/20	15/2/21	14/10/20	15/2/21
TRH - NEPM 1999																													
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	-	<50	<50	-	<50	<50	<50	<50	<50	-	<50	<50	-	<50	<50	<50
C15-C28 Fraction	µg/L	100						<100	<100	<100	<100	<100	680	-	1130	<100	-	<100	160	640	530	<100	-	<100	<100	-	<100	<100	<100
C29-C36 Fraction	µg/L	50						<50	<50	<50	<50	<50	210	-	450	<50	-	<50	<50	120	120	<50	-	<50	<50	-	<50	<50	<50
C10-C36 (Sum of Total)	µg/L	50						<50	<50	<50	<50	<50	890	-	1580	<50	-	<50	160	760	650	<50	-	<50	<50	-	<50	<50	<50
PAHs - standard 16																													
Acenaphthene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Acenaphthylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Anthracene	µg/L	0.001			0.4	0.01		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Benz(a)anthracene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Benzo(a)pyrene	µg/L	0.001	0.01		0.2	0.1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Benzo[b+j]fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004
Benzo(k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004
Benzo(g,h,i)perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Chrysene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Dibenz(a,h)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Fluoranthene	µg/L	0.001			1.4	1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Fluorene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	0.002	0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Naphthalene	µg/L	0.004			16	2.5		<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<5	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004
Phenanthrene	µg/L	0.002			2	0.6		<0.002	<0.002	<0.002	<0.002	<0.002	0.004	-	<0.002	-	<0.002	0.002	0.006	0.008	0.006	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
PAHs (Sum of total) - Lab calc	µg/L	0.001	0.01					<0.001	<0.001	<0.001	<0.001	<0.001	0.004	-	<0.001	-	<0.001	0.002	0.008	0.01	0.008	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ) Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
PAHs - extended																													
2-methylnaphthalene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
3-methylcholanthrene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004
7,12-dimethylbenz(a)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Benzo(e)pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
Perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Benzo(b+j+k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004
OC Pesticides																													
4,4'-DDE	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
a-BHC	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Aldrin	µg/L	0.001						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	-
Aldrin + Dieldrin	µg/L	0.002	0.3					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
b-BHC	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Chlordane	µg/L	0.001	2		0.08	0.03		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	-
Chlordane (cis)	µg/L	0.001						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	-
Chlordane (trans)	µg/L	0.001						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	-
d-BHC	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
4,4 DDD	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
4,4 DDT	µg/L	0.002	9		0.01	0.006		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
DDT+DDE+DDD - Lab Calc	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Dieldrin	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endosulfan	µg/L	0.002	20		0.2	0.03		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endosulfan I (alpha)	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endosulfan II (beta)	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endosulfan Sulfate	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endrin	µg/L	0.002			0.02	0.01		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endrin aldehyde	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Endrin ketone	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
g-BHC (Lindane)	µg/L	0.002	10		0.2	0.07		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Heptachlor	µg/L	0.002	0.3		0.09	0.01		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Heptachlor epoxide	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Hexachlorobenzene	µg/L	0.002			0.1	0.05		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Methoxychlor	µg/L	0.002	300					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-
Oxychlordane	µg/L	0.002						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	-

	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	B01	B02		B04		B07			B08			B09	B09_B		B10			B11			B12_D	
								16/10/20	16/10/20	16/2/21	16/10/20	16/2/21	13/10/20	15/10/20	15/2/21	13/10/20	15/10/20	15/2/21	19/10/20	13/10/20	15/2/21	15/10/20	22/10/20	16/2/21	15/10/20	22/10/20	15/2/21	14/10/20	15/2/21
Explosives																													
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
1,3-Dinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
2,6-dinitrotoluene	µg/L	1						<1	<1	<2	<1	<2	<1	-	<2	-	-	<2	<1	<1	<2	<1	-	<2	<1	-	<2	<1	<2
2-Amino-4,6-DNT	µg/L	1						<1	<1	<2	<1	<2	<1	-	<2	-	-	<2	<1	<1	<2	<1	-	<2	<1	-	<2	<1	<2
2-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
4-Amino,2,6-DNT	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
4-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
HMX	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
m-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
Nitrobenzene	µg/L	1			550	230		<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
Nitroglycerine	µg/L	5						<5	<5	<5	<5	<5	<5	-	<5	-	-	<5	<5	<5	<5	<5	-	<5	<5	-	<5	<5	<5
PETN	µg/L	5						<5	<5	<5	<5	<5	9	-	<5	-	-	<5	<5	<5	<5	<5	-	<5	<5	-	<5	<5	<5
RDX	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
Tetryl	µg/L	1						<1	<1	<1	<1	<1	<1	-	<1	-	-	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1
SVOCs																													
Coronene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
PFAS - Perfluoroalkyl Carboxylic Acids																													
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	0.56				0.56	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
PFAS - Perfluoroalkyl Sulfonic Acids																													
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003
PFAS - Fluorotelomer Sulfonic Acids																													
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001
PFAS - Sums																													
Sum of PFHxS and PFOS	µg/L	0.0003	0.07				0.07	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003

	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	B12_S	B13		B16_D		B17		B24			J4012-1A	J3803-4A		K3917-1A			K4011-1A	K4104-1A		K4106-1A	L4009-3A	
								14/10/20	14/10/20	15/2/21	14/10/20	15/2/21	14/10/20	15/2/21	15/10/20	22/10/20	15/2/21	14/10/20	15/10/20	22/10/20	15/10/20	22/10/20	16/2/21	16/10/20	16/10/20	16/2/21	19/10/20	16/10/20	16/2/21
Inorganics																													
pH (Lab)	pH units	0.01		6.5-8				6.32	6.54	6.12	6.27	5.54	5.85	5.36	-	6.57	6.03	6.71	-	5.54	-	6.38	6.17	5.49	5.99	6.1	5.93	6.24	6.15
Electrical conductivity (lab)	µS/cm	1						232	291	273	757	714	229	261	-	574	520	749	-	324	-	477	501	500	223	217	2410	310	578
Turbidity	NTU	0.1						268	23	-	0.2	-	4.7	-	-	-	-	1720	-	-	-	-	-	166	288	-	145	242	-
Total Suspended Solids	mg/L	5						942	53	-	<5	-	12	-	-	-	-	3920	-	-	-	-	-	220	681	-	-	186	-
Salinity	mg/L	0.00001						0.00012	0.00016	0.00015	0.00041	0.00039	0.00012	0.00014	-	0.00029	0.00028	0.00041	-	0.00016	-	0.00024	0.00027	0.00027	0.00012	0.00012	0.00139	0.00017	0.00031
Acidity & Alkalinity																													
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						24	14	11	26	12	10	5	-	65	27	61	-	7	-	50	24	7	15	15	36	7	16
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						24	14	11	26	12	10	5	-	65	27	61	-	7	-	50	24	7	15	15	36	7	16
Hardness as CaCO3 (Filtered)	mg/L	1						20	36	33	83	78	25	24	-	89	62	88	-	30	-	79	59	45	35	32	242	38	58
Major Ions																													
Calcium (Filtered)	mg/L	1						3	6	5	12	8	5	3	-	19	10	12	-	2	-	12	7	5	4	3	31	2	5
Magnesium (Filtered)	mg/L	1						3	5	5	13	14	3	4	-	10	9	14	-	6	-	12	10	8	6	6	40	8	11
Potassium (Filtered)	mg/L	1						1	2	2	3	3	2	2	-	4	3	2	-	2	-	2	2	2	1	2	7	2	3
Sodium (Filtered)	mg/L	1						40	40	43	107	116	31	40	-	80	78	107	-	56	-	68	66	72	28	27	384	46	83
Chloride	mg/L	1						40	74	67	226	223	52	64	-	143	139	196	-	94	-	121	135	143	46	41	682	87	171
Sulfate (Filtered)	mg/L	1	500					20	9	9	23	19	10	6	-	19	18	28	-	11	-	15	16	16	18	16	107	5	10
Cations Total	meq/L	0.01						2.16	2.5	2.58	6.4	6.67	1.9	2.27	-	5.35	4.71	6.46	-	3.08	-	4.6	4.09	4.09	1.94	1.87	21.7	2.81	4.84
Anions Total	meq/L	0.01						2.02	2.55	2.3	7.37	6.92	1.87	2.03	-	5.73	4.84	7.33	-	3.02	-	4.72	4.62	4.51	1.97	1.79	22.2	2.7	5.35
Ionic Balance	%	0.01						3.29	1.04	5.85	7.07	1.85	0.56	5.58	-	3.38	1.32	6.34	-	0.98	-	1.38	6.04	4.84	0.9	2.18	1.06	2.04	5
Nutrients																													
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	0.05	<0.01	-	0.02	-	0.08	0.05	0.12	0.28	0.05	0.04	0.19
Nitrate (as N)	mg/L	0.01	11.29					0.03	0.4	0.36	0.02	<0.01	0.09	0.14	0.08	-	0.05	0.02	0.06	-	<0.01	-	<0.01	0.02	0.01	<0.01	0.04	0.02	0.04
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				0.03	0.4	0.36	0.02	<0.01	0.09	0.14	0.08	-	0.05	0.02	0.06	-	<0.01	-	<0.01	0.02	0.01	<0.01	0.04	0.02	0.04
Nitrogen (Total)	mg/L	0.1		0.45				1.3	0.4	0.4	<0.1	<0.1	<0.1	0.3	<0.1	-	<0.1	1.2	0.4	-	<0.2	-	0.1	0.2	0.4	0.7	0.5	<0.1	0.4
Kjeldahl Nitrogen Total	mg/L	0.1						1.3	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	-	<0.1	1.2	0.3	-	<0.2	-	0.1	0.2	0.4	0.7	0.5	<0.1	0.4
Reactive Phosphorus as P	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus (Total)	mg/L	0.01		0.02				0.36	0.01	0.02	0.02	<0.01	0.02	0.42	0.01	-	0.01	2.15	0.06	-	0.44	-	0.09	0.07	0.07	0.31	0.07	0.02	0.06
Metals																													
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	2					0.02	0.028	0.039	0.104	0.109	0.03	0.053	0.049	-	0.059	0.04	0.025	-	0.02	-	0.025	0.045	0.011	0.013	0.042	0.025	0.051
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	-	<0.05	-	<0.05	<0.05	<0.05	<0.05	0.11	<0.05	<0.05
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Filtered)	mg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	-	<0.001	0.006	<0.001	-	0.002	-	0.002	0.002	0.001	<0.001	0.01	<0.001	0.001
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	0.011	0.001	-	<0.001	-	<0.001	0.007	<0.001	<0.001	0.055	<0.001	0.008
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	0.004	-	<0.001	-	0.001	0.005	<0.001	<0.001	0.041	<0.001	<0.001
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.222	0.034	0.031	0.101	0.037	0.118	0.096	0.083	-	0.083	0.133	0.042	-	0.032	-	0.053	0.059	0.009	0.009	0.348	0.007	0.013
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.006	<0.001	-	<0.001	0.006	<0.001	-	0.003	-	0.005	0.002	<0.001	0.002	0.004	<0.001	0.003
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005			0.008	0.0024		<0.005	<0.005	<0.005	0.008	0.006	<0.005	0.006	<0.005	-	<0.005	0.009	0.317	-	0.019	-	0.01	0.035	0.016	0.006	4.21	0.008	0.045
BTEXN																													
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	-	<2	-	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	-	<2	-	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	-	<2	-	<2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	-	<2	-	<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	600					<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	-	<2	-	<2	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
TRH - NEPM 2013																													
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	-	<20	-	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	-	<20	-	<20	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	-	<100	-	<100	<100	<100	<100	<100	<100	<100
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	-	<100	-	<100	<100	<100	<100	<100	<100	<100
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	260	<100	-	<100	<100	180	-	<100	-	<100	160	<100	<100	180	120	<100
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	-	<100	-	<100	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	<100	<100	<100	<100	260	<100	-	<100	<100	180	-	<100	-	<100	160	<100	<100	180	120	<100

	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	B12_S	B13		B16_D		B17		B24			J4012-1A	J3803-4A		K3917-1A			K4011-1A	K4104-1A		K4106-1A	L4009-3A	
								14/10/20	14/10/20	15/2/21	14/10/20	15/2/21	14/10/20	15/2/21	15/10/20	22/10/20	15/2/21	14/10/20	15/10/20	22/10/20	15/10/20	22/10/20	16/2/21	16/10/20	16/10/20	16/2/21	19/10/20	16/10/20	16/2/21
TRH - NEPM 1999																													
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	-	<20	-	<20	<20	<20	<20	<20	<20	<20
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	<50	-	<50	-	<50	<50	<50	<50	<50	<50	<50
C15-C28 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	210	<100	-	<100	<100	140	-	<100	-	<100	120	<100	<100	110	<100	<100
C29-C36 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	70	<50	-	<50	<50	60	-	<50	-	<50	60	<50	<50	90	<50	<50
C10-C36 (Sum of Total)	µg/L	50						<50	<50	<50	<50	<50	<50	280	<50	-	<50	<50	200	-	<50	-	<50	180	<50	<50	200	<50	<50
PAHs - standard 16																													
Acenaphthene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acenaphthylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	µg/L	0.001			0.4	0.01		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benz(a)anthracene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(a)pyrene	µg/L	0.001	0.01		0.2	0.1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo[b+j]fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(g,h,i)perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chrysene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenz(a,h)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene	µg/L	0.001			1.4	1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluorene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Naphthalene	µg/L	0.004			16	2.5		<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<5 - 0.007	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Phenanthrene	µg/L	0.002			2	0.6		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs (Sum of total) - Lab calc	µg/L	0.001	0.01					<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	0.009	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ) Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs - extended																													
2-methylnaphthalene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	0.003	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3-methylcholanthrene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
7,12-dimethylbenz(a)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(e)pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(b+j+k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
OC Pesticides																													
4,4'-DDE	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
a-BHC	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Aldrin	µg/L	0.001						<0.001	<0.001	-	<0.001	-	<0.001	-	-	-	-	<0.001	-	-	-	-	-	-	-	-	-	-	-
Aldrin + Dieldrin	µg/L	0.002	0.3					<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
b-BHC	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Chlordane	µg/L	0.001	2		0.08	0.03		<0.001	<0.001	-	<0.001	-	<0.001	-	-	-	-	<0.001	-	-	-	-	-	-	-	-	-	-	-
Chlordane (cis)	µg/L	0.001						<0.001	<0.001	-	<0.001	-	<0.001	-	-	-	-	<0.001	-	-	-	-	-	-	-	-	-	-	-
Chlordane (trans)	µg/L	0.001						<0.001	<0.001	-	<0.001	-	<0.001	-	-	-	-	<0.001	-	-	-	-	-	-	-	-	-	-	-
d-BHC	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
4,4 DDD	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
4,4 DDT	µg/L	0.002	9		0.01	0.006		<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
DDT+DDE+DDD - Lab Calc	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Dieldrin	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endosulfan	µg/L	0.002	20		0.2	0.03		<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endosulfan I (alpha)	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endosulfan II (beta)	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endosulfan Sulfate	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endrin	µg/L	0.002			0.02	0.01		<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endrin aldehyde	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Endrin ketone	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
g-BHC (Lindane)	µg/L	0.002	10		0.2	0.07		<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Heptachlor	µg/L	0.002	0.3		0.09	0.01		<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Heptachlor epoxide	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Hexachlorobenzene	µg/L	0.002			0.1	0.05		<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Methoxychlor	µg/L	0.002	300					<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-
Oxychlordane	µg/L	0.002						<0.002	<0.002	-	<0.002	-	<0.002	-	-	-	-	<0.002	-	-	-	-	-	-	-	-	-	-	-

	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	B12_S	B13		B16_D		B17		B24			J4012-1A	J3803-4A		K3917-1A			K4011-1A	K4104-1A		K4106-1A	L4009-3A	
								14/10/20	14/10/20	15/2/21	14/10/20	15/2/21	14/10/20	15/2/21	15/10/20	22/10/20	15/2/21	14/10/20	15/10/20	22/10/20	15/10/20	22/10/20	16/2/21	16/10/20	16/10/20	16/2/21	19/10/20	16/10/20	16/2/21
Explosives																													
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
1,3-Dinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
2,6-dinitrotoluene	µg/L	1						<1	<1	<2	<1	<2	<1	<2	<1	-	<2	<1	<1	-	<1	-	<2	<1	<1	<2	<1	<1	<2
2-Amino-4,6-DNT	µg/L	1						<1	<1	<2	<1	<2	<1	<2	<1	-	<2	<1	<1	-	<1	-	<2	<1	<1	<2	<1	<1	<2
2-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
4-Amino,2,6-DNT	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
4-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
HMX	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
m-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
Nitrobenzene	µg/L	1			550	230		<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
Nitroglycerine	µg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	<5	-	<5	-	<5	<5	<5	<5	<5	<5	<5
PETN	µg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	<5	-	<5	-	<5	8	<5	<5	<5	<5	<5
RDX	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
Tetryl	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	-	<1	-	<1	<1	<1	<1	<1	<1	<1
SVOCs																													
Coronene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PFAS - Perfluoroalkyl Carboxylic Acids																													
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0016	<0.0005	-	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0016	<0.0005	-	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0022
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0016	<0.0005	-	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	0.56				0.56	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0016	<0.0005	-	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	0.001	<0.0005	<0.0005
PFAS - Perfluoroalkyl Sulfonic Acids																													
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0016	<0.0005	-	<0.0005	-	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0016	<0.0005	-	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	0.0005	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0016	<0.0003	-	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	0.0006	<0.0003	<0.0003
PFAS - Fluorotelomer Sulfonic Acids																													
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.002	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.002	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.002	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.002	<0.001	-	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PFAS - Sums																													
Sum of PFHxS and PFOS	µg/L	0.0003	0.07				0.07	0.0005	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0016	<0.0003	-	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	0.0006	<0.0003	<0.0003
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						0.0005	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0016	<0.0003	-	<0.0003	-	<0.0003	<0.0003	<0.0003	0.0006	0.0016	<0.0003	0.0029

Chem Name	Units	EQL	ADWG 2011 Health (v3.6 updated 2021)	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95% DGV	ANZG (2018) - FW - 99% DGV	PFAS NEMP 2.0 2020 Health DW	6141121	6141125			GG03		SN01			SN02				SN04			SW01		SW02			SW03		
								22/9/20	5/8/20	22/9/20	12/10/20	21/9/20	12/10/20	4/8/20	22/9/20	12/10/20	5/8/20	22/9/20	12/10/20	4/11/20	21/9/20	12/10/20	4/11/20	3/8/20	21/9/20	5/8/20	22/9/20	12/10/20	22/9/20	13/10/20	4/11/20
Inorganics																															
pH (Lab)	pH units	0.01		6.5-8				6.69	6.96	6.97	6.68	6.68	6.6	6.81	7.05	6.92	6.82	6.79	6.2	6.81	6.39	6.29	7.09	6.82	6.77	7.01	6.96	7.01	6.8	6.89	7.08
Electrical conductivity (lab)	µS/cm	1						164	203	222	292	240	259	171	176	217	280	254	641	2800	162	197	203	187	193	193	192	225	220	252	266
Turbidity	NTU	0.1						0.3	0.4	0.6	1.2	0.3	0.3	1.4	1.7	4.6	1.5	1.2	4	5.5	2.3	2	1.9	2.9	0.8	0.2	0.3	0.5	0.4	1.6	0.8
Total Suspended Solids	mg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Salinity	mg/L	0.00001						0.00009	0.00011	0.00012	0.00016	0.00013	0.00014	0.00009	0.00009	0.00014	0.00015	0.00014	0.00035	0.00158	0.00009	0.00011	0.00009	0.0001	0.0001	0.0001	0.0001	0.00012	0.00012	0.00013	0.00013
Biological																															
E.coli	orgs/100mL	1						7	8	55	26	34	22	10	32	16	22	97	10	-	13	<1	-	11	27	<1	12	<1	7	<1	-
Enterococci	orgs/100mL	1						6	7	24	7	26	43	4	16	4	6	33	1	-	6	2	-	3	24	2	15	<1	17	6	-
Acidity & Alkalinity																															
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						9	8	8	10	9	11	10	10	25	9	9	5	8	8	8	9	7	8	9	10	12	7	12	15
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						9	8	8	10	9	11	10	10	25	9	9	5	8	8	8	9	7	8	9	10	12	7	12	15
Hardness as CaCO3 (Filtered)	mg/L	1						21	21	28	32	30	37	21	21	26	28	28	76	363	17	17	17	17	21	24	24	24	26	32	32
Major Ions																															
Calcium (Filtered)	mg/L	1						2	2	3	3	4	5	2	2	4	3	3	9	40	2	2	2	2	2	3	3	3	2	3	3
Magnesium (Filtered)	mg/L	1						4	4	5	6	5	6	4	4	4	5	5	13	64	3	3	3	3	4	4	4	4	5	6	6
Potassium (Filtered)	mg/L	1						2	1	1	2	2	2	1	1	1	<1	1	1	6	2	1	1	2	1	1	1	1	1	2	2
Sodium (Filtered)	mg/L	1						24	31	36	42	34	35	26	28	31	44	40	90	390	25	29	32	29	31	28	31	32	34	38	40
Chloride	mg/L	1						35	51	54	87	57	70	44	40	52	74	63	205	789	38	54	59	46	45	48	44	64	53	70	71
Sulfate (Filtered)	mg/L	1	500					12	11	10	11	15	15	9	9	7	13	11	30	58	8	7	4	12	12	10	8	8	11	13	8
Cations Total	meq/L	0.01						1.52	1.8	2.15	2.52	2.14	2.32	1.58	1.67	1.9	2.48	2.33	5.46	24.4	1.48	1.63	1.76	1.66	1.8	1.72	1.85	1.9	2.02	2.35	2.43
Anions Total	meq/L	0.01						1.42	1.83	1.89	2.88	2.1	2.51	1.63	1.52	2.11	2.54	2.18	6.51	23.6	1.4	1.83	1.93	1.69	1.68	1.74	1.61	2.21	1.86	2.48	2.47
Ionic Balance	%	0.01						3.64	0.67	-	6.69	0.97	3.94	1.33	4.92	5.21	1.25	3.12	8.76	1.58	3.02	5.64	4.42	0.84	3.56	0.57	-	7.67	3.91	2.84	0.7
Nutrients																															
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		0.02	0.01	0.02	0.02	<0.01	0.02	<0.01	0.02	0.04	0.02	0.02	0.03	-	<0.01	0.02	-	0.03	<0.01	0.01	0.02	0.02	0.01	<0.01	-
Nitrate (as N)	mg/L	0.01	11.29					0.04	0.02	0.01	0.02	0.72	0.22	0.01	<0.01	<0.01	0.04	0.03	0.03	-	<0.01	<0.01	-	<0.01	0.01	0.02	<0.01	0.02	<0.01	<0.01	-
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				0.04	0.02	0.01	0.02	0.72	0.22	0.01	<0.01	<0.01	0.04	0.03	0.03	-	<0.01	<0.01	-	<0.01	0.01	0.02	<0.01	0.02	<0.01	<0.01	-
Nitrogen (Total)	mg/L	0.1		0.45				<0.1	0.2	0.1	0.2	0.8	0.3	0.2	<0.1	0.3	0.2	0.2	0.2	-	0.1	0.1	-	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.2	-
Kjeldahl Nitrogen Total	mg/L	0.1						<0.1	0.2	0.1	0.2	0.1	0.1	0.2	<0.1	0.3	0.2	0.2	0.2	-	0.1	0.1	-	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.2	-
Reactive Phosphorus as P	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	-
Phosphorus (Total)	mg/L	0.01		0.02				<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	-	0.01	0.01	-	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	-
Metals																															
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Barium (Filtered)	mg/L	0.001	2					0.009	0.007	0.01	0.012	0.013	0.013	0.004	0.004	0.011	0.006	0.006	0.017	-	0.005	0.006	-	0.002	0.002	0.008	0.009	0.01	0.008	0.013	-
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Cobalt (Filtered)	mg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	0.004	-	0.001	0.002	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.002	0.003	0.007	0.014	0.002	0.01	0.008	0.005	0.282	0.02	0.011	0.145	-	0.03	0.068	-	0.001	0.004	0.011	0.018	0.039	0.002	0.013	-
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Zinc (Filtered)	mg/L	0.005			0.008	0.0024		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
BTEXN																															
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-
Xylene Total	µg/L	2	600					<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
TRH - NEPM 2013																															
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-
TRH - NEPM 1999																															
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-
C15-C28 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-
C29-C36 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-
C10-C36 (Sum of Total)	µg/L	50						<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-

Chem Name	Units	EQL	ADWG 2011 Health (v3.6 updated 2021)	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95% DGV	ANZG (2018) - FW - 99% DGV	PFAS NEMP 2.0 2020 Health DW	6141121	6141125			GG03		SN01			SN02				SN04			SW01		SW02			SW03		
								22/9/20	5/8/20	22/9/20	12/10/20	21/9/20	12/10/20	4/8/20	22/9/20	12/10/20	5/8/20	22/9/20	12/10/20	4/11/20	21/9/20	12/10/20	4/11/20	3/8/20	21/9/20	5/8/20	22/9/20	12/10/20	22/9/20	13/10/20	4/11/20
PAHs - standard 16																															
Acenaphthene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Acenaphthylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Anthracene	µg/L	0.001			0.4	0.01		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Benz(a)anthracene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Benzo(a)pyrene	µg/L	0.001	0.01		0.2	0.1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Benzo[b+j]fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
Benzo(k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
Benzo(g,h,i)perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Chrysene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Dibenz(a,h)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Fluoranthene	µg/L	0.001			1.4	1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Fluorene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Naphthalene	µg/L	0.004			16	2.5		<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
Phenanthrene	µg/L	0.002			2	0.6		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Sum of standard 16 PAHs	µg/L	0.001	0.01					<0.001	-	<0.001	-	<0.001	-	-	<0.001	-	-	<0.001	-	-	<0.001	-	-	-	<0.001	-	<0.001	-	<0.001	-	-
PAHs (Sum of total) - Lab calc	µg/L	0.001	0.01					-	<0.001	-	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	-	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-
Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Total 8 PAHs (as BaP TEQ) (half LOR) - Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Total 8 PAHs (as BaP TEQ)(full LOR) - Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
PAHs - extended																															
2-methylnaphthalene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
3-methylcholanthrene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
7,12-dimethylbenz(a)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Benzo(e)pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Benzo(b+j+k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
OC Pesticides																															
4,4'-DDE	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
a-BHC	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Aldrin	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Aldrin + Dieldrin	µg/L	0.002	0.3					<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	0.033	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
b-BHC	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Chlordane	µg/L	0.001	2		0.08	0.03		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Chlordane (cis)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Chlordane (trans)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
d-BHC	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
4,4 DDD	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
4,4 DDT	µg/L	0.002	9		0.01	0.006		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
DDT+DDE+DDD - Lab Calc	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Dieldrin	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	0.033	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endosulfan	µg/L	0.002	20		0.2	0.03		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endosulfan I (alpha)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endosulfan II (beta)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endosulfan Sulfate	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endrin	µg/L	0.002			0.02	0.01		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endrin aldehyde	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Endrin ketone	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
g-BHC (Lindane)	µg/L	0.002	10		0.2	0.07		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Heptachlor	µg/L	0.002	0.3		0.09	0.01		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Heptachlor epoxide	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Hexachlorobenzene	µg/L	0.002			0.1	0.05		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Methoxychlor	µg/L	0.002	300					<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Oxychlordane	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Explosives																															
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
1,3-Dinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
2,6-dinitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
2-Amino-4,6-DNT	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
2-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
4-Amino,2,6-DNT	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
4-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
HMX	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
m-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
Nitrobenzene	µg/L	1			550	230		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
Nitroglycerine	µg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	-	<5	<5	<5	<5	<5	<5	<5	-
PETN	µg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	-	<5	<5	<5	<5	<5	<5	<5	-
RDX	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-
Tetryl	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-

Chem Name	Units	EQL	ADWG 2011 Health (v3.6 updated 2021)	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95% DGV	ANZG (2018) - FW - 99% DGV	PFAS NEMP 2.0 2020 Health DW	6141121	6141125			GG03		SN01			SN02				SN04			SW01		SW02			SW03		
								22/9/20	5/8/20	22/9/20	12/10/20	21/9/20	12/10/20	4/8/20	22/9/20	12/10/20	5/8/20	22/9/20	12/10/20	4/11/20	21/9/20	12/10/20	4/11/20	3/8/20	21/9/20	5/8/20	22/9/20	12/10/20	22/9/20	13/10/20	4/11/20
Herbicides																															
Glyphosate	µg/L	10	1000		1200	370		-	-	-	<10	-	<10	-	-	<10	-	-	<10	-	-	<10	-	-	-	-	-	<10	-	<10	-
Metsulfuron Methyl	µg/L	5	40					-	-	-	<5	-	<5	-	-	<5	-	-	<5	-	-	<5	-	-	-	-	-	<5	-	<5	-
Surfactants																															
Anionic Surfactants as MBAS	µg/L	100						<100	-	<100	<100	<100	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	-	<100	-	<100	<100	<100	<100	-
SVOCs																															
Coronene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
PFAS - Perfluoroalkyl Carboxylic Acids																															
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	0.56				0.56	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
PFAS - Perfluoroalkyl Sulfonic Acids																															
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	<0.0003	0.0024	0.0053	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-
PFAS - Fluorotelomer Sulfonic Acids																															
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
PFAS - Sums																															
Sum of PFHxS and PFOS	µg/L	0.0003	0.07				0.07	<0.0003	0.0024	0.0053	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						<0.0003	0.0024	0.0053	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-

Chem Name	Units	EQL	ADWG 2011 Health (v3.6 updated 2021)	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95% DGV	ANZG (2018) - FW - 99% DGV	PFAS NEMP 2.0 2020 Health DW	SW04	SW05						SW06					SW07		SW08		TN01	TN14					TN34			WG42		WG54
								22/9/20	4/8/20	22/9/20	13/10/20	4/11/20	9/12/20	6/1/21	4/8/20	22/9/20	13/10/20	4/11/20	9/12/20	3/8/20	21/9/20	22/9/20	14/10/20	21/9/20	5/8/20	21/9/20	12/10/20	4/11/20	9/12/20	5/8/20	21/9/20	12/10/20	21/9/20	12/10/20	21/9/20
Inorganics																																		
pH (Lab)	pH units	0.01		6.5-8				6.46	6.45	6.68	6.61	6.75	6.96	6.6	6.28	6.44	6.54	6.68	6.79	6.75	6.67	6.82	6.91	6.98	5.99	6.65	6.31	6.65	6.47	6.92	6.96	7.01	6.53	6.65	6.59
Electrical conductivity (lab)	µS/cm	1						163	301	305	292	288	270	263	236	228	290	329	330	209	197	266	315	218	230	218	348	400	473	263	239	284	219	233	263
Turbidity	NTU	0.1						1.5	0.4	0.3	2.3	0.2	0.2	<0.1	0.3	0.2	0.4	0.2	1	3	0.8	0.7	1.9	0.6	0.6	0.5	1.4	1.7	1.5	0.2	0.9	0.4	0.2	0.2	0.2
Total Suspended Solids	mg/L	5						<5	<5	<5	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6
Salinity	mg/L	0.00001						0.00009	0.00016	0.00016	0.00016	0.00014	0.00013	0.00014	0.00013	0.00012	0.00015	0.00016	0.00016	0.00011	0.00011	0.00014	0.00017	0.00012	0.00012	0.00012	0.00019	0.0002	0.00024	0.00014	0.00013	0.00015	0.00012	0.00012	0.00014
Biological																																		
E.coli	orgs/100mL	1						31	<1	7	32	-	-	-	3	2	<1	-	-	<1	4	35	82	49	1	15	<1	-	-	14	12	2	7	8	1
Enterococci	orgs/100mL	1						15	<1	<1	1	-	-	-	5	1	20	-	-	<1	22	10	24	51	1	12	<1	-	-	<1	17	3	2	9	12
Acidity & Alkalinity																																		
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						5	6	7	7	7	8	8	4	4	7	7	6	7	7	7	10	9	3	7	6	7	3	7	8	8	5	6	9
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						5	6	7	7	7	8	8	4	4	7	7	6	7	7	7	10	9	3	7	6	7	3	7	8	8	5	6	9
Hardness as CaCO3 (Filtered)	mg/L	1						21	26	32	28	26	21	21	23	23	30	34	30	21	21	32	35	26	28	26	43	43	51	26	26	30	21	21	30
Major Ions																																		
Calcium (Filtered)	mg/L	1						2	2	3	3	2	2	2	1	1	2	2	2	2	2	3	4	2	3	2	4	4	4	2	2	2	2	2	2
Magnesium (Filtered)	mg/L	1						4	5	6	5	5	4	4	5	5	6	7	6	4	4	6	6	5	5	5	8	8	10	5	5	6	4	4	6
Potassium (Filtered)	mg/L	1						2	1	1	1	2	1	2	1	1	2	2	2	2	1	2	2	1	<1	1	1	2	2	1	2	2	1	1	2
Sodium (Filtered)	mg/L	1						24	49	50	45	52	42	41	38	36	44	56	54	32	32	42	46	34	34	35	49	64	68	39	38	42	35	35	42
Chloride	mg/L	1						38	95	84	90	87	75	72	71	58	88	105	94	50	45	70	87	54	59	55	102	115	136	72	60	83	60	71	70
Sulfate (Filtered)	mg/L	1	500					8	7	8	7	6	6	6	7	7	7	7	7	11	13	9	9	10	15	10	21	19	27	11	10	13	6	6	10
Cations Total	meq/L	0.01						1.52	2.67	2.84	2.54	2.82	2.28	2.26	2.14	2.05	2.56	3.16	2.99	1.87	1.85	2.52	2.74	2.02	2.04	2.06	3.01	3.69	4.03	2.23	2.22	2.47	1.98	1.98	2.47
Anions Total	meq/L	0.01						1.34	2.94	2.68	2.82	2.72	2.4	2.32	2.23	1.86	2.77	3.25	2.92	1.78	1.68	2.3	2.84	1.91	2.04	1.9	3.43	3.78	4.46	2.4	2.06	2.77	1.92	2.25	2.36
Ionic Balance	%	0.01						-	4.94	3.04	5.22	1.9	2.54	1.14	2.03	4.88	3.93	1.32	1.29	2.54	4.72	4.55	1.72	2.66	0.09	4.04	6.5	1.16	5.03	3.6	3.62	5.72	1.53	6.4	2.26
Nutrients																																		
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		0.02	0.01	0.02	0.01	-	-	-	<0.01	0.02	0.01	-	-	0.02	<0.01	0.03	<0.01	<0.01	0.02	<0.01	0.01	-	-	0.02	0.03	0.02	<0.01	0.04	<0.01
Nitrate (as N)	mg/L	0.01	11.29					0.01	0.02	0.02	0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	0.02	0.03	0.01	0.01	<0.01	<0.01
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				0.01	0.02	0.02	0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	0.02	0.03	0.01	0.01	<0.01	<0.01
Nitrogen (Total)	mg/L	0.1		0.45				0.1	0.1	<0.1	0.2	-	-	-	0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	0.2	0.1	0.1	<0.1	<0.1	-	-	0.1	<0.1	<0.1	<0.1	<0.1	0.2
Kjeldahl Nitrogen Total	mg/L	0.1						0.1	0.1	<0.1	0.2	-	-	-	0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	0.2	0.1	0.1	<0.1	<0.1	-	-	0.1	<0.1	<0.1	<0.1	<0.1	0.2
Reactive Phosphorus as P	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus (Total)	mg/L	0.01		0.02				<0.01	<0.01	<0.01	0.01	-	-	-	0.02	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	0.01	0.02	<0.01	0.01	-	-	0.03	<0.01	0.01	<0.01	<0.01	<0.01
Metals																																		
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	2					0.011	0.024	0.023	0.024	-	-	-	0.013	0.012	0.023	-	-	0.005	0.005	0.01	0.014	0.007	0.014	0.008	0.024	-	-	0.012	0.011	0.014	0.01	0.012	0.012
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Filtered)	mg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	0.006	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.004	0.005	0.006	0.004	-	-	-	0.003	0.002	0.011	-	-	0.003	0.002	0.017	0.074	0.002	0.035	0.004	0.063	-	-	0.002	0.003	0.009	0.002	0.004	0.008
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.002	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005			0.008	0.0024		<0.005	<0.005	<0.005	<0.005	-	-	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.006	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
BTEXN																																		
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	-	-	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	-	-	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	-	-	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	-	-	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	600					<2	<2	<2	<2	-	-	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
TRH - NEPM 2013																																		
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	-	-	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	-	-	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	-	-	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	-	-	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	<100	<100	-	-	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	-	-	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	<100	<100	-	-	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
TRH - NEPM 1999																																		
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	-	-	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	-	-	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
C15-C28 Fraction	µg/L	100						<100	<100	<100	<100	-	-	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
C29-C36 Fraction	µg/L	50						<50	<50	<50	<50	-	-	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
C10-C36 (Sum of Total)	µg/L	50						<50	<50	<50	<50	-	-	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50

Chem Name	Units	EQL	ADWG 2011 Health (v3.6 updated 2021)	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95% DGV	ANZG (2018) - FW - 99% DGV	PFAS NEMP 2.0 2020 Health DW	SW04	SW05						SW06					SW07		SW08		TN01	TN14					TN34			WG42		WG54
								22/9/20	4/8/20	22/9/20	13/10/20	4/11/20	9/12/20	6/1/21	4/8/20	22/9/20	13/10/20	4/11/20	9/12/20	3/8/20	21/9/20	22/9/20	14/10/20	21/9/20	5/8/20	21/9/20	12/10/20	4/11/20	9/12/20	5/8/20	21/9/20	12/10/20	21/9/20	12/10/20	21/9/20
PAHs - standard 16																																		
Acenaphthene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acenaphthylene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	0.007	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	µg/L	0.001			0.4	0.01		-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benz(a)anthracene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(a)pyrene	µg/L	0.001	0.01		0.2	0.1		-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo[b+j]fluoranthene	µg/L	0.004						-	<0.004	<0.004	<0.004	-	-	-	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(k)fluoranthene	µg/L	0.004						-	<0.004	<0.004	<0.004	-	-	-	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(g,h,i)perylene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chrysene	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenz(a,h)anthracene	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene	µg/L	0.001			1.4	1		-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluorene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	0.003	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Naphthalene	µg/L	0.004			16	2.5		<5	<0.004	<0.004	<0.004	-	-	-	<0.004	<0.004	<5 - 0.02	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Phenanthrene	µg/L	0.002			2	0.6		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	0.009	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sum of standard 16 PAHs	µg/L	0.001	0.01					-	-	<0.001	-	-	-	-	-	<0.001	-	-	-	-	<0.001	<0.001	-	<0.001	-	<0.001	-	-	-	-	<0.001	<0.001	-	<0.001	-	<0.001
PAHs (Sum of total) - Lab calc	µg/L	0.001	0.01					-	<0.001	-	<0.001	-	-	-	<0.001	-	0.039	-	-	<0.001	-	-	<0.001	-	<0.001	-	<0.001	-	-	<0.001	-	<0.001	-	<0.001	-
Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ) (half LOR) - Lab Calc	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ)(full LOR) - Lab Calc	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs - extended																																		
2-methylnaphthalene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3-methylcholanthrene	µg/L	0.004						-	<0.004	<0.004	<0.004	-	-	-	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
7,12-dimethylbenz(a)anthracene	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(e)pyrene	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perylene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(b+j+k)fluoranthene	µg/L	0.004						-	<0.004	<0.004	<0.004	-	-	-	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
OC Pesticides																																		
4,4'-DDE	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
a-BHC	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Aldrin	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin + Dieldrin	µg/L	0.002	0.3					-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
b-BHC	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlordane	µg/L	0.001	2		0.08	0.03		-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (cis)	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (trans)	µg/L	0.001						-	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
d-BHC	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDD	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDT	µg/L	0.002	9		0.01	0.006		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
DDT+DDE+DDD - Lab Calc	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dieldrin	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan	µg/L	0.002	20		0.2	0.03		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan I (alpha)	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan II (beta)	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan Sulfate	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin	µg/L	0.002			0.02	0.01		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin aldehyde	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin ketone	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
g-BHC (Lindane)	µg/L	0.002	10		0.2	0.07		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor	µg/L	0.002	0.3		0.09	0.01		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor epoxide	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobenzene	µg/L	0.002			0.1	0.05		-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methoxychlor	µg/L	0.002	300					-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Oxychlordane	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Explosives																																		
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
1,3-Dinitrobenzene	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
2,6-dinitrotoluene	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
2-Amino-4,6-DNT	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
2-Nitrotoluene	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
4-Amino,2,6-DNT	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
4-Nitrotoluene	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
HMX	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
m-Nitrotoluene	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Nitrobenzene	µg/L	1			550	230		<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Nitroglycerine	µg/L	5						<5	<5	<5	<5	-	-	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
PETN	µg/L	5						<5	<5	<5	<5	-	-	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
RDX	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Tetryl	µg/L	1						<1	<1	<1	<1	-	-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1

Chem Name	Units	EQL	ADWG 2011 Health (v3.6 updated 2021)	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95% DGV	ANZG (2018) - FW - 99% DGV	PFAS NEMP 2.0 2020 Health DW	SW04	SW05						SW06					SW07		SW08		TN01	TN14					TN34			WG42		WG54
								22/9/20	4/8/20	22/9/20	13/10/20	4/11/20	9/12/20	6/1/21	4/8/20	22/9/20	13/10/20	4/11/20	9/12/20	3/8/20	21/9/20	22/9/20	14/10/20	21/9/20	5/8/20	21/9/20	12/10/20	4/11/20	9/12/20	5/8/20	21/9/20	12/10/20	21/9/20	12/10/20	21/9/20
Herbicides																																		
Glyphosate	µg/L	10	1000		1200	370		-	-	-	<10	-	-	-	-	-	<10	-	-	-	-	-	<10	-	-	<10	-	-	-	-	<10	-	<10	-
Metsulfuron Methyl	µg/L	5	40					-	-	-	<5	-	-	-	-	-	<5	-	-	-	-	-	<5	-	-	<5	-	-	-	-	<5	-	<5	-
Surfactants																																		
Anionic Surfactants as MBAS	µg/L	100						<100	-	<100	<100	-	-	-	-	<100	<100	-	-	-	<100	<100	<100	<100	-	<100	<100	-	-	-	<100	<100	<100	<100
SVOCs																																		
Coronene	µg/L	0.002						-	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PFAS - Perfluoroalkyl Carboxylic Acids																																		
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	-	-	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	0.56				0.56	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
PFAS - Perfluoroalkyl Sulfonic Acids																																		
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	0.0051	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	<0.0003	<0.0003	<0.0003	<0.0003	-	-	-	<0.0003	<0.0003	<0.0003	-	-	<0.0003	<0.0003	0.0046	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	-	0.0004	<0.0003	<0.0003	0.0004	<0.0003	<0.0003
PFAS - Fluorotelomer Sulfonic Acids																																		
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PFAS - Sums																																		
Sum of PFHxS and PFOS	µg/L	0.0003	0.07				0.07	<0.0003	<0.0003	<0.0003	<0.0003	-	-	-	<0.0003	<0.0003	<0.0003	-	-	<0.0003	<0.0003	0.0097	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	-	0.0004	<0.0003	<0.0003	0.0004	<0.0003	<0.0003
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						<0.0003	<0.0003	<0.0003	<0.0003	-	-	-	<0.0003	<0.0003	<0.0003	-	-	<0.0003	<0.0003	0.0178	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	-	0.0004	<0.0003	<0.0003	0.0004	<0.0003	<0.0003

			ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	BH01		BH02		BH03		BH04		BH05		BH06		BH07		BH08	
								20/10/20	18/2/21	20/10/20	18/2/21	20/10/20	18/2/21	20/10/20	18/2/21	19/10/20	18/2/21	20/10/20	18/2/21	19/10/20	17/2/21	21/10/20	17/2/21
Inorganics																							
pH (Lab)	pH units	0.01		6.5-8				7.14	6.97	6.47	6.57	6.58	6.69	10.4	7.58	6.52	6.63	7.18	6.25	6.55	6.74	6.36	6.51
Electrical conductivity (lab)	µS/cm	1						657	645	468	442	1550	1710	603	896	2470	2500	780	1330	666	694	424	450
Turbidity	NTU	0.1						25.5	-	238	-	9.4	-	10.1	-	7800	-	8.8	-	98.6	-	-	-
Total Suspended Solids	mg/L	5						53	-	228	-	6	-	26	-	-	-	13	-	-	-	-	-
Salinity	mg/L	0.00001						0.00036	0.00035	0.00026	0.00024	0.00087	0.00097	0.00033	0.00049	0.00143	0.00144	0.00043	0.00074	0.00036	0.00038	0.00023	0.00024
Acidity & Alkalinity																							
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	38	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						138	132	43	33	92	73	<1	162	82	61	56	37	70	60	16	12
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	11	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						138	132	43	33	92	73	49	162	82	61	56	37	70	60	16	12
Hardness as CaCO3 (Filtered)	mg/L	1						126	113	36	26	267	257	49	223	494	481	190	269	64	46	46	37
Major Ions																							
Calcium (Filtered)	mg/L	1						34	27	6	4	54	50	13	58	102	97	30	32	11	7	7	5
Magnesium (Filtered)	mg/L	1						10	11	5	4	32	32	4	19	58	58	28	46	9	7	7	6
Potassium (Filtered)	mg/L	1						6	4	2	1	7	6	7	4	8	7	10	13	2	2	2	2
Sodium (Filtered)	mg/L	1						91	85	82	81	221	240	96	100	300	314	99	147	116	119	68	71
Chloride	mg/L	1						125	120	114	104	454	489	144	205	735	742	228	434	106	95	123	115
Sulfate (Filtered)	mg/L	1	500					17	12	26	26	50	52	27	21	55	53	8	11	106	116	25	24
Cations Total	meq/L	0.01						6.63	6.05	4.33	4.08	15.1	15.7	5.33	8.91	23.1	23.4	8.36	12.1	6.39	6.15	3.93	3.88
Anions Total	meq/L	0.01						6.64	6.27	4.62	4.13	15.7	16.3	5.6	9.46	23.5	23.2	7.72	13.2	6.6	6.29	4.31	3.98
Ionic Balance	%	0.01						0.04	1.78	3.21	0.69	1.84	1.91	2.47	2.98	0.86	0.42	4.02	4.35	1.61	1.13	4.55	1.28
Nutrients																							
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		<0.01	0.02	0.03	0.01	<0.01	<0.01	0.02	0.03	<0.01	<0.01	<0.01	0.02	<0.01	0.02	0.01	0.01
Nitrate (as N)	mg/L	0.01	11.29					0.06	<0.01	0.01	<0.01	0.25	0.02	0.57	0.12	<0.01	<0.01	0.14	0.04	0.14	0.05	0.05	0.06
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.26	0.02	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				0.06	<0.01	0.01	<0.01	0.27	0.02	0.83	0.14	<0.01	<0.01	0.14	0.04	0.16	0.05	0.05	0.06
Nitrogen (Total)	mg/L	0.1		0.45				<0.1	<0.1	0.1	<0.1	0.3	<0.1	1	0.2	0.9	1.6	0.2	0.1	0.2	<0.1	<0.1	<0.1
Kjeldahl Nitrogen Total	mg/L	0.1						<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	0.1	0.9	1.6	0.1	0.1	<0.1	<0.1	<0.1	<0.1
Reactive Phosphorus as P	mg/L	0.01						0.02	<0.01	0.02	0.03	0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus (Total)	mg/L	0.01		0.02				0.04	0.01	1.07	0.03	0.02	0.01	0.06	0.03	3.89	9.18	<0.01	<0.01	0.14	0.04	<0.01	0.01
Metals																							
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	2					0.102	0.155	0.042	0.032	0.133	0.128	0.05	0.132	0.224	0.375	0.182	0.413	0.033	0.034	0.058	0.065
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.09	<0.05	<0.05
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Filtered)	mg/L	0.001						0.002	0.005	0.005	0.003	0.002	0.003	<0.001	0.001	0.01	0.015	0.002	0.004	0.001	0.001	<0.001	<0.001
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.14	0.696	0.252	0.157	0.216	0.203	<0.001	0.166	1.02	2.52	0.087	0.148	0.069	0.081	0.023	0.022
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		<0.001	0.001	0.001	<0.001	0.002	0.002	<0.001	<0.001	0.008	0.008	0.003	0.009	<0.001	<0.001	<0.001	<0.001
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005			0.008	0.0024		<0.005	0.008	<0.005	<0.005	<0.005	0.009	<0.005	0.005	0.021	0.021	0.01	0.04	<0.005	<0.005	<0.005	<0.005
BTEXN																							
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	600					<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TRH - NEPM 2013																							
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	170	<100	<100	<100	<100	<100	1760	2420	<100	<100	<100	<100	<100	<100
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	110	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	170	<100	<100	<100	<100	<100	1760	2530	<100	<100	<100	<100	<100	<100
TRH - NEPM 1999																							
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15-C28 Fraction	µg/L	100						<100	<100	110	<100	<100	<100	<100	<100	1460	1980	<100	<100	<100	<100	<100	<100
C29-C36 Fraction	µg/L	50						<50	<50	60	<50	<50	<50	<50	<50	380	470	<50	<50	<50	<50	<50	<50
C10-C36 (Sum of Total)	µg/L	50						<50	<50	170	<50	<50	<50	<50	<50	1840	2450	<50	<50	<50	<50	<50	<50

			ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	BH01		BH02		BH03		BH04		BH05		BH06		BH07		BH08	
								20/10/20	18/2/21	20/10/20	18/2/21	20/10/20	18/2/21	20/10/20	18/2/21	19/10/20	18/2/21	20/10/20	18/2/21	19/10/20	17/2/21	21/10/20	17/2/21
PAHs - standard 16																							
Acenaphthene	µg/L	0.002						0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acenaphthylene	µg/L	0.002						0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	µg/L	0.001			0.4	0.01		0.001	<0.001	<0.001	0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benz(a)anthracene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(a)pyrene	µg/L	0.001	**0.01**		0.2	0.1		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo[b+j]fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(g,h,i)perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chrysene	µg/L	0.001						0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenz(a,h)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene	µg/L	0.001			1.4	1		0.003	0.001	0.002	<0.001	0.003	<0.001	0.006	0.002	0.004	0.003	<0.001	<0.001	0.002	<0.001	0.001	<0.001
Fluorene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Naphthalene	µg/L	0.004			16	2.5		<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<5 - 0.005	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Phenanthrene	µg/L	0.002			2	0.6		0.009	0.004	0.004	<0.002	<0.002	<0.002	0.009	<0.002	0.003	0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	µg/L	0.001						0.005	0.002	0.003	<0.001	0.005	<0.001	0.005	0.002	0.004	0.003	<0.001	<0.001	0.002	<0.001	0.002	<0.001
PAHs (Sum of total) - Lab calc	µg/L	0.001	**0.01**					**0.025**	0.007	0.009	0.001	0.008	0.001	**0.033**	0.004	**0.011**	0.008	0.003	<0.001	0.004	<0.001	0.003	<0.001
Total 8 PAHs (as BaP TEQ)- Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs - extended																							
2-methylnaphthalene	µg/L	0.002						0.019	0.004	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3-methylcholanthrene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
7,12-dimethylbenz(a)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(e)pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(b+j+k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Explosives																							
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-Dinitrobenzene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,6-dinitrotoluene	µg/L	1						<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2
2-Amino-4,6-DNT	µg/L	1						<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2
2-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-Amino,2,6-DNT	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
HMX	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
m-Nitrotoluene	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nitrobenzene	µg/L	1			550	230		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nitroglycerine	µg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
PETN	µg/L	5						<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
RDX	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetryl	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SVOCs																							
Coronene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PFAS - Perfluoroalkyl Carboxylic Acids																							
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	**0.56**				0.56	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
PFAS - Perfluoroalkyl Sulfonic Acids																							
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
PFAS - Fluorotelomer Sulfonic Acids																							
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PFAS - Sums																							
Sum of PFHxS and PFOS	µg/L	0.0003	**0.07**				0.07	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003

			ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	BH09		BH10	BH11		BH12		BH13		BH14		BH16		BH17		J4904-4.25	K4916-2A	
								21/10/20	17/2/21	21/10/20	22/10/20	17/2/21	21/10/20	17/2/21	21/10/20	17/2/21	22/10/20	17/2/21	23/10/20	19/2/21	23/10/20	19/2/21	22/10/20	22/10/20	18/2/21
Inorganics																								
pH (Lab)	pH units	0.01		6.5-8				7.03	7.11	7.31	6.36	6.88	6.61	6.72	6.71	6.78	6.12	6.97	8.4	6.99	7.43	6.72	5.64	6.02	5.73
Electrical conductivity (lab)	µS/cm	1						512	510	1100	683	732	2830	2690	630	630	715	768	691	933	559	739	167	2980	3040
Turbidity	NTU	0.1						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	mg/L	5						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	mg/L	0.00001						0.00028	0.00028	0.00061	0.00037	0.0004	0.00165	0.00156	0.00034	0.00034	0.00039	0.00042	0.00038	0.00051	0.0003	0.0004	0.00009	0.00174	0.00178
Acidity & Alkalinity																								
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						61	51	222	54	45	75	62	80	69	46	42	57	109	60	63	4	69	30
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						61	51	222	54	45	75	62	80	69	46	42	59	109	60	63	4	69	30
Hardness as CaCO3 (Filtered)	mg/L	1						64	52	246	93	84	314	270	84	56	83	77	66	173	114	119	15	293	316
Major Ions																								
Calcium (Filtered)	mg/L	1						14	11	59	16	14	53	42	17	11	12	11	15	43	29	28	1	25	26
Magnesium (Filtered)	mg/L	1						7	6	24	13	12	44	40	10	7	13	12	7	16	10	12	3	56	61
Potassium (Filtered)	mg/L	1						2	2	15	4	3	19	15	5	4	3	3	8	5	6	4	<1	10	6
Sodium (Filtered)	mg/L	1						81	80	142	95	103	467	438	101	97	108	117	101	121	71	101	26	464	499
Chloride	mg/L	1						116	100	188	184	194	813	700	152	138	198	205	170	226	123	194	40	853	887
Sulfate (Filtered)	mg/L	1	500					41	38	71	29	26	248	207	26	24	29	26	26	31	35	28	12	58	119
Cations Total	meq/L	0.01						4.85	4.57	11.5	6.1	6.24	27.1	24.8	6.19	5.45	6.44	6.7	5.92	8.85	5.51	6.88	1.43	26.3	28.2
Anions Total	meq/L	0.01						5.34	4.63	11.2	6.87	6.91	29.6	25.3	6.43	5.77	7.11	7.16	6.52	9.2	5.4	7.31	1.46	26.6	28.1
Ionic Balance	%	0.01						4.86	0.62	1.16	5.94	5.09	4.46	0.94	1.86	2.89	4.91	3.32	4.77	1.91	1.05	3.06	1.05	0.67	0.14
Nutrients																								
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		<0.01	0.02	0.12	0.06	0.01	0.01	0.09	<0.01	0.02	0.02	<0.01	0.07	0.01	0.14	<0.01	<0.01	0.1	0.03
Nitrate (as N)	mg/L	0.01	11.29					0.09	0.02	9.59	0.5	0.09	1.48	0.15	0.94	0.11	0.17	0.02	1.92	0.06	1.53	0.07	0.03	0.03	<0.01
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	0.36	0.03	<0.01	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.02	0.01	0.03	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				0.09	0.02	9.95	0.53	0.09	1.5	0.15	0.96	0.11	0.17	0.02	1.94	0.07	1.56	0.07	0.03	0.03	<0.01
Nitrogen (Total)	mg/L	0.1		0.45				<0.1	<0.1	11.8	1	<0.1	2.5	1	1.3	0.1	0.3	<0.1	2.6	<0.1	2.5	0.3	0.8	6.3	0.5
Kjeldahl Nitrogen Total	mg/L	0.1						<0.1	<0.1	1.8	0.5	<0.1	1	0.9	0.3	<0.1	0.1	<0.1	0.7	<0.1	0.9	0.2	0.8	6.3	0.5
Reactive Phosphorus as P	mg/L	0.01						0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01	0.04	0.05	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.05	<0.01
Phosphorus (Total)	mg/L	0.01		0.02				0.01	0.01	0.24	0.45	0.83	1.66	0.92	0.04	0.05	0.01	0.02	0.07	0.02	8.96	1.33	0.17	1.35	0.11
Metals																								
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	2					0.018	0.024	0.104	0.065	0.085	0.204	0.144	0.081	0.1	0.09	0.106	0.036	0.107	0.043	0.09	0.021	0.132	0.158
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	<0.05	0.09	<0.05	0.06	0.05	0.08	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.004	0.006	0.002	<0.001	<0.001	<0.001
Cobalt (Filtered)	mg/L	0.001						0.002	0.002	<0.001	0.003	0.003	0.006	0.003	<0.001	<0.001	0.004	0.001	<0.001	0.009	<0.001	<0.001	<0.001	0.006	0.006
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		<0.001	<0.001	0.002	<0.001	<0.001	0.003	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.004	0.004	0.001
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	<0.001
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.144	0.156	0.19	0.173	0.204	0.75	0.785	0.157	0.152	0.124	0.026	0.003	0.665	0.022	0.073	0.009	0.128	0.119
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		0.001	<0.001	0.002	0.001	<0.001	0.01	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.004	0.007
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005			0.008	0.0024		<0.005	<0.005	0.01	<0.005	0.009	0.02	0.234	0.008	0.006	<0.005	0.007	<0.005	0.01	<0.005	<0.005	<0.005	0.064	0.03
BTEXN																								
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	600					<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TRH - NEPM 2013																								
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	160	<100	<100	610	320	<100	<100	<100	<100	<100	<100	<100	<100	<100	170	<100
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	160	<100	<100	610	320	<100	<100	<100	<100	<100	<100	<100	<100	<100	170	<100
TRH - NEPM 1999																								
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15-C28 Fraction	µg/L	100						<100	<100	120	<100	<100	450	250	<100	<100	<100	<100	<100	<100	<100	<100	<100	130	<100
C29-C36 Fraction	µg/L	50						<50	<50	<50	<50	<50	170	70	<50	<50	<50	<50	<50	<50	<50	<50	<50	80	<50
C10-C36 (Sum of Total)	µg/L	50						<50	<50	120	<50	<50	620	320	<50	<50	<50	<50	<50	<50	<50	<50	<50	210	<50

			ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	BH09		BH10	BH11		BH12		BH13		BH14		BH16		BH17		J4904-4.25	K4916-2A	
								21/10/20	17/2/21	21/10/20	22/10/20	17/2/21	21/10/20	17/2/21	21/10/20	17/2/21	22/10/20	17/2/21	23/10/20	19/2/21	23/10/20	19/2/21	22/10/20	22/10/20	18/2/21
PAHs - standard 16																								
Acenaphthene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
Acenaphthylene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	µg/L	0.001			0.4	0.01		<0.001	<0.001	-	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benz(a)anthracene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(a)pyrene	µg/L	0.001	**0.01**		0.2	0.1		<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo[b+j]fluoranthene	µg/L	0.004						<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(k)fluoranthene	µg/L	0.004						<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(g,h,i)perylene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chrysene	µg/L	0.001						0.001	<0.001	-	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenz(a,h)anthracene	µg/L	0.001						<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene	µg/L	0.001			1.4	1		0.002	<0.001	-	0.004	<0.001	0.003	0.002	0.002	<0.001	0.002	<0.001	0.003	<0.001	0.005	<0.001	0.002	<0.001	0.002
Fluorene	µg/L	0.002						<0.002	<0.002	-	0.003	0.003	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	0.003	<0.002	0.002	<0.002	0.002
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Naphthalene	µg/L	0.004			16	2.5		<0.004	<0.004	<5	<0.004	<5 - 0.006	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<5 - 0.007
Phenanthrene	µg/L	0.002			2	0.6		<0.002	<0.002	-	0.013	0.004	0.012	0.003	0.002	<0.002	0.004	<0.002	0.008	<0.002	<0.002	<0.002	0.007	<0.002	0.008
Pyrene	µg/L	0.001						0.002	<0.001	-	0.002	<0.001	0.003	0.002	0.002	<0.001	0.002	<0.001	0.002	<0.001	0.004	0.002	0.005	<0.001	0.003
PAHs (Sum of total) - Lab calc	µg/L	0.001	**0.01**					0.005	<0.001	-	**0.022**	**0.013**	**0.023**	0.007	0.007	<0.001	0.008	<0.001	**0.015**	<0.001	**0.012**	0.002	**0.018**	<0.001	**0.022**
Total 8 PAHs (as BaP TEQ)- Lab Calc	µg/L	0.001						<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs - extended																									
2-methylnaphthalene	µg/L	0.002						<0.002	<0.002	-	0.003	0.008	0.002	<0.002	0.002	<0.002	<0.002	<0.002	0.003	0.003	<0.002	0.003	<0.002	<0.002	0.012
3-methylcholanthrene	µg/L	0.004						<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
7,12-dimethylbenz(a)anthracene	µg/L	0.001						<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(e)pyrene	µg/L	0.001						<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perylene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(b+j+k)fluoranthene	µg/L	0.004						<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Explosives																									
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-Dinitrobenzene	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,6-dinitrotoluene	µg/L	1						<1	<2	-	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<1	<2
2-Amino-4,6-DNT	µg/L	1						<1	<2	-	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<2	<1	<1	<2
2-Nitrotoluene	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-Amino,2,6-DNT	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-Nitrotoluene	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
HMX	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
m-Nitrotoluene	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nitrobenzene	µg/L	1			550	230		<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nitroglycerine	µg/L	5						<5	<5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
PETN	µg/L	5						<5	<5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
RDX	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetryl	µg/L	1						<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SVOCs																									
Coronene	µg/L	0.002						<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PFAS - Perfluoroalkyl Carboxylic Acids																									
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	<0.002	0.109	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	0.0034	<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	0.0019	<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	**0.56**				0.56	<0.0005	<0.0005	0.0021	<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
PFAS - Perfluoroalkyl Sulfonic Acids																									
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	0.0018	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0016	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	0.0004	<0.0003	0.0046	<0.0003	<0.0003	0.0021	0.0004	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.001	<0.0003
PFAS - Fluorotelomer Sulfonic Acids																									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	0.04	<0.001	<0.001	0.076	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PFAS - Sums																									
Sum of PFHxS and PFOS	µg/L	0.0003	**0.07**				0.07	0.0004	<0.0003	0.0046	<0.0003	<0.0003	0.0021	0.0004	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.001	<0.0003
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						0.0004	<0.0003	0.161	<0.0003	<0.0003	0.0799	0.0004	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.004	<0.0003	<0.0003	0.001	<0.0003

Chem Name	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	6141005		6141333			6141349				6141352	BF20		DV04	HSW01				HSW02		HSW04		HSW05		SD31
								13/8/20	28/9/20	13/8/20	28/9/20	3/11/20	17/8/20	28/9/20	19/10/20	21/10/20	17/8/20	17/8/20	28/9/20	28/9/20	17/8/20	28/9/20	19/10/20	3/11/20	14/8/20	28/9/20	17/8/20	28/9/20	13/8/20	28/9/20	28/9/20
Inorganics																														
pH (Lab)	pH units	0.01		6.5-8				6.84	7.14	6.81	6.86	6.75	6.85	7.28	7.14	-	6.95	6.54	6.5	6.63	6.84	6.89	7.01	7.19	6.9	6.72	6.95	6.83	6.74	6.98	6.79
Electrical conductivity (lab)	µS/cm	1						117	186	170	190	299	123	187	201	-	136	109	176	368	115	204	232	244	271	295	133	194	156	183	306
Turbidity	NTU	0.1						3.6	4.2	2.7	1.7	7.1	2.6	19.3	22.9	-	1	1.1	1.2	1	2	2.1	2.7	2.6	0.4	0.2	0.4	0.4	6.1	5.3	0.6
Total Suspended Solids	mg/L	5						<5	<5	<5	<5	<5	<5	21	25	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Salinity	mg/L	0.00001						0.00004	0.0001	0.00007	0.0001	0.00014	0.00005	0.0001	0.00011	-	0.00005	0.00004	0.00009	0.0002	0.00004	0.00011	0.00012	0.00011	0.00013	0.00016	0.00005	0.0001	0.00007	0.0001	0.00016
Biological																														
E.coli	orgs/100mL	1						21	12	2	3	-	69	200	31	-	10	14	14	1	170	12	13	-	<1	1	9	<1	7	15	<1
Enterococci	orgs/100mL	1						40	21	5	13	-	39	3	17	-	27	91	15	14	62	24	22	-	2	3	12	8	9	31	25
Acidity & Alkalinity																														
Alkalinity (Carbonate as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1						8	15	7	9	10	8	13	17	-	8	7	8	10	10	11	10	13	14	15	7	12	6	12	17
Alkalinity (Hydroxide as CaCO3)	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1						8	15	7	9	10	8	13	17	-	8	7	8	10	10	11	10	13	14	15	7	12	6	12	17
Hardness as CaCO3 (Filtered)	mg/L	1						13	24	17	21	32	13	24	24	-	17	13	17	41	13	24	24	26	28	26	13	21	17	21	36
Major Ions																														
Calcium (Filtered)	mg/L	1						2	3	2	2	3	2	3	3	-	2	2	2	5	2	3	3	2	3	2	2	2	2	3
Magnesium (Filtered)	mg/L	1						2	4	3	4	6	2	4	4	-	3	2	3	7	2	4	4	5	5	5	2	4	3	4	7
Potassium (Filtered)	mg/L	1						2	2	2	1	3	2	2	3	-	2	3	<1	2	2	2	2	4	3	3	2	1	2	2	2
Sodium (Filtered)	mg/L	1						19	27	27	30	54	20	28	31	-	21	17	26	56	19	31	37	39	44	46	21	29	25	28	44
Chloride	mg/L	1						25	44	39	45	80	28	44	46	-	28	23	40	80	24	50	62	68	72	71	29	43	36	42	68
Sulfate (Filtered)	mg/L	1	500					5	3	9	12	13	5	3	<1	-	11	<1	9	39	6	6	3	3	13	14	10	13	8	9	22
Cations Total	meq/L	0.01						1.14	1.7	1.57	1.76	3.07	1.18	1.75	1.9	-	1.31	1.08	1.48	3.31	1.14	1.88	2.14	2.31	2.55	2.59	1.23	1.72	1.48	1.7	2.69
Anions Total	meq/L	0.01						0.97	1.6	1.43	1.7	2.73	1.05	1.56	1.64	-	1.18	0.79	1.48	3.27	1	1.76	2.01	2.24	2.58	2.59	1.17	1.72	1.3	1.61	2.72
Ionic Balance	%	0.01						-	3.06	-	1.75	5.9	-	5.57	-	-	-	-	0.07	0.67	-	3.39	3.09	1.53	0.58	0.1	-	0.21	-	2.6	0.46
Nutrients																														
Ammonia as N	mg/L	0.01		0.06	0.9	0.32		<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	11.29					<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (as N)	mg/L	0.01	0.91					<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.2				<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Total)	mg/L	0.1		0.45				0.4	0.6	0.2	0.4	-	0.3	0.7	0.7	-	0.1	0.4	0.2	0.2	0.3	0.4	0.6	-	0.2	0.2	0.1	0.1	0.5	1.2	0.1
Kjeldahl Nitrogen Total	mg/L	0.1						0.4	0.6	0.2	0.4	-	0.3	0.7	0.7	-	0.1	0.4	0.2	0.2	0.3	0.4	0.6	-	0.2	0.2	0.1	0.1	0.5	1.2	0.1
Reactive Phosphorus as P	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus (Total)	mg/L	0.01		0.02				0.01	0.02	0.02	0.02	-	0.01	0.02	0.05	-	0.01	0.01	<0.01	3.4	0.01	0.68	0.02	-	0.02	0.01	<0.01	<0.01	<0.01	0.02	0.01
Metals																														
Arsenic (Filtered)	mg/L	0.001	0.01		0.013	0.0008		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	2					0.002	0.004	0.009	0.014	-	0.002	0.005	0.084	-	0.002	0.001	0.004	0.044	0.001	0.004	0.002	-	0.014	0.018	0.002	0.005	0.007	0.012	0.025
Beryllium (Filtered)	mg/L	0.001	0.06					<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (Filtered)	mg/L	0.05	4		0.37	0.09		<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium (Filtered)	mg/L	0.0001	0.002		0.0002	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001			0.001	0.00001		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Filtered)	mg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Copper (Filtered)	mg/L	0.001	2		0.0014	0.001		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Filtered)	mg/L	0.001	0.01		0.0034	0.001		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese (Filtered)	mg/L	0.001	0.5		1.9	1.2		0.006	0.023	0.003	0.007	-	0.007	0.033	0.024	-	0.004	0.034	0.016	0.007	0.015	0.018	0.011	-	0.014	0.017	0.002	0.032	0.004	0.013	0.022
Mercury (Filtered)	mg/L	0.0001	0.001		0.0006	0.00006		<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (Filtered)	mg/L	0.001	0.02		0.011	0.008		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium (Filtered)	mg/L	0.01	0.01		0.011	0.005		<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (Filtered)	mg/L	0.01						<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005		0.008		0.0024		<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	0.023	-	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
BTEXN																														
Benzene	µg/L	1	1		950	600		<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	800		180	110		<2	<2	<2	<2	-	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	300		80	50		<2	<2	<2	<2	-	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2			350	200		<2	<2	<2	<2	-	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2						<2	<2	<2	<2	-	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	600					<2	<2	<2	<2	-	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
TRH - NEPM 2013																														
F1 (C6-C10 minus BTEX)	µg/L	20						<20	<20	<20	<20	-	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	20						<20	<20	<20	<20	-	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	100						<100	<100	<100	<100	-	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100
>C10-C16 Fraction	µg/L	100						<100	<100	<100	<100	-	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100
F3 (>C16-C34 Fraction)	µg/L	100						<100	<100	<100	<100	-	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100
F4 (>C34-C40 Fraction)	µg/L	100						<100	<100	<100	<100	-	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	100						<100	<100	<100	<100	-	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100
TRH - NEPM 1999																														
C6-C9 Fraction	µg/L	20						<20	<20	<20	<20	-	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20
C10-C14 Fraction	µg/L	50						<50	<50	<50	<50	-	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50
C15-C28 Fraction	µg/L	100						<100	<100	<100	<100	-	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100
C29-C36 Fraction	µg/L	50						<50	<50	<50	<50	-	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50
C10-C36 (Sum of Total)	µg/L	50						<50	<50	<50	<50	-	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50

Chem Name	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	6141005		6141333			6141349				6141352	BF20		DV04	HSW01				HSW02		HSW04		HSW05		SD31
								13/8/20	28/9/20	13/8/20	28/9/20	3/11/20	17/8/20	28/9/20	19/10/20	21/10/20	17/8/20	17/8/20	28/9/20	28/9/20	17/8/20	28/9/20	19/10/20	3/11/20	14/8/20	28/9/20	17/8/20	28/9/20	13/8/20	28/9/20	28/9/20
PAHs - standard 16																														
Acenaphthene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acenaphthylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	µg/L	0.001			0.4	0.01		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benz(a)anthracene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(a)pyrene	µg/L	0.001	0.01		0.2	0.1		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo[b+j]fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(g,h,i)perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chrysene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenz(a,h)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene	µg/L	0.001			1.4	1		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluorene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-c,d)pyrene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Naphthalene	µg/L	0.004			16	2.5		<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Phenanthrene	µg/L	0.002			2	0.6		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs (Sum of total) - Lab calc	µg/L	0.001	0.01					<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ) (half LOR) - Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total 8 PAHs (as BaP TEQ)(full LOR) - Lab Calc	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAHs - extended																														
2-methylnaphthalene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3-methylcholanthrene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
7,12-dimethylbenz(a)anthracene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(e)pyrene	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perylene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzo(b+j+k)fluoranthene	µg/L	0.004						<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
OC Pesticides																														
4,4'-DDE	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
a-BHC	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Aldrin	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin + Dieldrin	µg/L	0.002	0.3					<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
b-BHC	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlordane	µg/L	0.001	2		0.08	0.03		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (cis)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (trans)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
d-BHC	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDD	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDT	µg/L	0.002	9		0.01	0.006		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
DDT+DDE+DDD - Lab Calc	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dieldrin	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan	µg/L	0.002	20		0.2	0.03		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan I (alpha)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan II (beta)	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan Sulfate	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin	µg/L	0.002			0.02	0.01		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin aldehyde	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin ketone	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
g-BHC (Lindane)	µg/L	0.002	10		0.2	0.07		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor	µg/L	0.002	0.3		0.09	0.01		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor epoxide	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobenzene	µg/L	0.002			0.1	0.05		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methoxychlor	µg/L	0.002	300					<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Oxychlordane	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Explosives																														
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
1,3,5-Trinitrobenzene	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
1,3-Dinitrobenzene	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
2,4,6-Trinitrotoluene	µg/L	1			140	100		<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
2,4-Dinitrotoluene	µg/L	1			65	16		<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
2,6-dinitrotoluene	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
2-Amino-4,6-DNT	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
2-Nitrotoluene	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
4-Amino,2,6-DNT	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
4-Nitrotoluene	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
HMX	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
m-Nitrotoluene	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Nitrobenzene	µg/L	1			550	230		<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Nitroglycerine	µg/L	5						<5	<5	<5	<5	-	<5	<5	<5	-	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	<5	<5	<5	<5	<5
PETN	µg/L	5						<5	<5	<5	<5	-	<5	<5	<5	-	<5	<5	<5	<5	<5	<5	<5	-	<5	<5	<5	<5	<5	<5	<5
RDX	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Tetryl	µg/L	1						<1	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Herbicides																														
Glyphosate	µg/L	10	1000		1200	370		-	<10	-	<10	-	-	<10	-	<10	-	-	<10	<10	-	<10	<10	-	-	<10	-	<10	-	<10	<10
Metsulfuron Methyl	µg/L	5	40					-	<5	-	<5	-	-	<5	-	<5	-	-	<5	<5	-	<5	<5	-	-	<5	-	<5	-	<5	<5
Surfactants																														
Anionic Surfactants as MBAS	µg/L	100						<100	<100	<100	<100	-	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100

Chem Name	Units	EQL	ADWG 2011 Health	ANZECC 2000 SW Upland River	ANZG (2018) - FW - 95%	ANZG (2018) - FW - 99%	PFAS NEMP 2.0 2020 Health DW	6141005		6141333			6141349				6141352	BF20		DV04	HSW01				HSW02		HSW04		HSW05		SD31
								13/8/20	28/9/20	13/8/20	28/9/20	3/11/20	17/8/20	28/9/20	19/10/20	21/10/20	17/8/20	17/8/20	28/9/20	28/9/20	17/8/20	28/9/20	19/10/20	3/11/20	14/8/20	28/9/20	17/8/20	28/9/20	13/8/20	28/9/20	28/9/20
SVOCs																														
Coronene	µg/L	0.002						<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PFAS - Perfluoroalkyl Carboxylic Acids																														
Perfluorobutanoic acid (PFBA)	µg/L	0.002						<0.002	0.002	<0.002	<0.002	-	<0.002	0.003	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0016
Perfluorohexanoic acid (PFHxA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	0.0005	0.56				0.56	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
PFAS - Perfluoroalkyl Sulfonic Acids																														
Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005						<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005					0.07	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0003					0.07	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	0.0004	<0.0003	0.0006	<0.0003	<0.0003	<0.0003
PFAS - Fluorotelomer Sulfonic Acids																														
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.001						<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PFAS - Sums																														
Sum of PFHxS and PFOS	µg/L	0.0003	0.07				0.07	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	0.0004	<0.0003	0.0006	<0.0003	<0.0003	<0.0003
PFAS (Sum of Total)(WA DER List)	µg/L	0.0003						<0.0003	0.002	<0.0003	<0.0003	-	<0.0003	0.003	<0.0003	-	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	-	<0.0003	0.0004	<0.0003	0.0006	0.002	<0.0003	<0.0003

Appendix M

Baseline Hydrology Monitoring Program and SAQP

Baseline Monitoring Program and Sampling Analysis and Quality Plan

Pinjarra Alumina Refinery Revised Proposal

Alcoa World Alumina Australia

14 January 2022

The Power of Commitment

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Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	SW, KH, AO	N Deeks		M Brook		14/01/2022

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Appendices

Appendix A Water monitoring locations
Appendix B Groundwater and surface water locations

Terminology

Terminology	Definition
Alcoa of Australia Limited (Alcoa)	The proponent of the Proposal.
GHD Pty Ltd (GHD)	Consultant engaged by Alcoa to prepare environmental approvals documentation and supporting technical studies for the Proposal.
Myara North Development Envelope	Myara North mine region and associated infrastructure corridor within the Huntly mine region. 22,703 ha total
Myara North Infrastructure Corridor	Corridor adjacent to Myara North mine region in which a conveyor, haul road and other infrastructure may be developed. May also be referred to as a transport study area or conveyor/haul road corridor. 5,254 ha
Holyoake Development Envelope	Holyoake mine region and associated infrastructure corridor within the Huntly mine region. 18,700 ha total
Holyoake Infrastructure Corridor	Corridor adjacent to Holyoake mine region in which a conveyor, haul road, access road and other infrastructure may be developed. May also be referred to as a transport study area or conveyor/haul road corridor. 9,542 ha
Mine Development Envelope	Total Mine Development Envelope for the Proposal, this being Myara North and Holyoake mine regions and associated infrastructure corridors. 41,403 ha
Mining region	Sub-regions that comprise the Huntly Mine, including current (Myara), past (O'Neil, McCoy) and future (Myara North, Holyoake), etc.
Haul Road	Truck and mine infrastructure access road linking into existing corridors.
Huntly Mine	Huntly Bauxite Mine within ML1SA. This includes the previous and current mine regions of Del Park, Huntly, White Road, McCoy, O'Neil, and Myara, and the transition to the future mine regions of Myara North and Holyoake.

Abbreviations

Abbreviations	Definition
ANZG	Australia New Zealand Guidelines
BoM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CoC	Chain of Custody
DAWE	Department of Agriculture, Water and Environment
DBCA	Department of Biodiversity Conservations and Attractions
DE	Development Envelope
DWER	Department of Water and Environmental Regulation
EC	Electrical Conductivity
EPA	Environmental Protection Authority Western Australia
EP Act	Environmental Protection Act 1986
EPBC Act	Environmental Protection and Biodiversity Conservation Act
ERD	Environmental Review Document
ESD	Environmental Scoping Document
FMP	Forest Management Plan
GDE	Groundwater Dependent Ecosystem
ha	Hectares
km	Kilometres
LOR	Limit of reporting
MBAS	Methylene Blue Active Substances
mBGL	Metres Below Ground Level
mg/L	Milligrams Per Litre
PAH	Polycyclic Aromatic Hydrocarbons
PER	Public Environmental Review
PDWSA	Public drinking water source area
RFA	Regional Forest Agreement
PFAS	Per- and Polyfluoroalkyl Substances
QA	Quality Assurance
QC	Quality Control
RPZ	Reservoir Protection Zone
SAQP	Sampling, analysis and quality plan
SWL	Standing Water Level
TDS	Total Dissolved Solids
TRH	Total Recoverable Hydrocarbons

1. Introduction

1.1 Background

Alcoa of Australia Limited (Alcoa) is proposing to increase production at the Pinjarra Alumina Refinery and Huntly Bauxite Mine (the Alcoa Proposal). The Huntly Mine operations will transition into the Myara North and Holyoake regions. The Myara North region lies adjacent and north of the existing Myara mining operations. The Holyoake region lies north-east of Dwellingup, approximately 20 km south of Myara North.

Alcoa has referred the Proposal to the Environmental Protection Authority (EPA) for assessment under Part IV of the WA Environmental Protection Act 1986 (EP Act) and to the Department of Agriculture, Water and Environment (DAWE) for consideration under the Commonwealth Environment Protection Biodiversity Conservation Act 1999 (EPBC Act).

The EPA have set the level of assessment of the Alcoa Proposal as Public Environmental Review (PER). Should the Commonwealth determine the Project a controlled action, then it is expected that assessment under the EPBC Act will be via the Bilateral Agreement.

The EPA have identified Inland Waters as a preliminary key environmental factor, noting that the proposed mining areas lie over catchments for public drinking water reservoirs.

Alcoa has engaged GHD to prepare the environmental approval documentation and supporting technical studies (the Project) for the Alcoa Proposal under the EP Act and EPBC Act. The study area includes Myara North and Holyoake regions.

1.2 Purpose and objective

The purpose of the monitoring program is to characterise baseline surface water and groundwater conditions within the Myara North Development Envelope (DE) and Holyoake DE.. The monitoring program has also been developed to provide data for input for hydrological modelling and risk assessment for the Proposal.

The monitoring program has been designed to be commensurate with the key risks associated with the bauxite mining activity, based on Alcoa's long history of bauxite mining in the Northern Jarrah Forest. The monitoring program builds on historic monitoring (groundwater levels, groundwater quality, surface water quality and surface water discharge) across the Huntly Mine, and aims to utilise existing infrastructure at key monitoring locations.

This monitoring program and sampling, analysis and quality plan (SAQP) documents the development of the baseline monitoring program, the sampling program and analytical work for the collection and validation of field data.

1.3 Monitoring program approval requirements

Alcoa undertakes mining within the catchments of public drinking water supply areas in accordance with the *Water Working Arrangements* (Version 5, 2018-2023). The working arrangements detail the coordinated approach in which the Department of Water and Environmental Regulation (DWER), Water Corporation and Alcoa will work together to manage Alcoa's mining activities in Western Australia with respect to water resource management and protection.

Access to the Reservoir Protection Zone (RPZ) is restricted and subject to an access agreement with Water Corporation.

1.4 Limitations and assumptions

This report: has been prepared by GHD for Alcoa World Alumina Australia and may only be used and relied on by Alcoa World Alumina Australia for the purpose agreed between GHD and Alcoa World Alumina Australia as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Alcoa World Alumina Australia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

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2. Site description and environmental setting

2.1 Site description

Huntly Mine lies predominantly within State Forest and is managed for multiple uses under the Regional Forest Agreement (RFA) and Forest Management Plan (FMP) including conservation, recreation, beekeeping, timber production and water supply.

2.1.1 Myara North

The Myara North DE is located within Jarrahdale State Forest 22, south east of the town of Jarrahdale, and predominantly in the Shire of Serpentine-Jarrahdale with a portion in the City of Armadale. Myara North is bounded by the Monadnocks Conservation Park to the north-east and the Serpentine National Park to the west.

State Forest 22 in the Myara North DE is managed for multiple uses including drinking water production, timber production and recreation. The Myara North DE features numerous gravel tracks and off-road tracks that are accessed by members of the public, and also intersects the Munda Biddi Trail, a long distance off-road cycling track.

Some public facilities are provided in relation to public access and use of the State Forest, including provision of a car park, fireplaces, picnic facilities and a composting toilet at the Balmoral Road Prisoner of War (POW) Camp Ruins site.

Existing and historic land use, infrastructure and activities within and upstream of Myara North include:

– Land and forest management, including timber harvesting, hazard reduction burning and feral animal control;
– Commercial land use such as mining, minesite rehabilitation and pine plantations;
– Infrastructure including Western Power transmission line, pipelines, roads, telephone lines and towers; and
– Recreation activities.

2.1.2 Holyoake

The Holyoake DE is located within Dwellingup State Forest 14, approximately 5 km east of Dwellingup in predominantly in the Shire of Murray, with a portion in the Shire of Boddington.

Holyoake DE is located adjacent to the Lane Poole reserve at its southern extent and intersects the Bibbulman Track, a long distance walk trail. Numerous gravel tracks and off-road tracks that are accessed by members of the public also exist throughout the DE. The Hotham Valley Railway line transects the southern end of the DE and is still used as a tourist railway. Existing and historic land use activities within and upstream of Holyoake include:

– Land and forest management, including timber harvesting and hazard reduction burning;
– Mining and gravel extraction, and minesite rehabilitation;
– Rural properties; and
– Recreation.

2.2 Hydrogeology

2.2.1 Geological setting

Myara North and Holyoake mine regions are within the Yilgarn Craton granite basement area. The bedrock outcrops over less than 10% of the region, as an extensive layer of Cainozoic lateritic profile developed over the basement. A typical lateritic profile in the Darling Range is distinctly zoned. The laterite has been derived from the weathering of parent rock and consists of a ferruginous or aluminous hard cap layer which overlies a pallid, and often mottled kaolinitic zone of varied thickness (saprolite). The transition zone between the fresh basement and saprolite is referred to as saprock.

The laterite layer hosts the bauxite resources which are proposed to be mined. Development of bauxite ore has been especially pronounced along the flanks and upper slopes of ridges. In the lower lying valleys, the occurrence of bauxite is limited (eroded). The lateritic (bauxite) horizon is on average 2 to 3 m thick for granite-derived bauxite.

Younger age tholeiitic quartz dolerite dykes also intrude the Archaean basement. The dykes are generally 10 m thick although the width can vary widely. These dykes generally follow eastwest to northwest to southeast directions. Observations of outcrops along the railway cutting near Jarrahdale suggest significant differences between the profile developed over metagranites and dolerites. These are related to the dominance or preservation of quartz in the profile developed over the metagranite whereas it is almost totally absent from the profile developed over the dolerite.

2.2.2 Groundwater occurrence

The groundwater host rocks of the Myara North and Holyoake DEs predominantly comprise the weathered and fresh Archaean basement crystalline rocks. Where drainage lines are sufficiently developed, and have eroded the basement material, sediments, typically alluvial, have accumulated in the lower lying areas. The permeability of the sediments is variably distributed and related to lithology, depth and degree of weathering.

Groundwater is stored and transmitted within the saprolite profile, most often at its base where it transitions to fresh rock. Occurrence of clays within the zone of saprolitic weathering can cause localised perching. Groundwater also occurs in alluvial sediments where developed along the drainage lines, including waterlogged area where finer fractions of alluvial sediments are present.

Broadly, groundwater levels within all aquifers reflect the topography, such that groundwater level is highest in areas of highest topography and lowest in areas of lowest topography. Groundwater is considered likely to be providing baseflow, following winter rains and aquifer recharge, to the major surface water bodies of the area.

Groundwater migrates from topographical highs towards the groundwater discharge boundaries of the region which based on the regional groundwater flow direction, is generally to the west and southwest, but can be locally modified in response to topographic and drainage trends. Where groundwater levels intersect the base of the creek groundwater discharges provide baseflow following winter rains (which top up aquifer storage and elevate groundwater levels).

2.3 Surface water features

2.3.1 Drainage

The Myara North and Holyoake mine regions are part of the Darling Plateau, which is characterized by sharply incised drainage lines forming dense drainage networks in the western, higher rainfall zone (HRZ), with these transitioning to open, flat-floored valleys in the eastern, lower rainfall zone (IRZ) (Churchwood and Dimmock, 1989).

Some of the larger streams in the high rainfall zone (HRZ) have previously exhibited perennial flows (baseflow). A significant reduction in streamflow has been observed in recent decades resulting in a shift to ephemeral flows, typically between late June to early November. These streamflow declines have been attributed to the long-term decline in rainfall observed in the region, which have lowered groundwater levels below the streambed in most areas, resulting in a groundwater 'disconnect' (Petrone et al., 2010; Hughes et al., 2012).Unless above-average annual rainfalls persist, most streams will only flow in larger rain events after saturation has occurred (Petrone et al., 2010; Hughes et al., 2012).

2.3.1.1 Myara North

The Myara North DE drains into four catchment areas:

– **Serpentine Dam** - The majority of Myara North (127 km^2 or 73%) lies within the Serpentine Dam catchment area. The largest of the Serpentine Dam tributaries within the Myara North Development Envelope is the 39 Mile Brook, with other named tributaries including Banksia Gully and Goldmine Gully. Linear hydrographic mapping of the Myara North region identifies eight (8) tributaries that are second order streams and above

and a further twelve (12) first order tributaries that discharge directly into the Serpentine River and Serpentine Dam. The Serpentine River runs adjacent the southern boundary of the Myara North area.

– **Serpentine Pipehead Dam –** A small portion (<2 km^2, or 1%) of Myara North lies within the Serpentine Pipehead Dam catchment area. This includes the headwaters of two first order tributaries that discharge directly into the dam.
– **Gooralong Brook** - The north western portion of Myara North (25 km^2, 14%) is drained by Gooralong Brook which joins the Serpentine River downstream of the Serpentine Pipehead Dam.
– **Wungong River** - In the northern portion of Myara North (21 km^2, 12%) the Chandler Road sub-catchment and Cobiac subcatchments drain in a north and north-westerly direction, converging as the Wungong River and flowing towards the Wungong Reservoir .

2.3.1.2 Holyoake

The Holyoake DE drains into two catchment areas:

– **South Dandalup Dam** - A large portion of Holyoake (~67 km^2 or 66%) lies within the South Dandalup Dam catchment. This portion drains either into South Dandalup River or one of four of its tributaries. The South Dandalup Dam catchment also extends well beyond the Holyoake boundary.
– **Murray River** - A portion in the south-western end of Holyoake (35 km^2, or 34%) lies within the Murray River catchment, with the area draining into two of the river's tributaries, Davies Brook and Swamp Oak Brook.

2.3.2 Mapped surface water bodies

2.3.2.1 Public drinking water supply reservoirs

The Myara North and Holyoake DEs intersect the catchment areas of public drinking water supply reservoirs, including:

– Serpentine Dam and Serpentine Pipehead Dam (Myara North);
– Wungong Brook Dam (Myara North);
– South Dandalup Dam (Holyoake).

The reservoirs form part of the Water Corporation's Integrated Water Supply System (IWSS) supplying drinking water to the Perth metropolitan region. The reservoirs are managed in accordance with their respective Drinking Water Source Protection Plan (DWSPP).

2.3.2.2 Other water bodies

The Landgate Medium Scale Topo Water Polygon dataset identifies several water bodies within and in proximity to the proposed mine regions. The largest of these include the Serpentine Dam and Serpentine Pipehead Dam (Myara North) and the South Dandalup Dam (Holyoake). In the Myara North DE other waterbodies identified as non-perennial marsh and non-perennial swamp are mapped as occurring in the mid and upper valley floors of 39 Mile Brook, Goldmine Brook and the unnamed eastern tributaries. In the Holyoake DE waterbodies mapped as non-perennial swamps are mapped within the valley floors of the central part of the area.

2.3.2.3 Wetlands

The Myara North DE is located at the eastern extent of the Department of Biodiversity Conservations and Attractions (DBCA) *Geomorphic Wetlands Swan Coastal plain dataset*. The north-western portion of the Development Envelope has some mapped geomorphic wetlands which occur within the Gooralong Brook, Serpentine Pipehead Dam and Serpentine River catchments. A number of other wetlands occur in the area which are not part of the DBCA dataset.

3. Existing monitoring

3.1 Surface water

Existing surface water monitoring of some tributaries in the proposed mine regions has been completed by Alcoa and the DWER. Data collected by Alcoa and DWER is primarily focused on flow, salinity (as electrical conductivity) and turbidity data, with very limited to no monitoring of a broader suite of parameters.

The spatial distribution and monitoring frequency varies widely across the proposed mine regions. There is a higher density of monitoring locations and longer monitoring period within the Myara North DE, associated with historic mining and research catchments. Surface water monitoring in the Holyoake DE primarily consists of DWER data, with limited Alcoa data available. Historical data are available for research catchments in proximity of the Holyoake DE, including the Gordon, Cameron West, Cameron Central, Chadoora, Pindalup, Wuraming, and Yarragil catchments. These catchments are shown in Figure A-2 of Appendix A.

Monitoring of the public drinking water supply reservoirs (Section 2.3.2) is completed by Water Corporation. It is understood this monitoring is undertaken in accordance with the Australian Drinking Water Guidelines, and with regard to key risks within the public drinking water supply area (PDWSA) catchments identified within the respective DWSPP. This data has not been provided by the Water Corporation.

3.2 Groundwater

A number of bauxite exploration and groundwater monitoring bores were established in Myara North DE. Bauxite exploration bores are generally too shallow to inform an understanding of the lithological profile and groundwater conditions.

Available groundwater monitoring bores do not generally have geological log records. Consequently, the site-specific information on the thickness of the weathering zone and how it changes spatially within Myara North is not available.

In Myara North the historical focus on salinity risk associated has resulted in a focus of existing monitoring bores in the eastern portion of Myara North, east of the historical 1,100 mm isohyet. Information on regolith and groundwater is therefore concentrated in the eastern portion of Myara North. There are significant gaps in the spatial distribution of monitoring bores to the west of the 1,100 mm isohyet.

Groundwater information within the Holyoake DE is limited to four “transect” locations and a period before 1983. The transects appear to be historic project or investigation sites, and their physical locations were checked during site investigations to establish bores useable for monitoring purposes. As with surface water, historical data are available for several research catchments in the vicinity of the Holyoake DE (Figure A-2 of Appendix A).

4. Potential contaminant sources and pathways

Hazard identification was completed based on proposed mining activities and existing activities that occur within the Mine Development Envelope.

4.1 Hazard identification

4.1.1 Proposal activities that may impact surface water

A risk assessment workshop was held with key Alcoa operational personnel to identify Proposal activities that may impact surface water within the proposed Myara North and Holyoake DEs. Based on information reviewed and outcomes from the risk assessment workshop the key potential impacts to surface water from the Huntly Mine transition include:

– Increases in sediment, suspended solids, and turbidity from erosion during mining activities.
– Increases in stream salinity as a result of mining-induced saline groundwater discharge.
– Contamination from spills, leaks, and/or emissions from the storage, handling, and use of hazardous materials and waste.
– Generation and discharge of pathogenic microorganisms from human activities.

The potential contamination source and pathways are summarised in Table 4-1.

Table 4-1 Contamination sources and pathways from mining

Possible origin of contamination	Potential contaminant	Possible contamination pathway
Exploration Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation	Pathogenic microorganisms	Use of bushland for toileting and vomiting, given difficulty accessing toilets on such a large site, especially by people with diarrhoea, followed by that material moving into the reservoir after rain or via animal ingestion, amplification and shedding, leading to increased source water vulnerability as compared with benchmarks for pathogenic microorganisms
Clearing and construction Mining	Pathogenic microorganisms	Failure of on-site sanitation systems at toilet facilities which in turn leaches to the reservoir, leading to increased source water vulnerability as compared with benchmarks for pathogenic microorganisms
Exploration Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation	Petrochemical hydrocarbons	Petrochemical leakage or dispersal from vehicles or machinery or operations (fault related, crash related, refuelling related) directly into a flowing stream that impacts water quality and treatment capacity
Exploration Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation	Suspended solids and turbidity	Wild fire due to machinery or electrical sparks during fire danger season that burns vegetation and impacts water quality and treatment capacity
Rehabilitation	Nutrients	Mobilisation of fertiliser impacting surface water, reducing water quality in the reservoir
Exploration	Specific ionic species (metals)	Solid waste generation potentially impacting water quality

Possible origin of contamination	Potential contaminant	Possible contamination pathway
Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation		
Exploration Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation	PFAS	Firefighting foam runoff potentially impacting surface and ground water quality, resulting in raw water PFAS concentrations above recommended limits
Exploration Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation	Concrete sludge Alkaline concrete water Waste oils Batteries, tyres Packaging equipment Food waste Bitumen	Generation of construction phase solid and liquid waste that mobilises via stormwater runoff to the reservoir
Exploration Clearing and construction	Sediments, suspended solids and turbidity	Vegetation clearing that increases sediment laden runoff, impacting flora and fauna in the drainage routes, and increasing turbidity of reservoir water
Roads and infrastructure	Sediments, suspended solids turbidity, hydrocarbons	Discharge of sediment and petrochemical hydrocarbon laden stormwater runoff from haul roads, impacting fauna habitats and flora in the drainage routes, and increasing turbidity of reservoir water
Mining	Sediments, suspended solids, plastics, metals, plastic additives, hydrocarbons	Conveyor crossing over reservoir spilling ore and/or sediment from damaged equipment or dusting off the belt. Abrasion of the belt discharging pollutants. Hydrocarbons leaking from bearings
Exploration Clearing and construction Roads and infrastructure Mining support Mining Rehabilitation	Salinity	Rise in groundwater due to clearing of forested catchment, resulting in increase in salinity discharged to surface water from saline groundwater/soil
Rehabilitation	Turbidity	Turbid runoff from rehabilitation areas due to low vegetation cover in early stages of rehabilitation
Mining	Suspended solids, petrochemical hydrocarbons, surfactants, nutrients, metals	Heavy vehicle and equipment washdowns discharging pollutants via runoff
Mining	Suspended solids, petrochemical hydrocarbons, surfactants, metals	Contaminated surface runoff from fuel bays, fuel delivery areas, vehicle and equipment workshops, vehicle carparks.
Mining	Suspended solids, petrochemical hydrocarbons, surfactants, nutrients	Overflow of contaminated water ponds
Mining	Petrochemical hydrocarbons	Bulk diesel fuel storage for heavy and light vehicles, leaks from tanks into soil and groundwater
Mining	Petroleum hydrocarbons, organic solvents (TBC), surfactants	Package chemical storage and use for heavy vehicle and equipment maintenance

4.1.2 Existing activities

Existing and historic land uses may be impacting the water quality or hydrology within the proposed mine regions. . Given a large portion of the Myara North and Holyoake DE occur within PDWSA (Section 2.3.2), the existing land-uses are well understood, as documented within the DWSPP for the respective catchments. A review of DWER's contaminated sites database, relevant town planning schemes, and current aerial imagery was also undertaken to validate the DWSPP and assess for any additional sources of water quality contamination outside of these protected catchments.

The following sections summarise the existing activities within the catchments. The key contaminants of concern from existing activities are listed in Table 4-2.

Myara NorthLand uses within and upstream of the Myara North DE include:

- Land and forest management, including timber harvesting
- Commercial land uses such as mining and pine plantations
- Linear infrastructure including the Muja Northern Terminal Western Power transmission line, pipelines, roads (including Albany Highway), tracks, and telephone lines
- Recreation.

The following aspects are noted with respect to existing activities within the Myara North DE:

- **Forest management –** Including hazard reduction burning and feral animal control. Prescribed burns and fire response activities are undertaken by DBCA and DFES. Prescribed burns are scheduled within the Myara North DE during the monitoring period. bait used for fox control contains 1080 (sodium monofluoroacetate), which is a naturally occurring chemical that does not pose a risk to water quality. Shooting to control problem animals is only undertaken by authorised personnel.
- **Tree farming** – Includes pine plantation and native timber harvesting. PDWSAs include pockets of pine plantations, including a 105 ha pine plantation 5 km north of the Serpentine Main Dam reservoir. Timber harvesting is undertaken by Forest Products Commission (FPC) within the Jarrahdale and Dwellingup State Forests in accordance with the Forest Management Plan (FMP) and Regional Forest Agreement (RFA).
- **Firewood** – firewood is collected within Jarrahdale and Dwellingup State Forests for private use, which is managed via licences issued by DBCA.**Mine rehabilitation** - Bauxite mining and rehabilitation was previously undertaken by Alcoa in the north-western corner of Myara North. Rehabilitation of these areas was completed from years 1994 to 2001.
- **Recreation** - Boating, swimming, fishing, and marroning are prohibited in the PDWSA reservoirs for health reasons. Camping, hiking, cycling, horse riding, picnicking, licensed vehicle access, and motor rally events are listed as activities in specific areas, and illegal hunting, illegal firewood collection and unlicenced vehicle access may also occur. According to the DWSPP, motor rally events have not been held in the PDWSA catchment areas since 2006, however it is noted that a motor rally event is scheduled for 7 November 2020.
- **Infrastructure** – Includes Western Power transmission line, pipelines, roads, telephone lines and towers.

It is noted that Boddington Gold Mining (BGM) Management Company acquired under 100 ha of private land in the Serpentine Catchment with the intent to use it as part of a land exchange with DBCA. BGM do not intend to use this land for mining.

An area of Myara North at its western edge lies beyond existing catchment protection areas. This western area predominantly consists of State Forest, however also includes a small number of private properties which, based on aerial imagery, have been cleared for rural pursuits (crops/tree farming), with small dams on each property. One lot at the very western edge of Myara North is zoned as residential under the Shire of Serpentine-Jarrahdale Planning Scheme. No rezoning is proposed under the Shire of Serpentine-Jarrahdale Town Planning Scheme.

Some public facilities are provided in relation to public access and use of the State Forest, including provision of a car park, fireplaces, picnic facilities and a composting toilet at the Balmoral Road Prisoner of War (POW) Camp Ruins site, east of Jarrahdale in the proposed Myara North mine region.

Numerous gravel tracks and off-road tracks exist throughout the catchment that are accessed by members of the public.

A review of DWER's contaminated sites database indicates there are no reported contaminated sites.

4.1.2.1 Holyoake

Land uses within and upstream of Holyoake DE include:

– Land and forest management, including timber harvesting and hazard reduction burning;
– Mining and gravel extraction; and
– Recreation.

A review of the Shire of Murray and Shire of Boddington Town Planning Schemes indicate that land uses within and upstream of Holyoake are consistent with those identified in the So*uth Dandalup Dam Drinking Water Source Protection Plan* (DoE, 2005).. These land uses are generally the same as those identified for Myara North, with the exception that a gold mining lease exists in the South Dandalup Dam catchment area, however the proposed operation does not extend into the Holyoake DE.

A review of DWER's contaminated sites database indicates there are no reported contaminated sites within or upstream of Holyoake.

Table 4-2 Myara North and Holyoake– Potential water quality risks from existing land uses

Hazards identified	Tree farming	Gold Mining (Holyoake only)	Mine rehabilitation	Fire management	Wild fires	Firewood collection	Apiaries/ wildflower picking/seed collection	Roads and tracks	Gravel pits	Research projects	Feral animals (and their control)	Recreation	Infrastructure maintenance
Pathogen contamination	X	X	X	X	X	X	X	X	X	X	X	X	X
Increased turbidity	X	X			X	X	X	X	X	X	X	X	X
Fuel spills from vehicles and machinery	X	X	X	X				X	X			X	X
Rubbish dumping (including tyres, car bodies and wastes containing nutrient, chemical, hydrocarbons and heavy metals)						X		X	X			X	
Spread of forest disease by vehicle use	X							X				X	X
Nutrient contamination	X		X		X								
Carbon contamination				X	X								
Fertiliser and pesticide contamination	X												
Herbicides								X					X
Per- and polyfluoroalkyl substances (PFAS)[1]				X	X								
Increased salinity	X	X											
Increased acidity	X												

[1] Department of Fire and Emergency Services advised it phased out use of PFOS-based aqueous fire-forming foams (AFFF) in 2003 (https://www.der.wa.gov.au/our-work/community-updates/416-pfas-investigations-in-western-australia)

5. Data gap review

Review of available existing surface and groundwater data for the Myara North Development Envelope has identified a substantial body of primarily historical monitoring data that forms a preliminary understanding of site conditions. Within the Holyoake Development Envelope there is reasonable distribution of existing surface water monitoring sites, however availability of groundwater data and spatial distribution are limited. Table 5-1 summarises key data gaps that have been identified.

Table 5-1 Data review

Data gap	Currently available data	Data required	Data sources
Myara North			
Surface water quality data – temporal and spatial resolution of monitoring, and parameters	Numerous existing Alcoa and DWER surface water monitoring locations. Spatial and temporal distribution varies widely, with majority of data collection focused on period 1970s to mid 1980s, with some sites extending to mid 1990s. More recent Alcoa data available for some eastern tributaries. Parameter suite limited to salinity and turbidity.	Monitoring data representative of current conditions and broader parameter suite at selected existing Alcoa and DWER sampling locations. Additional sampling locations required on key tributary sites based on proposed mining plan and to provide representative upstream and downstream locations.	Incorporation of existing data into overall dataset. Collection and analysis of new surface water samples. Installation of water quality loggers at selected locations.
Surface water flow	DWER/Alcoa gauging station data for two stations: Jack Rocks (39 Mile Brook) and River Road (Serpentine River). Limited Alcoa data comprises snapshot discharge estimates.	Flow data representative of conditions during the baseline monitoring program, to inform surface water and groundwater assessment.	Incorporation of existing data into overall dataset. Installation of water level loggers at selected locations.
Groundwater quality - temporal and spatial resolution of existing network and parameters	Review of the existing Myara North monitoring bore network identified the requirement for additional monitoring bores to provide adequate spatial resolution across the Proposal area.	Increased monitoring bore resolution required to infill gaps in the existing network. Monitoring data representative of current conditions and broader parameter suite for selected bores.	Incorporation of existing data into overall dataset. Sampling of selected existing and new monitoring bores.
Groundwater level	Review of the existing Myara North monitoring bore network identified the requirement for additional monitoring bores to provide adequate spatial resolution across the Proposal area.	Increased monitoring bore resolution required to infill gaps in the existing network. Hydraulic aquifer testing (e.g. slug tests) will be carried out to improve understanding of local conditions.	Incorporation of existing data into overall dataset. Monitoring of existing and new bores.
Holyoake			
Surface water quality	Good network of existing DWER surface water monitoring locations with historic data (majority mid 1970s to mid 1980s). Parameter suite limited to salinity and turbidity.	Monitoring data representative of current conditions for a broader parameter suite at selected existing Alcoa and DWER sampling locations. Additional sampling locations required on key tributary sites based on proposed mining plan and to provide representative upstream and downstream locations.	Incorporation of existing data into overall dataset. Collection and analysis of new surface water samples. Installation of water quality loggers at selected locations.

Data gap	Currently available data	Data required	Data sources
Surface water flow	DWER gauging station data available for Pindalup, Skeleton Rd, and Gordon catchment.	Flow data representative of conditions during the baseline monitoring program, to inform surface water and groundwater assessment.	Incorporation of existing data into overall dataset. Installation of water level loggers at selected locations.
Groundwater quality	Limited clusters of existing bores.	Installation of new monitoring bores.	Installation and sampling of new monitoring bores.
Groundwater data	Limited existing bores.	Installation of new monitoring bores.	Installation and monitoring of new monitoring bores.

6. Sampling and analytical program

6.1 Relevant guidelines

The primary guidelines that inform the baseline monitoring include:

– Australian Drinking Water Guidelines (ADWG) (NHMRC 2011, Version 3.5)
– Australian New Zealand Guidelines (ANZG 2018)

6.2 Occupational health and safety

All field personnel shall have completed all relevant Alcoa site inductions, and follow all standard health and safety practices prior to and throughout the duration of the works.

A Job Safety Analysis form should be completed by field personnel every time they prepare to undertake field sampling in accordance with Alcoa field work protocols. The safety analysis should indicate potential risks to field personnel before, during and after the sampling and strategies to minimise injuries while undertaking field work. New field personnel not familiar with the site should become familiar with the site access, site communications protocols and any potential OHS issues prior to the commencement of field work.

6.3 Monitoring standards

Sample collection, processing, transportation, storage, preservation and labelling of surface water samples will be conducted in accordance with the appropriate industry standards and general surface water sampling guidance (AS/NZS5667.1:1998).

6.4 Sampling locations

6.4.1 Groundwater monitoring

The groundwater monitoring locations were identified to provide spatial distribution across the Myara North and Holyoake DEs.

For Myara North DE groundwater monitoring will be undertaken of eighteen (18) new groundwater monitoring bores, with groundwater quality monitoring completed for a further seven (7) existing bores and groundwater level monitoring completed for a further twenty five (25) groundwater monitoring bores selected from the existing network.

For Holyoake DE groundwater monitoring will be undertaken of seventeen (17) new monitoring bores that are spatially distributed across the DE, with groundwater quality monitoring completed for a further four (4) existing bores and groundwater level monitoring completed for a further eight (8) groundwater monitoring bores selected from the existing network.

These locations are presented in Figure A-1 for Myara North DE and Figure A-2 for Holyoake DE (Appendix A). Existing and new groundwater monitoring bore location details for Myara North DE and Holyoake DE are summarised in Table B-1 (Appendix B).

6.4.2 Surface water monitoring

Surface water monitoring locations were selected based on desktop review of available information including existing surface water monitoring locations (Alcoa and DWER locations), surface water features that directly discharge to drinking water reservoirs, site access, proposed mining plan where available (e.g. Myara North), suitability for installation of monitoring equipment, representative locations both upstream and downstream of the proposed mining operations.

Twenty (20) surface water monitoring locations were selected for Myara North DE, and fifteen (15) sites selected for Holyoake DE. These locations were verified during site reconnaissance surveys and are presented in Figure A-1 and Figure A-2, respectively (Appendix A). Surface water monitoring location details are summarised for Myara North DE and Holyoake DE in Table B-2 (Appendix B).

6.5 Field sampling procedure

6.5.1 Surface water monitoring

6.5.1.1 Field parameters

Field parameters will be measured at the time of sampling using a pre-calibrated water quality meter and recorded on field sampling sheets. Two suites of field parameters will be measured in line with the short and extended laboratory programs (refer section 6.7.1):

– SW Short Suite monitoring rounds will comprise in-field measurements of electrical conductivity (EC), with EC and turbidity also measured daily in the Alcoa laboratory.
– SW Extended Suite monitoring rounds will use a multiparameter sonde to measure temperature, pH, dissolved oxygen, redox potential (ORP) and turbidity in-field.
– Field observations such as odours or sheen presence will be recorded on field sampling sheets.

6.5.1.2 Surface water grab sample collection

Where the embankment of the water body is stable and the water body can be safely accessed, surface water samples will be collected by hand. Where possible samples will be collected directly into the laboratory supplied sample containers. For samples that have preservatives, samples will be decanted into the laboratory supplied sample containers.

Where depth permits, the sample container will be positioned at least 10 cm below the surface water level, above the sediment bed and oriented with the capped opening facing downwards to avoid the collection of surface films. Once in position, the container cap will be removed to allow sample collection.

Where sampling points cannot be safely accessed, surface water samples will be collected using a long-handled sampler and decanted into the laboratory supplied sample containers.

6.5.1.3 PFAS sampling procedure

Monitoring for PFAS samples will be undertaken in accordance with Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Contaminated Sites Guidelines (Department of Environment Regulation 2016).

In addition to the surface water grab sample collection key aspects for consideration for PFAS sampling include:

– Where possible samples will be collected directly into the laboratory supplied sample containers.
– Where sampling points cannot be safely accessed, surface water samples will be collected using a long-handled sampler and decanted into the laboratory supplied sample containers.
– Use polypropylene or HDPE sample containers for sample collection. Do not use glass sample containers with lined lids.
– Follow mitigation practices as outlined in Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Contaminated Sites Guidelines (Department of Environment Regulation 2016).

6.5.2 Groundwater monitoring

6.5.2.1 Groundwater level monitoring

Groundwater levels will be recorded in selected groundwater monitoring bores on a monthly basis. For Myara North DE, groundwater levels will be recorded from the 18 new groundwater monitoring bores, and the selected 25

existing groundwater monitoring bores. For Holyoake DE groundwater levels will be recorded from the 17 new groundwater monitoring bores, and 8 existing groundwater monitoring bores.

Groundwater levels will be measured manually using an electronic interface water level meter prior to collection of all groundwater samples during all groundwater monitoring events. The electronic interface water level meter will be triple rinsed prior to use at each well.

6.5.2.2 Groundwater field water quality parameters

Groundwater field water quality parameters will be recorded in all groundwater monitoring bores on a monthly basis. For Myara North DE parameters will be recorded from the 18 new groundwater monitoring bores, and the selected 25 existing groundwater monitoring bores. For Holyoake DE parameters will be recorded from the 17 new groundwater monitoring bores, and 8 existing groundwater monitoring bores.

Groundwater field water quality parameters should be taken using a calibrated field water quality meter. These should include (as a minimum) electrical conductivity or total dissolved solids (TDS) and temperature.

For bores with 50 mm diameter or greater casing, the water quality probe should be lowered into the water column and measurements taken one metre below the water surface, and one metre above the base of the bore (if screened through entire saturated length). For discretely screened bores the measurement shall be taken at the nominal centre of the screen interval.

On narrow diameter bores, field EC and temperature will be recorded from a single field measurement from a bailed sample (no purging requirements).

6.5.2.3 Groundwater monitoring well purging

Groundwater quality laboratory analysis will occur over a total of two rounds (see Section 6.7). For Myara North DE, this will include the 18 new groundwater monitoring bores, and 7 existing groundwater monitoring bores. For Holyoake DE, this will include the 17 new groundwater monitoring bores, and 4 existing groundwater monitoring bores.

Groundwater monitoring wells will be purged prior to collection of groundwater quality samples to provide a representative sample of *in-situ* groundwater. Purging of groundwater monitoring wells will be based on AS/NZS 5667.11 – 1998 (Standards Australia 1998). Groundwater monitoring wells will be purged until stabilisation of field parameters has occurred over three consecutive readings.

6.5.2.4 Groundwater quality sample collection

Groundwater monitoring wells will be sampled using low-density polyethylene tubing coupled to an electric pumping system. Depending on bore type (i.e. diameter), and bore yield the pump may be either a peristaltic or micro purge ('low flow') pump system or a high flow submersible pump.

6.6 Field instrumentation

Selected surface water monitoring locations will be instrumented with water quality and water level loggers to provide a continuous record. The proposed location for deployment of loggers has been based on key water quality risks and impacts, including:

– Greenspan TS1000 Turbidity loggers deployed within selected tributaries of drinking water reservoirs (Serpentine Dam, South Dandalup Dam) to characterise baseline turbidity concentrations. Sites selected with reference to stream order (second order tributary and above) and available mining plan.
– Greenspan TS1000 Turbidity loggers deployed within selected tributaries with high social value. These include Gooralong Brook (Myara North) which passes through Jarrahdale and Swamp Oak Brook (Holyoake) which passes through Lane Poole Reserve.
– Hobo U24-001 electrical conductivity loggers to assess baseline electrical conductivity concentrations within selected tributaries with potential mining activity east of the 1,100 mm rainfall isohyet.
– Diver water levels loggers co-deployed with water quality loggers to measure stream levels within selected tributaries.

Loggers will be inspected on a quarterly basis to download data and replace batteries. No telemetry will be involved. Monitoring will be completed in January 2021 at which point the loggers and all installation materials (e.g. steel posts, ties, bolts, casing) will be removed.

6.7 Laboratory program

6.7.1 Laboratory analytical program

Laboratory analysis will be completed by a National Association of Testing Authorities (NATA) accredited laboratory (ALS, Section 6.7.2), with methods based on established internationally recognised procedures.

6.7.1.1 Surface water laboratory analytical suite

Two surface water sampling suites are proposed as summarised in Table 6-1 with notes below.

Table 6-1 Surface water laboratory analytical suite

Suite [1]	Group	Analytes
SW short suite	Physical parameters	pH, electrical conductivity, salinity, suspended solids, turbidity
	Major cations and anions	Ca, Mg, Na, K, Cl, SO_4, Alkalinity, hardness
SW extended suite	Physical parameters	pH, electrical conductivity, salinity, suspended solids, turbidity
	Major cations and anions	Ca, Mg, Na, K, Cl, SO_4, Alkalinity, hardness
	Nutrients	Total nitrogen, total kjeldahl nitrogen, nitrate, nitrite and ammonia as N, total phosphorus, reactive phosphorus
	Dissolved metals (filtered metals)	As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, B, Ba, Be, Co, Mn, Se, V
	Microbiological	*Enterococci*, *E. Coli*
	Surfactants	Anionic surfactants as MBAS
	Hydrocarbons	TRH/BTEXN, Super Trace PAHs
	Other potential contaminants of concern	PFAS, Pesticides, Herbicides, Explosives
Note	[1] Extended suites will be taken during wetter months as surface flows may cease by October. SW extended suite nominally – August 2020, September 2020, October 2020, SW short suite nominally –November 2020, December 2020, January 2021	

6.7.1.2 Ground water laboratory analytical suite

One groundwater sampling suite is proposed as summarised in Table 6-2.

Table 6-2 Groundwater laboratory analytical suite

Suite	Group	Analytes
GW suite	Physical parameters	pH, electrical conductivity, TDS,
	Major cations and anions	Ca, Mg, Na, K, Cl, SO_4, Alkalinity, hardness
	Nutrients	Total nitrogen, total kjeldahl nitrogen, nitrate, nitrite and ammonia as N, total phosphorus, reactive phosphorus
	Dissolved metals (filtered metals)	As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, B, Ba, Be, Co, Mn, Se, V
	Hydrocarbons	TRH/BTEXN, Super Trace PAHs
	Other potential contaminants of concern	PFAS, Explosives

6.7.2 Laboratory contact details

The nominated primary laboratory is accredited by the National Association of Testing Authorities (NATA) for the specified analytical procedures. Contact details are provided below.

ALS Laboratories

10 Hod Way

Malaga 6090, Western Australia

6.8 Monitoring summary

Table 6-3 provides a summary of the proposed monitoring program.

Table 6-3 Monitoring summary

Parameters	Analytes	Monitoring locations	Schedule
Surface water analytical			
SW extended suite	Field – temperature, pH, dissolved oxygen, redox potential (ORP) and turbidity. Lab - Physical parameters, major cations and anions, nutrients, dissolved metals (filtered metals), microbiological, surfactants, hydrocarbons, PFAS, explosives	Myara North 20 SW sites Holyoake 15 SW sites	August, September, October 2020
SW short suite	Field – EC Lab – Physical parameters, Major cations and anions	Myara North 20 SW sites Holyoake 15 SW sites	November, December 2020, January 2021
Groundwater			
GW field	Water level, EC or TDS, and temperature	Myara North 25 existing bores 18 new bores Holyoake 8 existing bores 17 new bores	Monthly until January 2021
GW lab	Physical parameters, major cations and anions, nutrients, dissolved metals (filtered metals), hydrocarbons, PFAS, explosives	Myara North 7 existing bores 18 new bores Holyoake 4 existing bores 17 new bores	Two events (October and December 2020)
Surface water instrumentation			
Suspended solids and turbidity	Greenspan TS1000 turbidity logger	Myara North GG03, SW04, SW03, SW08 Holyoake HSW05, 6141340, HSW03	Continuous logging (Nominally September – December 2020)
Salinity	Hobo U24 EC logger	Myara North 6141121, 6141125 Holyoake HSW05, 6141340, HSW03	Continuous logging (Nominally September – December 2020)
Water level	Diver water level logger	All logger locations	Continuous logging (Nominally September – December 2020)

7. Quality assurance/Quality control

7.1.1 General

The quality assurance/quality control (QA/QC) is based on *AS 4482.1 - 2005* (Standards Australia 2005) and *AS 4482.2 – 1999* (Standards Australia 1999).

QA involves all of the actions, procedures, checks and decisions, undertaken to ensure the representativeness and integrity of samples and accuracy and reliability of analytical results. QC involves protocols to monitor and measure the effectiveness of QA procedures.

7.1.2 Field sampling

Field sampling will be completed in accordance with industry accepted standards using uniform and systematic methods to ensure collection of representative environmental samples. Key requirements of these procedures are as follows:

– Calibration of field equipment:
– Water quality meter will have calibration checks completed prior to use using appropriate calibration standards.
– Appropriately trained and experienced staff will conduct and document site activities. Field activities will be conducted in general accordance with procedures outlined in GHD Standard Field Operating Procedures, which are based on accepted industry protocols for environmental sampling. GHD personnel will complete the surface water extended suite (Table 6-1) and groundwater sampling (Table 6-2). Sandbridge Consulting will complete surface water short suite sampling (Table 6-1) and monthly groundwater level dips (Section 6.5.2.1).
– Decontamination procedures - Including the use of new disposable gloves for the collection of each sample, decontamination of reusable sampling equipment between each sampling location, and the use of appropriate sampling containers provided by the primary laboratory.
– Sample identification procedures – Collected samples are immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers are clearly labelled with a sample number, job number, sample depth and sample date. The sample containers are then transferred to a chilled insulated container for sample preservation prior to and during shipment to the analytical laboratory.
– Chain of Custody (CoC) information requirements - A CoC form is completed and forwarded to the testing laboratory with the samples. A CoC form will be used for every batch of samples submitted to the laboratory. Delivery and analysis of samples to the laboratory will need to comply with sample holding times.
– Sample duplicate and blank frequency as per Table 7-1.
– Decontamination methodology
  - Where possible, single use sampling equipment will be utilised which does not require decontamination.
  - When needed, equipment is cleaned and decontaminated using a triple rinse system.
– Logging procedures - all samples are described using a recognised system.
– Samples are to be taken in accordance with the following guidelines:
  - Australian Standard (1998) 5667.1 Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS 5667.1:1998).
  - Australian Standard 5667:1998 Water Quality – Sampling, Part 11: Guidance on the Sampling of Groundwaters (AS 566.11:1998).
  - National Environment Protection Council (2013), National Environment Protection (Assessment of Site Contamination) Amendment Measure (No. 1).

    - Department of Environment Regulation (2016) Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Contaminated Sites Guidelines
– Samples will be taken in laboratory provided bottles in a chilled container before being couriered to the NATA accredited laboratory.

7.1.3 Sampling and analysis quality control

The QC samples to be collected during the assessment are described below:

– **Blind duplicate**: Blind duplicate samples are used to identify the variation in the analyte concentration between samples from the same sampling point.
– **Rinsate blanks**: Rinsate blank samples are used to estimate the amount of contamination introduced during the re-use of sampling equipment.
    - Rinsate blank samples are obtained by pouring laboratory supplied deionised water over decontaminated sampling equipment (water quality meter) into laboratory supplied bottles. Rinsate blanks are then kept cool in insulated containers until delivery to the laboratory.
– **Transport blanks**: A sample of laboratory supplied deionised water or spike accompanies the other samples over the course of the fieldworks and submitted to the laboratory for analyses. Transport blanks and spikes provide an indication of contamination introduced during sample transport and handling (including by sample containers).
    - One transport blank will be collected per batch of extended suite samples during the assessment.

The quality control sampling for the limited and extended sampling program is outlined in Table 7-1.

Table 7-1 Quality control sampling schedule

Monitoring event	QA/QC sample type	Rate	Analytic suite
Limited suite (November 2020, January 2021)	Blind duplicate	1 per 10 primary samples	Short suite
	Rinsate blank	1 per sampling event	Short suite
	Transport blank	Not required	-
Extended suite (August 2020, September 2020, October 2020, December 2020)	Blind duplicate	1 per 10 primary samples	Extended suite
	Rinsate blank	1 per sampling event	Extended suite
	Transport blank	1 per day	Extended suite

8. References

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, Available at www.waterquality.gov.au/anz-guidelines

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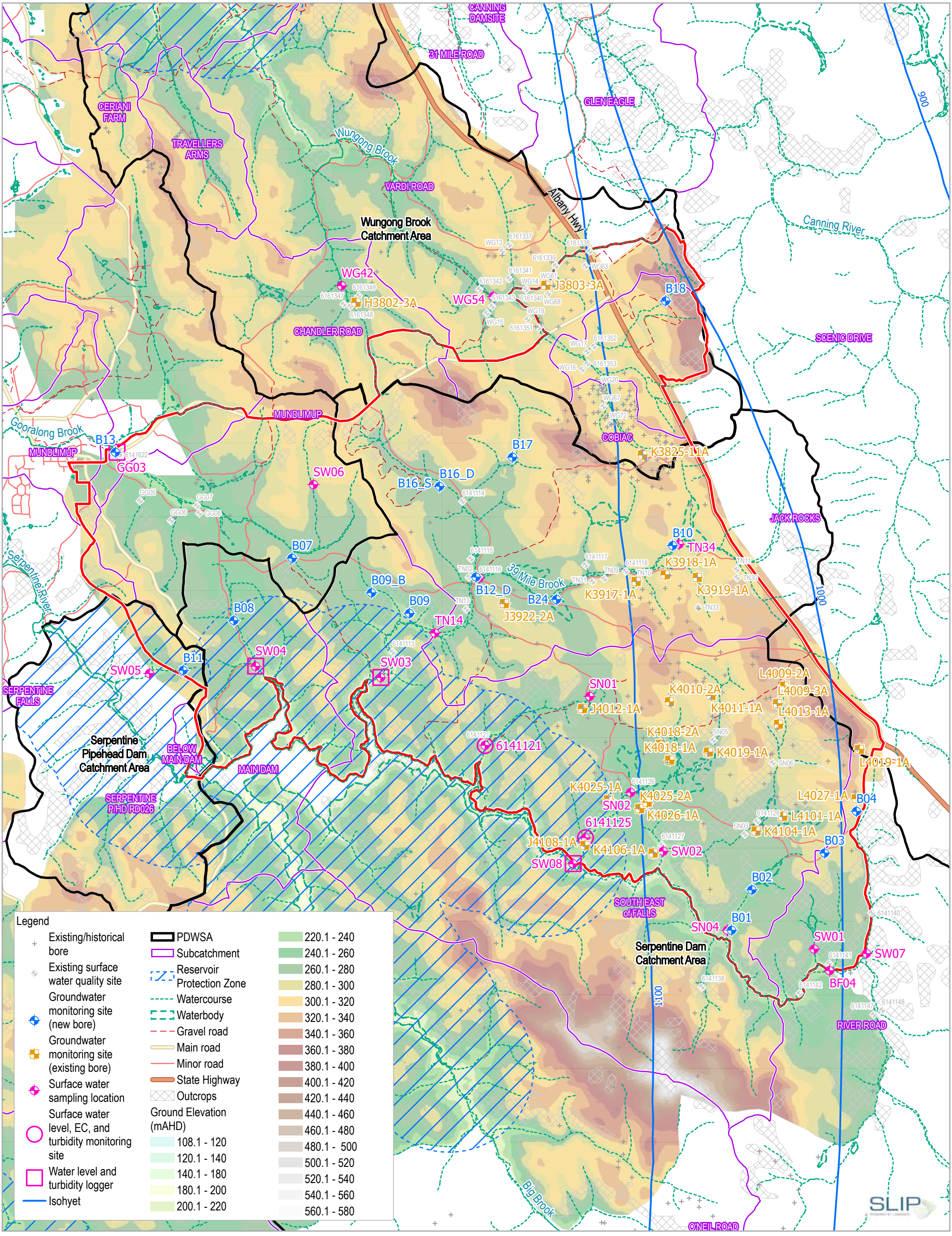
Appendices

Appendix A

Water monitoring locations

Figure A-1 Myara North water monitoring locations

Figure A-2 Holyoake water monitoring locations



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

1:80,000

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 50

N

GHD

Alcoa of Australia Limited

Hydrology Monitoring Program and SAQP Report

Myara North Water Monitoring Locations

Project No. **125120591**

Revision No. **0**

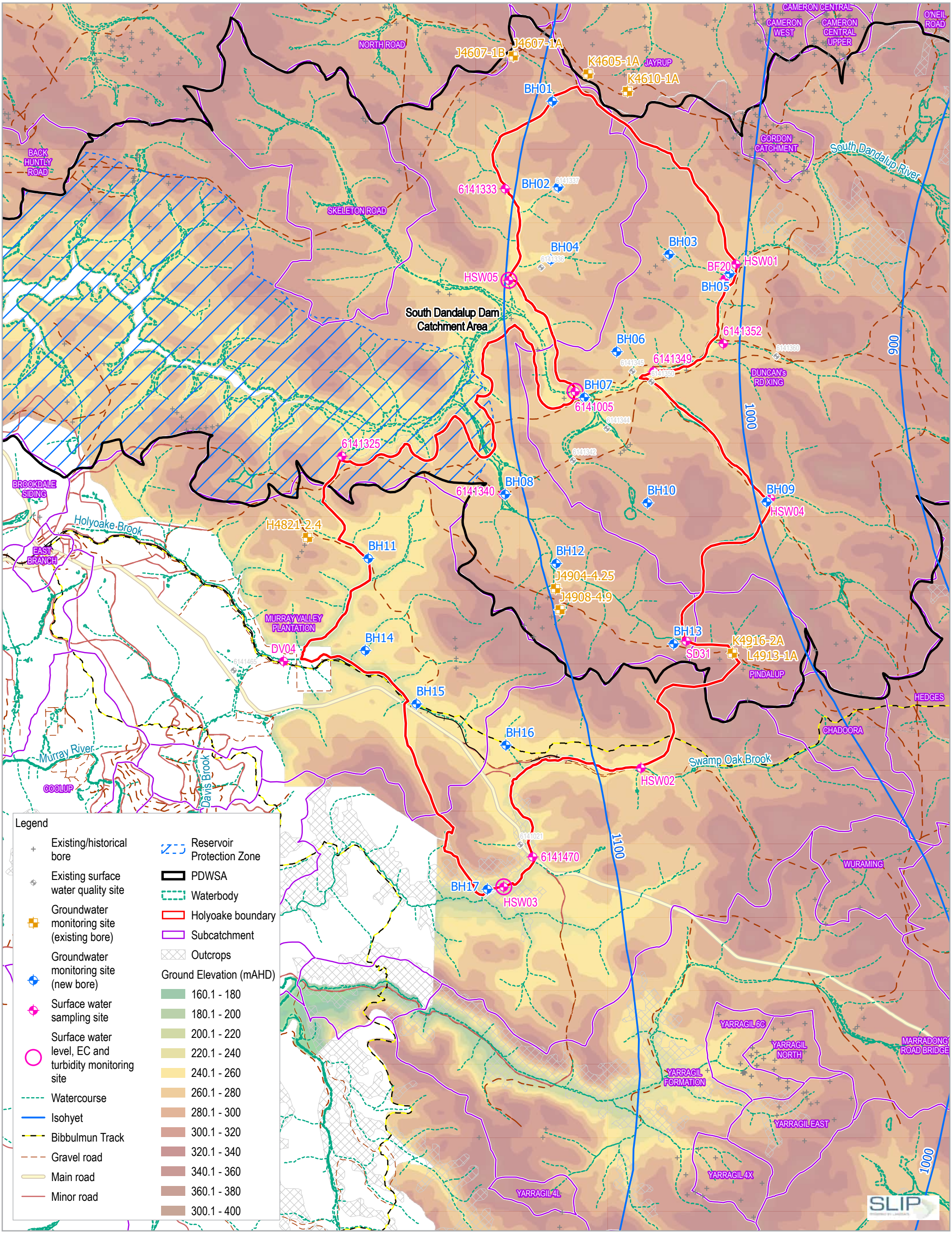
Date **12/01/2022**

FIGURE A-1

G:\61\12520591\GIS\Maps\Working\12520591-MAP-A-SW\12520591_Hydrology_Overview_PJH.aprx\12520591_A-1_SAQP_MyaraNorthWaterMonitoringLocations_RevA

Print date: 12 Jan 2022 - 14:57

Data source: GHD: Proposed sites - 20200825, Subcatchments - 20200624; Alcoa: Myara North Boundary - 20200618, LiDAR Elevation - 20200626, Reservoir Protection Zone, Isohyet - 20200225, Streams - 20200617; GA: SRTM - 20200526; DWER: Existing Monitoring Sites - 20200629; DoW: PDWSA - 20160607; Landgate: Roads - 20190128, . Created by: rbrown3



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

1:80,000

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Alcoa of Australia Limited
Hydrology Monitoring Program and SAPQ Report

Holyoake Water Monitoring Locations

Project No. **125120591**
Revision No. **0**
Date **11/01/2022**

FIGURE A-2

G:\61\12520591\GIS\Maps\Working\12520591-MAP-A-SW\12520591_Hydrology_Overview_PJH.aprx\12520591_A-2_SAQP_HolyoakeWaterMonitoringLocations_RevA
Print date: 11 Jan 2022 - 15:29

Data source: GHD: Proposed monitoring sites - 20200825, Subcatchments - 20200624; Alcoa: Myara North Boundary - 20200618, LiDAR Elevation - 20200626, Reservoir Protection Zone, Isohyet - 20200225, Streams - 20200617; GA: SRTM - 20200526; DWER: SW Monitoring Sites - 20200629; DoW: PDWSA - 20160607; Landgate: Roads - 20190128, . Created by: rbrown3

Appendix B

Groundwater and surface water locations

Table B-1 Groundwater monitoring locations

Type	ID	Sampling type	Easting (MGA50)	Northing (MGA50)
Myara North				
GHD	B01	Water quality and levels	427,687	6,410,644
GHD	B02	Water quality and levels	428,166	6,411,595
GHD	B03	Water quality and levels	429,882	6,412,459
GHD	B04	Water quality and levels	430,634	6,413,444
GHD	B07	Water quality and levels	417,322	6,419,415
GHD	B08	Water quality and levels	415,948	6,417,938
GHD	B09	Water quality and levels	420,091	6,418,115
GHD	B09_B	Water quality and levels	419,195	6,418,601
GHD	B10	Water quality and levels	426,297	6,419,709
GHD	B11	Water quality and levels	414,752	6,416,768
GHD	B12D	Water quality and levels	421,659	6,418,965
GHD	B12S	Water quality and levels	421,659	6,418,965
GHD	B13	Water quality and levels	413,156	6,421,906
GHD	B16D	Water quality and levels	420,801	6,421,111
GHD	B16S	Water quality and levels	420,800	6,421,111
GHD	B17	Water quality and levels	422,519	6,421,795
GHD	B18	Water quality and levels	426,132	6,425,478
GHD	B24	Water quality and levels	423,557	6,418,440
ALCOA	J3803-4A	Water quality and levels	423,857	6,425,953
ALCOA	J4012-1A	Water quality and levels	424,314	6,416,012
ALCOA	K3917-1A	Water quality and levels	425,580	6,419,008
ALCOA	K4011-1A	Water quality and levels	427,345	6,416,326
ALCOA	K4104-1A	Water quality and levels	428,407	6,413,122
ALCOA	K4106-1A	Water quality and levels	425,980	6,412,606
ALCOA	L4009-3A	Water quality and levels	428,915	6,416,135
ALCOA	J3803-3A	Water levels	423,445	6,425,994
ALCOA	J3922-2A	Water levels	422,468	6,418,491
ALCOA	J4108-1A	Water levels	424,370	6,412,792
ALCOA	K3825-11A	Water levels	425,729	6,421,999
ALCOA	K3918-1A	Water levels	426,264	6,419,167
ALCOA	K3919-1A	Water levels	426,866	6,418,916
ALCOA	K4010-2A	Water levels	426,364	6,416,172
ALCOA	K4018-1A	Water levels	426,371	6,414,800
ALCOA	K4018-2A	Water levels	426,145	6,415,171
ALCOA	K4019-1A	Water levels	427,280	6,414,986
ALCOA	K4025-1A	Water levels	424,925	6,413,867
ALCOA	K4025-2A	Water levels	425,664	6,413,655
ALCOA	K4026-1A	Water levels	425,841	6,413,802

Type	ID	Sampling type	Easting (MGA50)	Northing (MGA50)
ALCOA	L4009-2A	Water levels	429,079	6,416,547
ALCOA	L4013-1A	Water levels	428,936	6,415,647
ALCOA	L4019-1A	Water levels	430,845	6,415,054
ALCOA	L4027-1A	Water levels	430,770	6,413,886
ALCOA	L4101-1A	Water levels	429,036	6,413,478
Holyoake				
GHD	BH01	Water quality and levels	424,054	6,390,718
GHD	BH02	Water quality and levels	424,192	6,388,696
GHD	BH03	Water quality and levels	426,806	6,387,108
GHD	BH04	Water quality and levels	424,015	6,386,978
GHD	BH05	Water quality and levels	428,234	6,386,651
GHD	BH06	Water quality and levels	425,573	6,384,809
GHD	BH07	Water quality and levels	424,805	6,383,732
GHD	BH08	Water quality and levels	422,941	6,381,445
GHD	BH09	Water quality and levels	429,106	6,381,269
GHD	BH10	Water quality and levels	426,113	6,381,245
GHD	BH11	Water quality and levels	419,714	6,379,933
GHD	BH12	Water quality and levels	424,142	6,379,814
GHD	BH13	Water quality and levels	426,917	6,377,918
GHD	BH14	Water quality and levels	419,640	6,377,768
GHD	BH15	Water quality and levels	420,847	6,376,506
GHD	BH16	Water quality and levels	422,958	6,375,535
GHD	BH17	Water quality and levels	422,522	6,372,129
ALCOA	K4916-2A	Water quality and levels	428,489	6,377,903
ALCOA	J4904-4.25	Water quality and levels	424,091	6,379,273
ALCOA	H4821-2.4	Water levels	418,441	6,380,573
ALCOA	J4607-1A	Water levels	423,285	6,391,928
ALCOA	J4607-1B	Water levels	423,287	6,391,930
ALCOA	J4908-4.9	Water levels	424,357	6,378,864
ALCOA	K4605-1A	Water levels	425,037	6,391,511
ALCOA	K4610-1A	Water levels	425,967	6,391,100
ALCOA	L4913-1A	Water levels	428,774	6,378,098

Table B-2 Surface water monitoring locations

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
Myara North					
WG54	SW grab	Existing Alcoa	Wungong/Cobiac subcatchment Downstream of confluence of tributaries that have proposed mining	422,064	6,425,587
WG42	SW grab	Existing Alcoa	Wungong/Chandler Rd subcatchment Downstream of confluence of tributaries that have proposed mining	418,488	6,425,833
GG03	SW grab Turbidity WQ logger Diver WL logger	Existing Alcoa	Downstream extent of Gooralong Brook near study boundary (DWER site Gooralong Brook 12) Site located in proximity to Jarrahdale Rd	413,191	6,421,910
SW06	SW grab	New	Upstream tributary of Gooralong Brook Possible no upstream mining	417,826	6,421,144
SW05	SW grab	New	Minor tributary along western mining margin Direct flow into lower reach of Serpentine River Pipehead Dam	413,955	6,416,689
SW04	SW grab Turbidity WQ logger Diver WL logger	New	Minor tributary Direct flow into Serpentine River Pipehead Dam	416,461	6,416,868
TN34	SW grab	Existing Alcoa	39 Mile Brook upper catchment Background/control monitoring location Monitoring at suspected groundwater dependent ecosystem (GDE) location	426,450	6,419,745
TN01	SW grab	Existing DWER	39 Mile Brook - mid catchment Monitoring at suspected GDE location	421,739	6,418,949
TN14	SW grab	Existing Alcoa Existing DWER	39 Mile Brook Jack Rocks stream gauging Equipment installed by Alcoa	420,689	6,417,649

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
SW03	SW grab Turbidity WQ logger Diver WL logger	New	Downstream extent of 39 Mile Brook catchment	419,652	6,416,696
SN01	SW grab	Existing Alcoa	Upstream Banksia Gully Monitoring at suspected GDE location	424,339	6,416,149
6141121	SW grab EC WQ logger Diver WL logger	Existing DWER	Banksia Gully (DWER site Serpentine 22) Mining in upper extent of catchment extends into 1100mm isohyet	421,839	6,415,049
SN02	SW grab	Existing Alcoa	Goldmine Gully - mid catchment Monitoring at suspected GDE location	425,306	6,413,889
6141125	SW grab EC WQ logger Diver WL logger	Existing DWER	Central tributary Goldmine Gully (DWER site Serpentine 26) Subcatchment crosses 1100 mm isohyet Mining proposed in lower and upper sections of catchment	424,189	6,412,849
SW02	SW grab	New	Eastern tributary with limited mining activity identified	426,078	6,412,502
SN04	SW grab	Existing Alcoa	Minor tributary with no mining identified in catchment Proposed background location	427,589	6,410,640
SW01	SW grab	New	Minor eastern tributary with limited mining activity identified	429,636	6,410,191
BF04	SW grab	Existing Alcoa	Minor eastern tributary with limited mining activity identified	430,000	6,409,690
SW07	SW grab	New	Probable upstream mining (south east boundary)	430,870	6,410,090
SW08	SW grab Turbidity WQ logger Diver WL logger	New	Downstream proposed Serpentine River conveyor crossing location	423,946	6,412,188

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
Holyoake					
6141333	SW grab	Existing DWER	Northern South Dandalup tributary	422,939	6,388,649
HSW05	SW grab Turbidity WQ logger EC WQ logger Diver WL logger	New	Northern South Dandalup tributary Downstream proposed conveyor crossing location	423,041	6,386,536
HSW01	SW grab	New	Monitoring location sited to capture upstream contributing catchment	428,385	6,386,875
BF20	SW grab	Existing Alcoa	Minor internal tributary of South Dandalup River	428,128	6,386,529
6141352	SW grab	Existing DWER	Location sited to capture upstream Duncans Rd Crossing catchment	428,089	6,384,999
6141349	SW grab	Existing DWER	South Dandalup River Location sited along eastern boundary of proposal area	426,439	6,384,349
HSW04	SW grab	New	Location sited to capture two external tributaries	429,199	6,381,349
6141005	SW grab Turbidity WQ logger EC WQ logger Diver WL logger	Existing DWER	South Dandalup River Location sited along western boundary of proposal area Existing data: 1970s, Cl data, limited EC and turbidity	424,563	6,383,974
SD31	SW grab	Existing Alcoa	Upstream boundary on central South Dandalup – Pindalup tributary. Just downstream of 614043 DWER gauging station (flow data to 1998)	427,208	6,377,990
6141340	SW grab	Existing DWER	Downstream location on South Dandalup – Pindalup tributary Existing data: 1975-1995, EC and turbidity	422,889	6,381,448
6141325	SW grab	Existing DWER	Minor southern tributary Direct discharge into South Dandalup Dam	419,089	6,382,349

Site ID	Type	Category	Rationale	Easting (MGA50)	Northing (MGA50)
DV04	SW grab	Existing Alcoa	Characterise discharge of southern Proposal area to Davis Brook (Murray River)	417,714	6,377,514
HSW02	SW grab	New	Location sited to capture upstream and external contributing catchment (Oak Brook)	426,143	6,374,994
6141470	SW grab	Existing DWER	Located on southern Proposal boundary	423,589	6,372,898
HSW03	SW grab Turbidity WQ logger EC WQ logger Diver WL logger	New	Characterise discharge of southern Proposal area to Swamp Oak Brook (Murray River) Located upstream of Lane Poole Reserve which has high social value	422,381	6,371,886

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The Power of Commitment

Appendix N

Surface and Groundwater Monitoring; Installation Report

Alcoa World Alumina Australia

Alcoa Huntly Expansion Environmental approval

Surface water and groundwater monitoring: Installation report

December 2020

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Appendix C - Hobo U24-001
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Appendix F – Chip tray photographs (Myara North)
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1. Introduction

1.1 Background

Alcoa of Australia Limited (Alcoa) is proposing to increase production at the Pinjarra Alumina Refinery and Huntly Bauxite Mine (the Alcoa Proposal). The Huntly Mine operations will be extended into the Myara North and Holyoake regions. The Myara North region lies adjacent and north of the existing Myara mining operations. The Holyoake region lies north-east of Dwellingup, approximately 20 km south of Myara North.

Alcoa has engaged GHD to prepare the environmental approval documentation and supporting technical studies (the Project) for the Alcoa Proposal under the EP Act and EPBC Act. The technical studies include the characterisation of baseline surface water and groundwater conditions within the Myara North and Holyoake regions, which together are referred to as 'the Mine Development Envelope'.

To characterise baseline surface water and groundwater conditions it was identified that new monitoring locations were needed to provide representative hydrological and hydrogeological data for the Mine Development Envelope. This report provides a summary of the monitoring installations that have been completed in the Myara North and Holyoake project areas.

1.2 Purpose

This Installation Report (the Report) documents the locations of installed monitoring equipment and infrastructure (both temporary and permanent) and the specific nature and type of monitoring equipment installed. This report should be considered in conjunction with the Sampling Analysis Quality Plan.

The installed monitoring equipment and infrastructure is summarised as:

- **Myara North**
  - Six (6) surface water instrumentation locations
  - 18 new groundwater monitoring bores

- **Holyoake:**
  - Three (3) surface water instrumentation locations
  - 17 new groundwater monitoring bores

1.3 Scope and limitations

This report: has been prepared by GHD for Alcoa World Alumina Australia and may only be used and relied on by Alcoa World Alumina Australia for the purpose agreed between GHD and the Alcoa World Alumina Australia as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Alcoa World Alumina Australia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

This Report applies to the installation of surface water monitoring equipment in the Myara North and Holyoake regions and may only be used by Alcoa. It must not be copied to, used by, or relied on by any person other than Alcoa without the prior written consent of GHD and shall only be used for the purpose noted in Section 1.2.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Alcoa World Alumina Australia and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Surface Water

2.1 Installed equipment

2.1.1 Overview

Selected surface water monitoring locations were instrumented with water quality and water level loggers to provide a short-term continuous baseline monitoring record. A summary of the surface water monitoring equipment installed is provided in Table 2-1.

The equipment was installed for temporary monitoring only and associated supporting structures were built for this purpose.

Table 2-1 Surface water monitoring equipment

Equipment type	Parameter	Equipment details
Greenspan TS1000	Turbidity	Appendix A
Hobo U24-001	Electrical conductivity	Appendix C
Diver	Water level	Appendix D

2.1.2 Maintenance

Loggers were inspected a day after install to ensure they were in working order. Monitoring will be completed in January 2021 at which point the loggers and all installation materials (e.g. steel posts, ties, bolts, casing) will be removed. No telemetry is involved.

2.2 Monitoring locations

The location for installation of surface water monitoring equipment was based on key water quality risks and impacts, including:

- **Turbidity loggers** deployed within selected tributaries of drinking water reservoirs (Serpentine Dam, South Dandalup Dam) to characterise baseline turbidity concentrations. Sites selected with reference to stream order (second order tributary and above) and available mining plan.
- **Turbidity loggers** deployed within selected tributaries with high social value. These include Gooralong Brook (Myara North) which passes through Jarrahdale and Swamp Oak Brook (Holyoake) which passes through Lane Poole Reserve.
- **Electrical conductivity loggers** to assess baseline electrical conductivity concentrations within selected tributaries with potential mining activity east of the 1,100 mm rainfall isohyet.
- **Water levels loggers** co-deployed with water quality loggers to measure stream levels within selected tributaries.

The location of surface water monitoring equipment installation within Myara North and Holyoake are summarised in Appendix A as Table and Table , respectively. Likewise, locations for the two regions are depicted in Figure A-1 and Figure A-2, respectively.

2.3 Monitoring site reports

2.3.1 Overview

The following sections detail the individual site installation reports, which include site maps, photographs prior to and post installation, details of the specific equipment installed and notes regarding the installation.

2.3.2 Myara North

Site GG03 (Gooralong Brook)

Site GG03 is located on Gooralong Brook, downstream of Jarrahdale Road at the site of an existing weir and apparent gauging station. The gauging station is not identified in the Department of Water and Environmental Regulation Water Information Reporting database.

The site location is presented in Figure 2-1, with a photograph of the installation provided in Figure 2-2 and installation notes in Table 2-2.

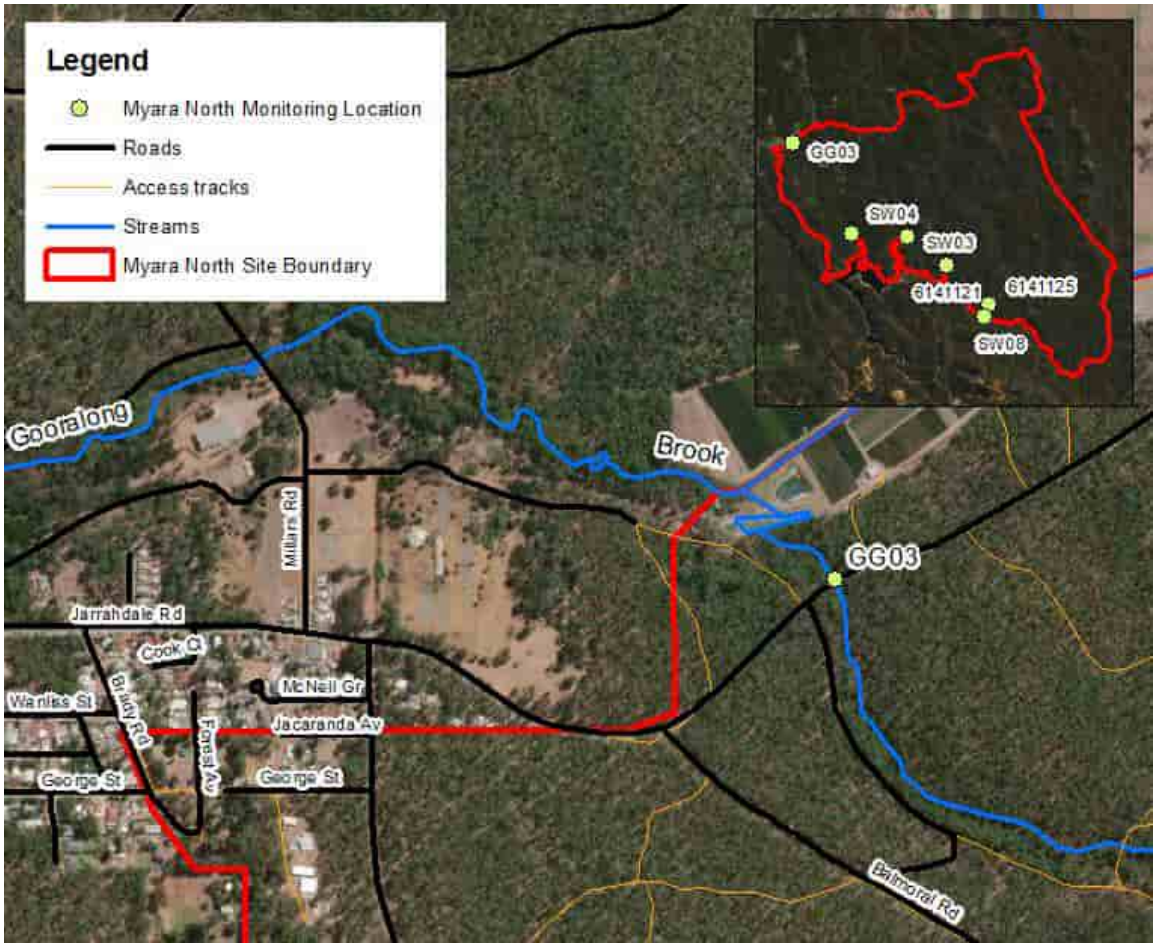


Figure 2-1 Location of GG03

Table 2-2 GG03 Installation notes

Note	Detail
Site ID	GG03
Monitoring equipment type	Turbidity, water level
Rationale	Downstream extent of Gooralong Brook near study boundary (DWER site Gooralong Brook 12) Site located in proximity to Jarrahdale Rd Gooralong Brook flows through Jarrahdale townsite, potential social impacts from mining within catchment
Installation date	17/09/2020
Install details	Secured in PVC piping upstream of weir. Back up chain link to secure to concrete in stream. Battery stored in water proof case on bank.

Figure 2-2 Photograph of GG03 installation

Site SW04 (Serpentine Main Dam – minor tributary)

Site SW04 is located on a minor tributary that flows in a south-easterly direction directly into the Serpentine Dam. The site location is presented in Figure 2-3, with a photograph of the installation provided in Figure 2-4 and installation notes in Table 2-3.

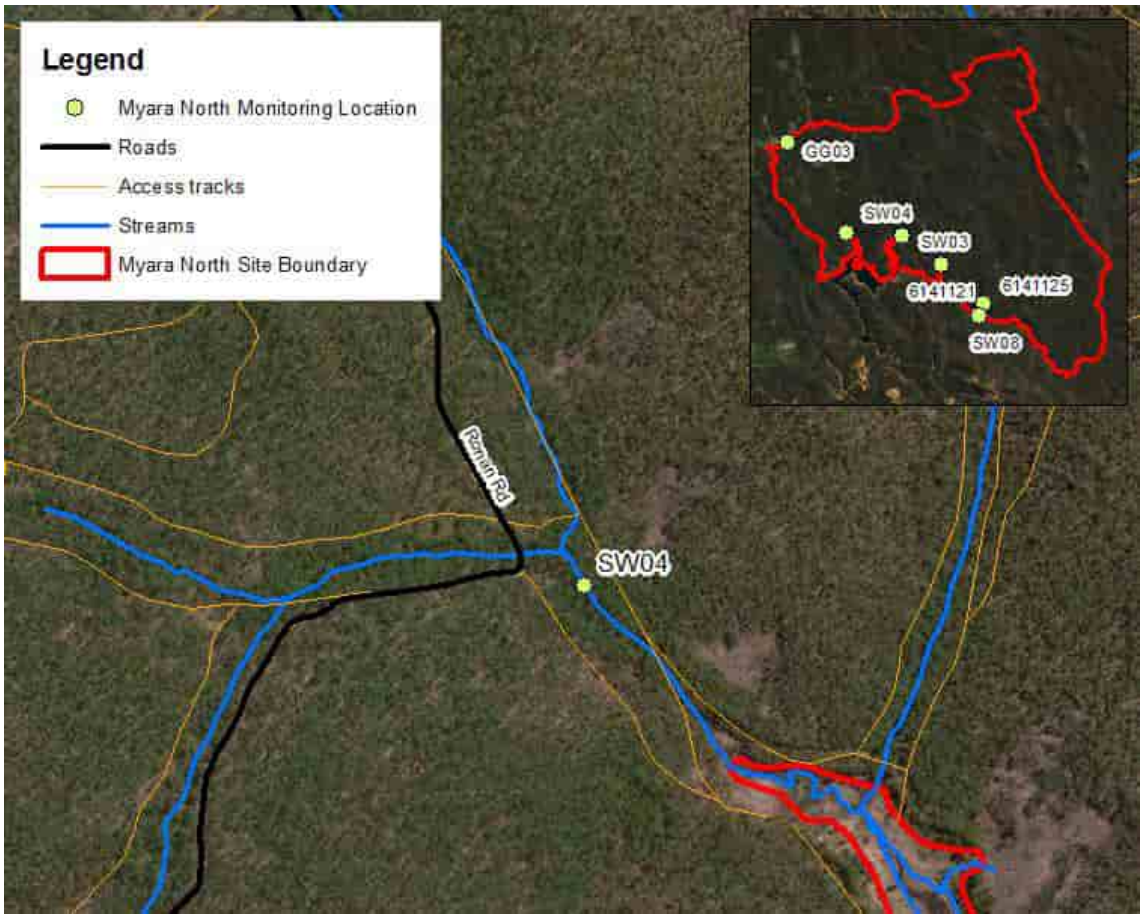


Figure 2-3 Location of SW04

Table 2-3 SW04 Installation notes

Note	Detail
Site ID	SW04
Monitoring equipment type	Turbidity, water level
Rationale	Minor tributary. Direct flow into Serpentine River Pipehead Dam
Installation date	19/09/2020
Install details	Secured in PVC piping attached to timber post. Battery stored in water proof case on bank.

Figure 2-4 Photograph of SW04 installation

Site SW03 (39 Mile Brook)

Site SW03 is located at the downstream extent of 39 Mile Brook at the site of an old timber bridge. 39 Mile Brook is the largest sub-catchment in the Myara North mining region, and the site shows evidence of high velocity flows and scour. The site location is presented in Figure 2-5, with a photograph of the installation provided in Figure 2-6 and installation notes in Table 2-4.

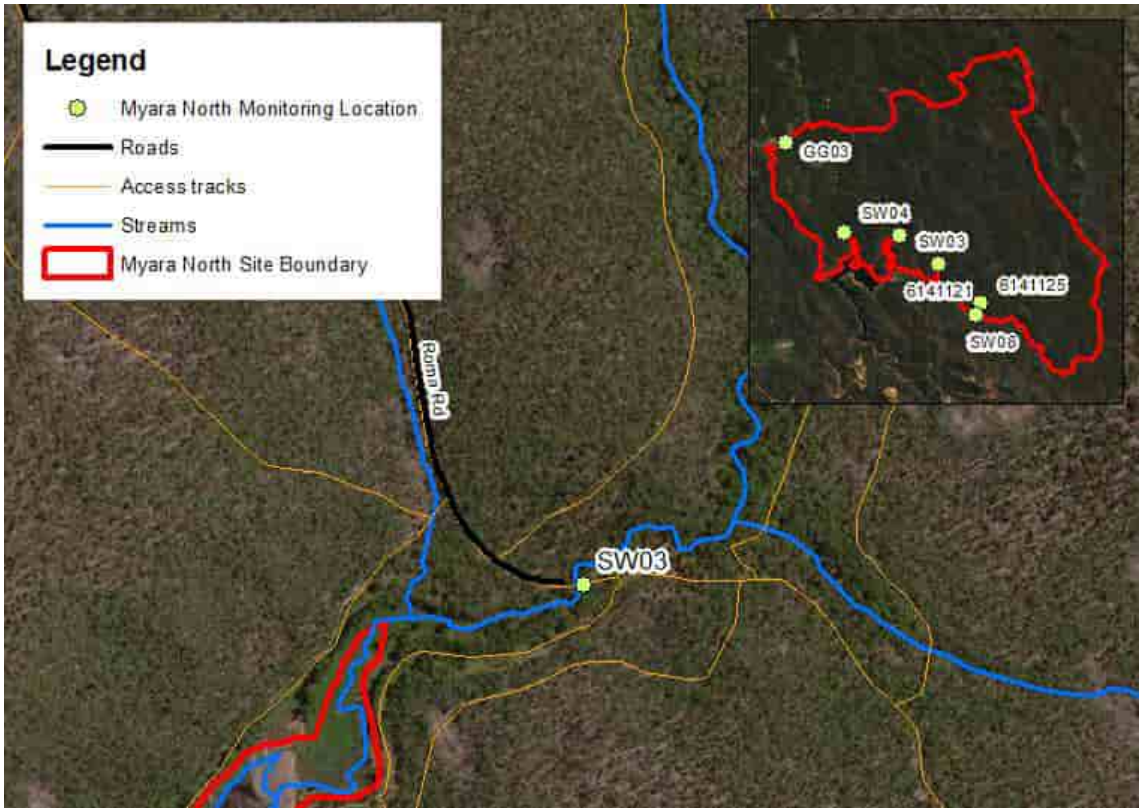


Figure 2-5 Location of SW03

Table 2-4 SW03 Installation notes

Note	Detail
Site ID	SW03
Monitoring equipment type	Turbidity, water level
Rationale	Downstream extent of 39 Mile Brook catchment, largest sub-catchment in proposed mining area.
Installation date	17/09/2020
Install details	Secured in PVC piping attached to timber bridge. Battery stored in water proof case on bank.

Figure 2-6 Photograph of SW03 installation

Site SW08 (Serpentine River)

Site SW08 is located in the Serpentine River downstream of the proposed conveyor crossing location. Site accessibility is limited with no defined access tracks, and thick remnant riparian vegetation from vehicle accessible areas. The site location is presented in Figure 2-7, with a photograph of the installation provided in Figure 2-8 and installation notes in Table 2-5.

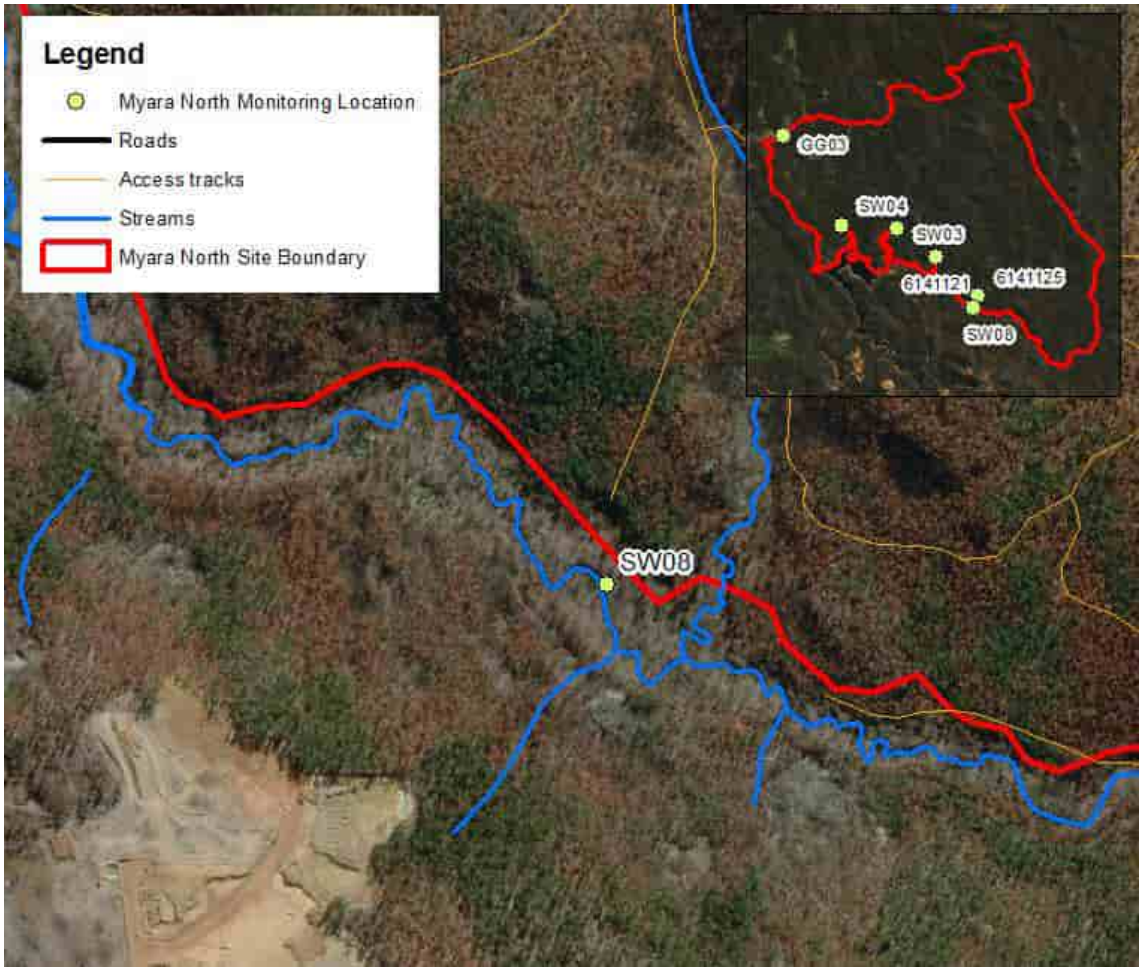


Figure 2-7 Location of SW08

Table 2-5 SW08 Installation notes

Note	Detail
Site ID	SW08
Monitoring equipment type	Turbidity, water level
Rationale	Background monitoring location downstream of proposed conveyor crossing of Serpentine River
Installation date	22/09/2020
Install details	Loggers secured in PVC piping attached to timber post. Battery stored in a water proof case attached on top of timber post.

Figure 2-8 Photograph of SW08 installation

Site 6141121 (Banksia Gully)

Site 6141121 is located at the downstream extent of the Banksia Gully catchment, at a site corresponding with DWER surface water monitoring location 6141121. The site location is presented in Figure 2-9, with a photograph of the installation provided in Figure 2-10 and installation notes in Table 2-6.

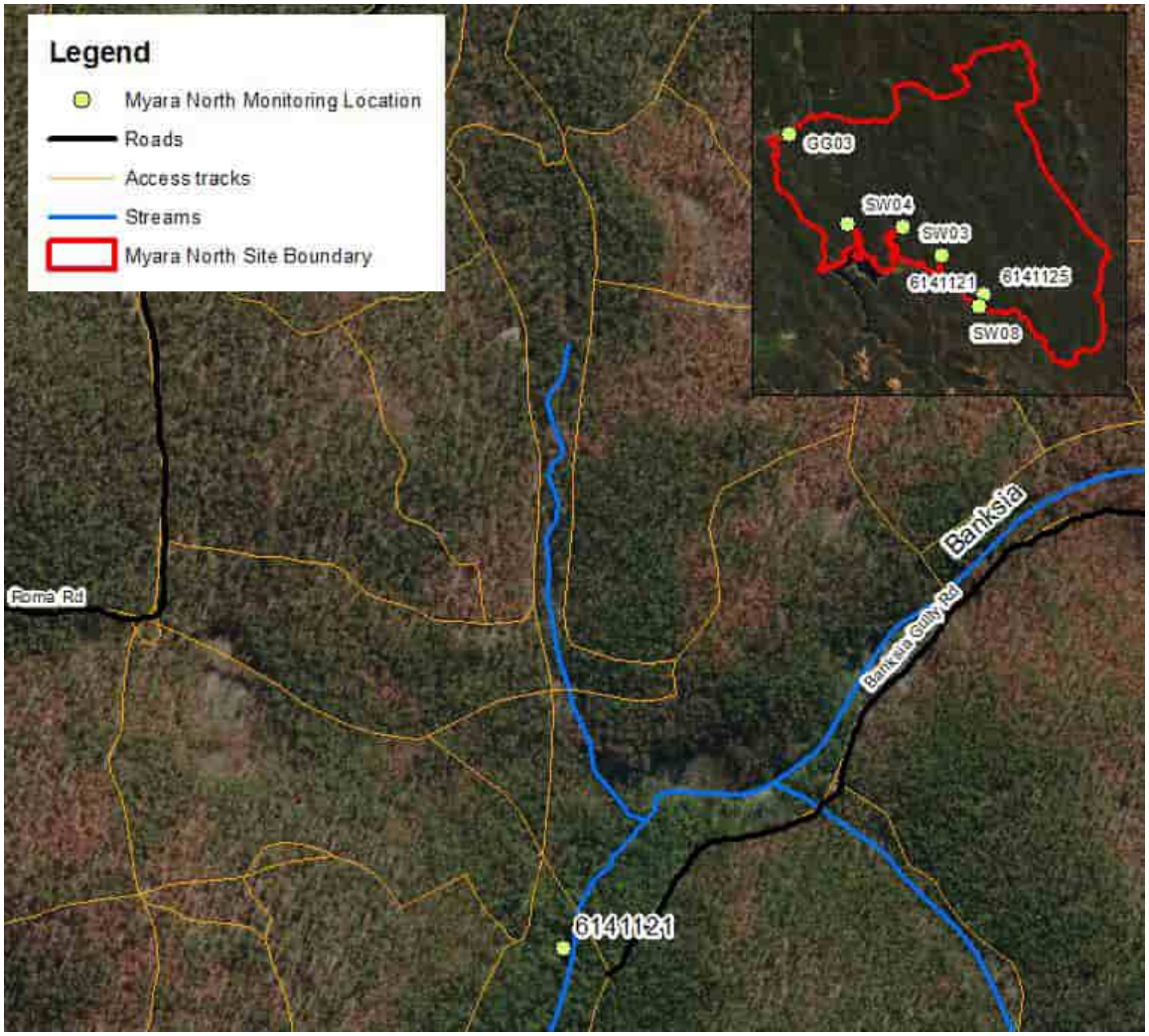


Figure 2-9 Location of 6141121

Table 2-6 6141121 Installation notes

Note	Detail
Site ID	6141121
Monitoring equipment type	EC, water level
Rationale	Downstream extent of Banksia Gully DWER site Serpentine 22 Mining in upper extent of catchment extends into 1100mm isohyet
Installation date	21/09/2020
Install details	Loggers secured in PVC piping. PVC piping secured to timber post for additional support.

Figure 2-10 Photograph of 6141121 installation

Site 6141125 (Goldmine Gully)

Site 6141125 is located at the downstream extent of the Goldmine Gully catchment, downstream of the confluence of tributaries. The site corresponds with DWER surface water monitoring location 6141125. The site location is presented in Figure 2-11, with a photograph of the installation provided in Figure 2-12 and installation notes in Table 2-7.

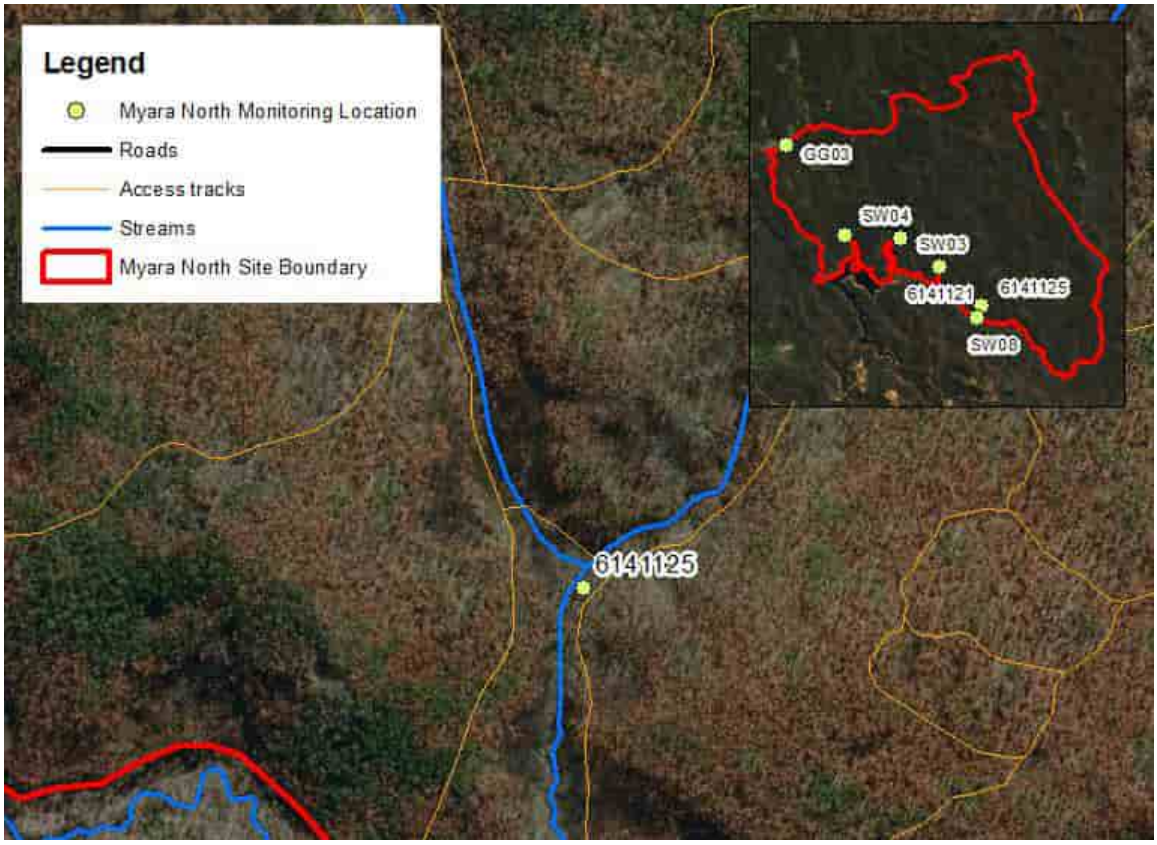


Figure 2-11 Location of 6141125

Table 2-7 6141125 Installation notes

Note	Detail
Site ID	6141125
Monitoring equipment type	EC, water level
Rationale	Central tributary Goldmine Gully DWER site Serpentine 26 Subcatchment crosses 1100 mm isohyet Mining proposed in lower and upper sections of catchment
Installation date	22/09/2020
Install details	Secured in PVC piping. Back up chain link to granite in stream.

Figure 2-12 Photograph of 6141125 installation

2.3.3 Holyoake

Site HSW05 (Northern South Dandalup tributary)

Site HSW05 is located downstream of the proposed conveyor crossing for the Holyoake region. The site location is presented in Figure 2-11, with a photograph of the installation provided in Figure 2-14 and installation notes in Table 2-8.

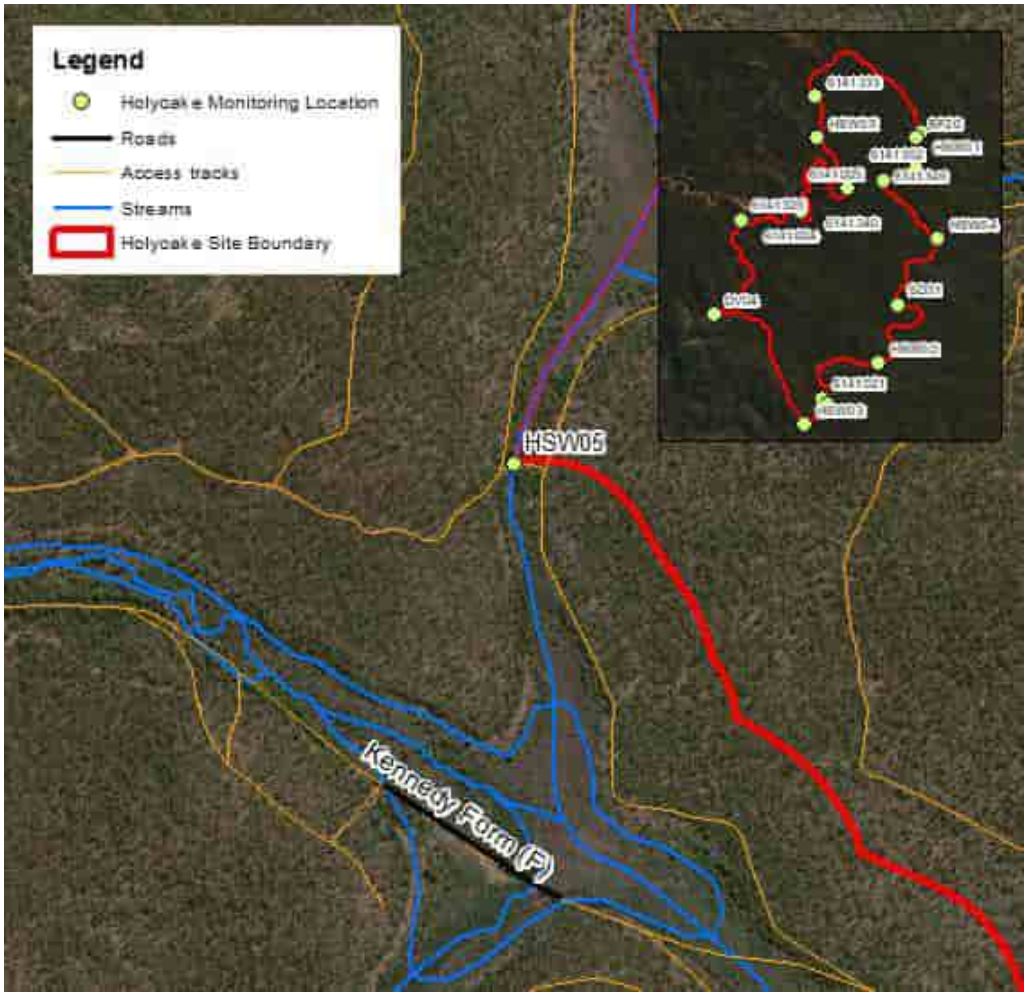


Figure 2-13 Location of HSW05

Table 2-8 HSW05 Installation notes

Note	Detail
Site ID	HSW05
Monitoring equipment type	Turbidity, EC, water level
Rationale	Site located downstream of proposed Holyoake conveyor crossing. Tributary runs along north-western boundary of Holyoake region.
Installation date	23/09/2020
Install details	Installed on upstream side of road crossing. Loggers secured in PVC piping and back up chain link to secure to concrete in stream. PVC piping painted forest green due to high site visibility from track.

Figure 2-14 Photograph of HSW05 installation

Site 6141005 (South Dandalup River)

Site 6141005 is located within the western boundary of the proposal area along the South Dandalup – River. The site location is presented in Figure 2-15, with a photograph of the installation provided in Figure 2-16 and installation notes in Table 2-9.

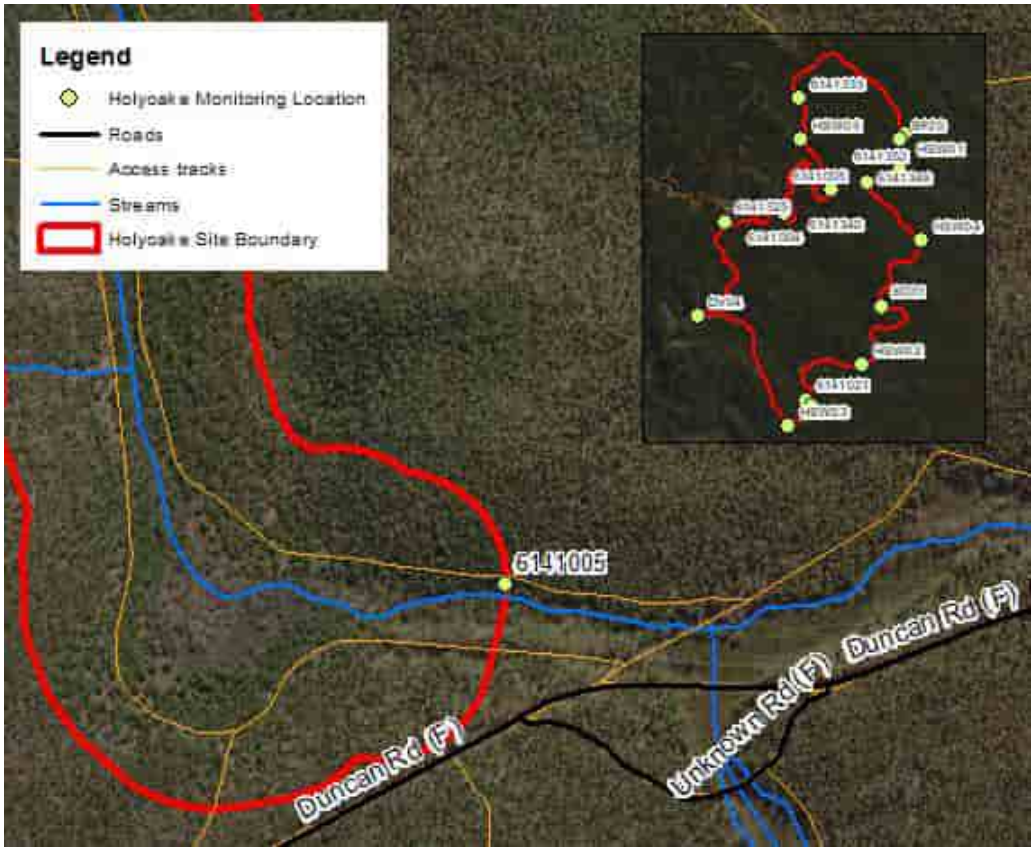


Figure 2-15 Location of 6141005

Table 2-9 6141005 Installation notes

Note	Detail
Site ID	6141005
Monitoring equipment type	Turbidity, EC, water level
Rationale	Located at downstream extent of South Dandalup River along western boundary of proposed Holyoake mining region
Installation date	24/09/2020
Install details	Loggers secured in PVC piping which is secured to timber post for additional support. Back up chain link to secure to timber post in stream. Battery stored in water proof case on bank.

Figure 2-16 Photograph of 6141005 installation

Site HSW03 (Swamp Oak Brook)

Site HSW03 is located at the southern extent of study area boundary, on the Swamp Oak Brook tributary. The site location is presented in Figure 2-17, with a photograph of the installation provided in Figure 2-18 and installation notes in Table 2-10.

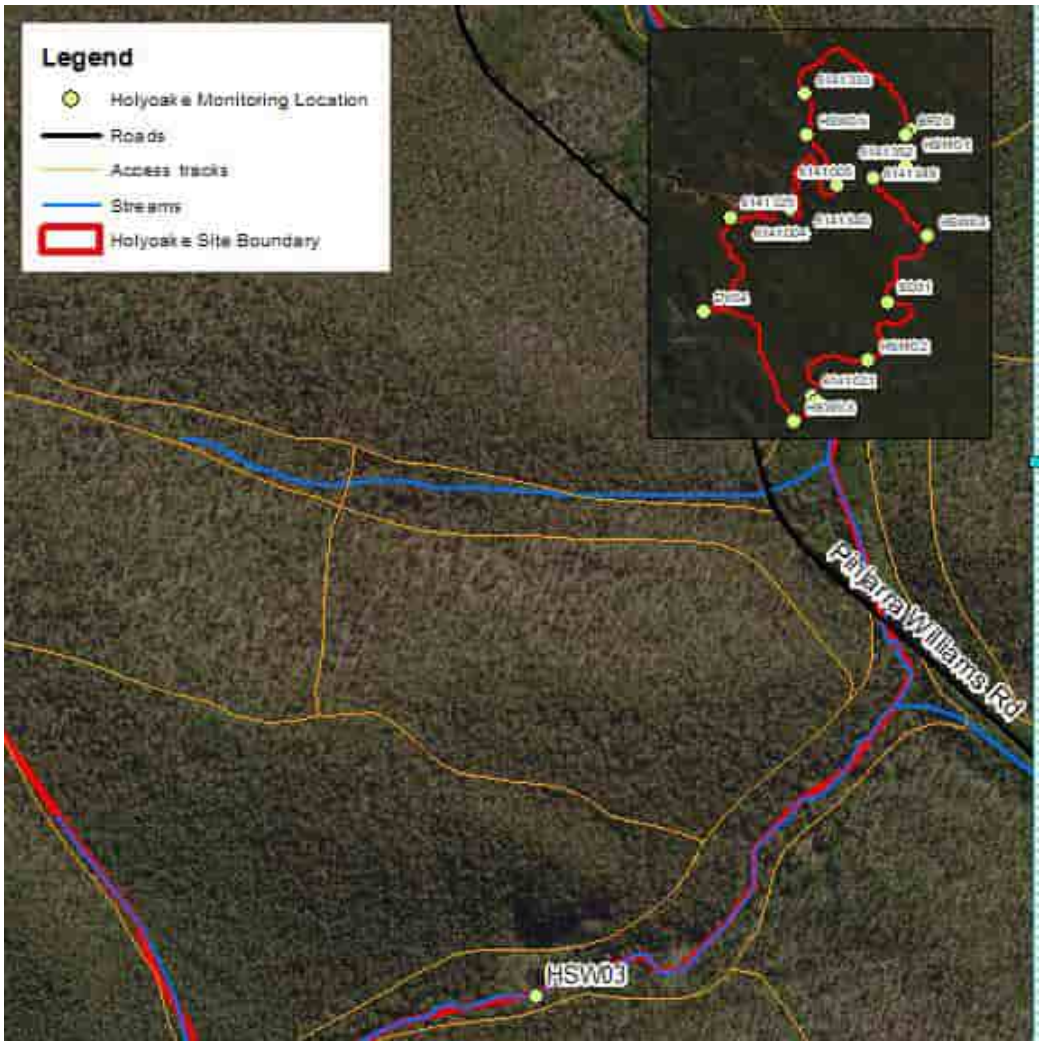


Figure 2-17 Location of HSW03

Table 2-10 HSW03 Installation notes

Note	Detail
Site ID	HSW03
Monitoring equipment type	Turbidity, EC, water level
Rationale	Baseline quality monitoring for flows leaving Holyoake region to Swamp Oak Brook, and subsequently Murray River Swamp Oak Brook passes through Lane Poole Reserve, and conservation and recreation reserve with high social value
Installation date	24/09/2020
Install details	Loggers secured in PVC piping. PVC piping painted forest green due to high site visibility from track. Battery stored in water proof case on bank.

Figure 2-18 Photograph of HSW03 installation

3. Groundwater

3.1 Bore licensing

According to the Department of Water and Environmental Regulation (DWER), a licence is not required to construct a well or take water if:

1. The development is within the water table (non-artesian) aquifer, and
2. The well is required for monitoring water level and water quality.

3.2 Bore locations

Eighteen new groundwater monitoring bore locations were selected at Myara North and seventeen at Holyoake. These monitoring bore locations will generate the data needed to better inform baseline conditions and for future hydrological modelling calibration. These monitoring locations were spatially distributed across the two sites, accounting for the presence of existing monitoring bores that will also be used for baseline monitoring. The locations are presented in Figure A-1 for Myara North and Figure A-2 for Holyoake.

The new bores will be monitored in addition to a number of existing bores within the two sites as specified in the *Baseline Hydrology Monitoring Program and Sampling Analysis and Quality Plan* (GHD 2020).

Prior to drilling, underground service checks were completed using the Dial Before You Dig (DBYD) online system. As nearly all locations were situated within uncleared, natural forest, no underground services were in the immediate vicinity.

All monitoring bore locations are accessible from existing sealed and unsealed roads and forest tracks. The locations are in naturally clear areas off these tracks. No physical clearing or pad preparation was undertaken. Typical drilling locations including completed monitoring bores are shown in the photos presented below as Figure 3-1, Figure 3-2 and Figure 3-3.

3.3 Drilling approach

The approach to drilling and bore installation was to drill to a sufficient depth so as to intersect the watertable and provide a suitable depth of saturated formation from which to monitor baseline groundwater levels and groundwater quality, and then to assess potential changes during the subsequent mining stages.

Additionally, the lithological data, including the thickness of weathered profile and depth to basement rock, will provide essential stratigraphic data to allow the development of a groundwater model. As such, the intention was therefore to drill to the basement rock at each location, and screen the key hydrogeological units found within the lithological profile.

Based on a review of nearby bores and other investigations within the area, the expected lithology was generally a lateritic profile (including possible bauxite zone), grading into residual clays to saprolite, and then weathered basement, likely to be dominated by granite. The weathered basement zone can often include a course quartz rich zone that can host the higher flowing portion of the aquifer.

3.4 Drilling methodology

All drilling and bore installation was completed to meet the industry standard: 'Minimum Construction Requirements of Water Bores in Australia' (4th Edition, 2020, Australian Government National Water Commission).

Drilling was undertaken by Proline Drilling using a Comacchio Geo 305 drilling rig, equipped to drill using a dual tube vacuum air-core methodology, with availability to switch to NQ diamond coring where required. The drill rig is shown on Figure 3-2.

Drilling was primarily undertaken with air-core methods with a 117 mm diameter drill bit (HWT size). At three sites at Myara North (B03, B07 and B09) and three sites at Holyoake (BH10, BH12 and BH15), the drilling method was changed to NQ diamond coring after the aircore system hit refusal on competent basement rock at depths above the watertable. The NQ coring was completed within the outer casing of the aircore drill rods, therefore keeping the unconsolidated material from collapsing and negating the need for drilling muds.

The aircore drilling method allowed the assessment of the drilled lithology and water strikes during drilling. All drilling was completed under the technical supervision of a GHD hydrogeologist. Samples were logged at 0.5 m intervals and placed in chip trays for assessment and a photographic record. Where sufficient water returns were noted during drilling, groundwater yield and groundwater quality (as Total Dissolved Solids (TDS), Electrical Conductivity (EC) and pH) was measured at each 1.5 m rod change. Water quality was measured using a calibrated water quality meter.

Based on the assessment of the drilled lithology, the supervising hydrogeologist determined the appropriate depths and methods for monitoring bore installation.

The bore drilling methodology depths (i.e. aircore or NQ diamond coring) are shown on the bore logs presented as Appendix E for Myara North and Appendix G for Holyoake.

3.5 Monitoring bore installations

All monitoring bores were constructed with Class 18 threaded PVC casing with a 50 mm internal diameter. Machine slotted screens (0.4 mm slot aperture) were installed from the base of each bore. The length of the screened interval varied between sites, with the screened sections generally aligned with the higher groundwater flow zones found towards the base of the saprolitic profile.

The drilling method allowed casing materials to be installed down the centre of the drill string to the required depths. The screened interval was gravel packed with 0.8 mm to 2.0 mm graded gravel to at least 0.5 m above the top of the screen. A bentonite plug was then emplaced above the gravel for a nominal thickness of around 1 m. The remaining bore annulus was generally cement grouted to around 0.5 to 1 m below the surface. A steel monument cover was then concreted in place at the surface.

All bores were developed using air-lifting techniques to remove fines from the bore and encourage groundwater flow to the bore screened interval. Air-lifting was completed until the purged groundwater was relatively free from fines. At sites with very low flow or only a shallow depth of groundwater, bore development was undertaken with a bailer.

A survey of the top of casing level and ground level at each monitoring bore are yet to be completed by Alcoa.

Bore installation details are presented on the bore logs presented as Appendix E for Myara North and Appendix G for Holyoake, and summarised in the tables presented in Section 3.7.

Figure 3-1 Typical monitoring bore headworks (BH15)

Figure 3-2 Monitoring bore and drill rig (BH17)

Figure 3-3 Typical monitoring bore location (bore on left of track – BH16)

3.6 Drilling summary

3.6.1 Myara North

Myara North drilled lithology is detailed on the bore logs presented as Appendix E, and the chip tray photographs presented as Appendix F.

With the exception of those areas with a shallow depth to bedrock (i.e. less than 10 m), a broadly consistent lithology profile was found across the site, with a typical weathering profile of between 15 to 25 m total depth. The typical drilled profile can be generalised as:

Upper lateritic unit/duricrust: often comprising of minor soil, pea-gravel and cemented duricrust/caprock. This tended to be between 1-3 m deep (but up to 4.5 m). At the majority of locations, the caprock layer was hard to very hard, with massive cemented pisolitic nodules. A moist zone, generally not saturated, was often found overlying the caprock. ‘

Clay zone: The clay zone varied between locations both in depth and general composition. Generally, the clays were found to transition from leached white silty clays, somewhat mottled at first, into more of an iron stained/greenish clays with some lithic fragments. Depending on the clay content, this unit was often drilled as dry or slightly moist.

Weathered zone: The weathered basement zone was generally less than 2 m in depth and was characterised by a gravelly texture of weathered basement, usually granite. Groundwater flow was highest in this zone, and pressurised in most locations (i.e. groundwater levels in completed bores found in the overlying clay zone that could be drilled as ‘dry’ clay).

Basement: The majority of sites with a significant lateritic profile (i.e. more than 10 m) encountered granite as the basement rock. For those shallow sites, with less of the lateritic profile, dolerite was the dominant basement rock (i.e. B01, B03 and B07). Shallow granite was encountered at B09 and B18 at 3.2 m and 8.2 m respectively.

As noted above, groundwater inflow was generally only found within the weathered zone, however some of the clays zones did have minor groundwater seepage. Groundwater flow in the weathered zone was quite variable, with flows up to 1 L/s found at B08 and B13.

3.6.2 Holyoake

Holyoake lithology is detailed on the bore logs presented as Appendix G, and the chip tray photographs presented as Appendix H.

The Holyoake lateritic profile was generally of greater thickness that at Myara North, with typical depth to bedrock being 20-30 m. Two sites, BH12 and BH15 had shallow depth to bedrock (i.e. less than 10 m). The typical drilled profile can be generalised as:

Upper lateritic unit/duricrust: often comprising of minor soil, pea-gravel and cemented duricrust/caprock. This tended to be between 1-2 m deep, however an increased thickness, with a secondary caprock was noted at BH07 to a depth of 7.5 m. The prevalence of a fully cemented caprock layer was slightly less ubiquitous with comparison to Myara. A moist zone, generally not saturated, was often found overlying the caprock. A noticeable anomaly was seen at BH16 where a grey well sorted sand horizon was found from the surface to a depth of 3.2 m with no duricrust.

Clay zone: The clay zone varied between locations both in depth and general composition. Generally, the clays were found to transition from leached white silty clays, somewhat mottled at first, into more of an iron stained/greenish clays with some lithic fragments. Several locations had a relatively thick mid sequence (up to 20 m) of quite uniform silty clays. Depending on the clay content, this unit was often drilled as dry or slightly moist.

Weathered zone: The weathered basement zone was generally of greater thickness than at Myara, however this was generally more clay rich and not associated with significant groundwater flow. Groundwater flow in this zone was generally only minor with measured flow during drilling of less than 4 L/minute at most locations.

Basement: The majority of sites encountered granite as the basement rock. At shallow sites BH12 and BH15 a quartzite and diabase basement was noted respectively. At BH13 a basement schist was recorded at a depth of 33.5 m, however the overlying weathering profile was not dissimilar to other sites.

3.7 Bore installation summary

3.7.1 Myara North installation summary

A summary of installed monitoring wells at Myara North Is presented in Table 3-1. In general, the monitoring wells were terminated at the top of basement rock. Depth to basement was found to vary across the site, with a maximum depth to basement of 28.5 m at B02. Many locations encountered basement rock at much shallower depths; approximately 10 m.

Each monitoring well was airlifted at target depth to ascertain water quality parameters and yield. pH was found to be slightly acidic to slightly basic.

Total dissolved solids (TDS) measured during airlift indicate the groundwater is fresh to marginal, with BH02 being brackish. Yields determined via airlift indicate limited groundwater flow, with all locations yielding 0.5 L/s or less, except BH08 which yielded 1 L/s.

Table 3-1 Myara North monitoring well installation summary

Location	MGA GDA94		Total depth (mbgl)	Screen top (mbgl)	Screen bottom (mbgl)	Static water level (mbtoc)[1]	Final airlift water quality			
	Easting	Northing					pH	TDS (mg/L)	EC (uS/cm)	Yield (L/s)
B01	424,054	6,390,718	7.7	4.4	7.7	4.38	7	297	458	0.03
B02	424,192	6,388,696	28.5	22.5	28.5	15.92	8.13	2106	3234	0.03
B03	426,806	6,387,108	23.9	17.9	23.9	24.23				0.02
B04	424,015	6,386,978	36	29.2	35.2	22.54	6.68	314	483	0.05
B07	428,234	6,386,651	8	5	8	4.95	5.34	352	542	0.08
B08	425,573	6,384,809	13.1	7.1	13.1	4.10	7	420	650	1.00
B09	424,805	6,383,732	3.2	0.7	3.2	3.10	7.3	399	615	0.02
B09_B	422,941	6,381,445	8.9	5.9	8.9	7.84	4.7	526	812	0.02
B10	429,106	6,381,269	21.5	15.2	21.2	10.79	9.8	682	1046	0.07
B11	426,113	6,381,245	14.1	11	14.0	7.35	5.5	196	290	0.33
B12_D	419,714	6,379,933	24.5	18.5	24.5	1.73	6.66	403	626	0.12
B12_S	424,142	6,379,814	3.5	0.5	3.5	1.86	7.62	148	228	0.02
B13	426,917	6,377,918	18.5	9.4	18.4	1.94	5.97	258	400	0.08
B16_D	419,640	6,377,768	17.5	11.5	17.5	7.88	7	500	768	0.20
B16_S	420,847	6,376,506	4	1	4	DRY	6.2	109	167	0.02
B17	422,958	6,375,535	10.7	4.7	10.7	7.07	5.4	221	34	0.03
B18	422,522	6,372,129	8.2	1.8	7.8	7.85	8.6	442	675	0.02
B24	424,054	6,390,718	24.9	12.3	24.3	2.92	9.1	416	638	0.17

Note [1] – Water level measurements taken during water quality sampling (16/10/2020).

3.7.2 Holyoake installation summary

Installation details for monitoring wells at Holyoake at presented in Table 3-2. A similar rationale was used when installing monitoring wells in the Holyoake area to that in Myara North, with boreholes terminated at the top of basement. Basement was, in general, encountered deeper in the Holyoake area than in Myara North, with BH06 encountering bedrock at 36 m.

Water quality across the Holyoake sites was generally consistent. pH values measured during airlift appear to be more basic than subsequent laboratory results, indicating potential field instrument error. Subsequent laboratory tested samples will confirm this.

Total dissolved solids (TDS) measured during airlift indicate the groundwater is fresh to marginal. Yields determined via airlift indicate limited groundwater flow, with all locations yielding 0.5 L/s or less.

Table 3-2 Holyoake monitoring well installation summary

Location	MGA GDA94		Total depth (mbgl)	Screen top (mbgl)	Screen bottom (mbgl)	Static water level (mbtoc)[1]	Final airlift water quality			
	Easting	Northing					pH	TDS (mg/L)	EC (uS/cm)	Yield (L/s)
BH01	424,054	6,390,718	29.5	20.5	29.5	8.55	10.2	630	816	0.27
BH02	424,192	6,388,696	17.5	12.5	17.5	12.02	8.75	360	556	0.07
BH03	426,806	6,387,108	40.2	28.2	40.2	20.48	7.9	362.7	558.3	0.13
BH04	424,015	6,386,978	29.7	23.7	29.7	15.69	9.64	694.5	933	0.08
BH05	428,234	6,386,651	14.2	12.2	14.2	11.34	9.64	715	1096	0.04
BH06	425,573	6,384,809	40.3	34.3	40.3	25.27	9.06	319.15	491.9	0.07
BH07	424,805	6,383,732	18	12	18	12.29	7.63	329.55	507	0.04
BH08	422,941	6,381,445	19	13	19	8.35	4.8	373	570	0.50
BH09	429,106	6,381,269	28.2	22.2	28.2	13.93	9.32	487.5	750	0.23
BH10	426,113	6,381,245	18.2	12.2	18.2	17.22	8.68	520	802	0.02
BH11	419,714	6,379,933	33	13.5	22.5		6.2	475	730	0.07
BH12	424,142	6,379,814	6.1	3.1	6.1	4.19	7.6	578	887	0.02
BH13	426,917	6,377,918	34	28	34	18.29	7.12	507	779	0.08
BH14	419,640	6,377,768	38.6	26.6	38.6	20.73	7.3	507	781	0.17
BH15	420,847	6,376,506	9.3	4.2	8.2	8.81	NA	NA	NA	0.02
BH16	422,958	6,375,535	34	28	34	22.13	10.17	540	838	0.05
BH17	422,522	6,372,129	25.2	19.2	25.2	13.59	8.3	302	465	0.03

Note [1] – Water level measurements taken during water quality sampling (20/10/2020).

Appendices

Appendix A – Water Monitoring Locations

Table A-1 Myara North surface water monitoring locations

Table A-2 Holyoake surface water monitoring locations

Figure A-1 Myara North Water Monitoring Locations

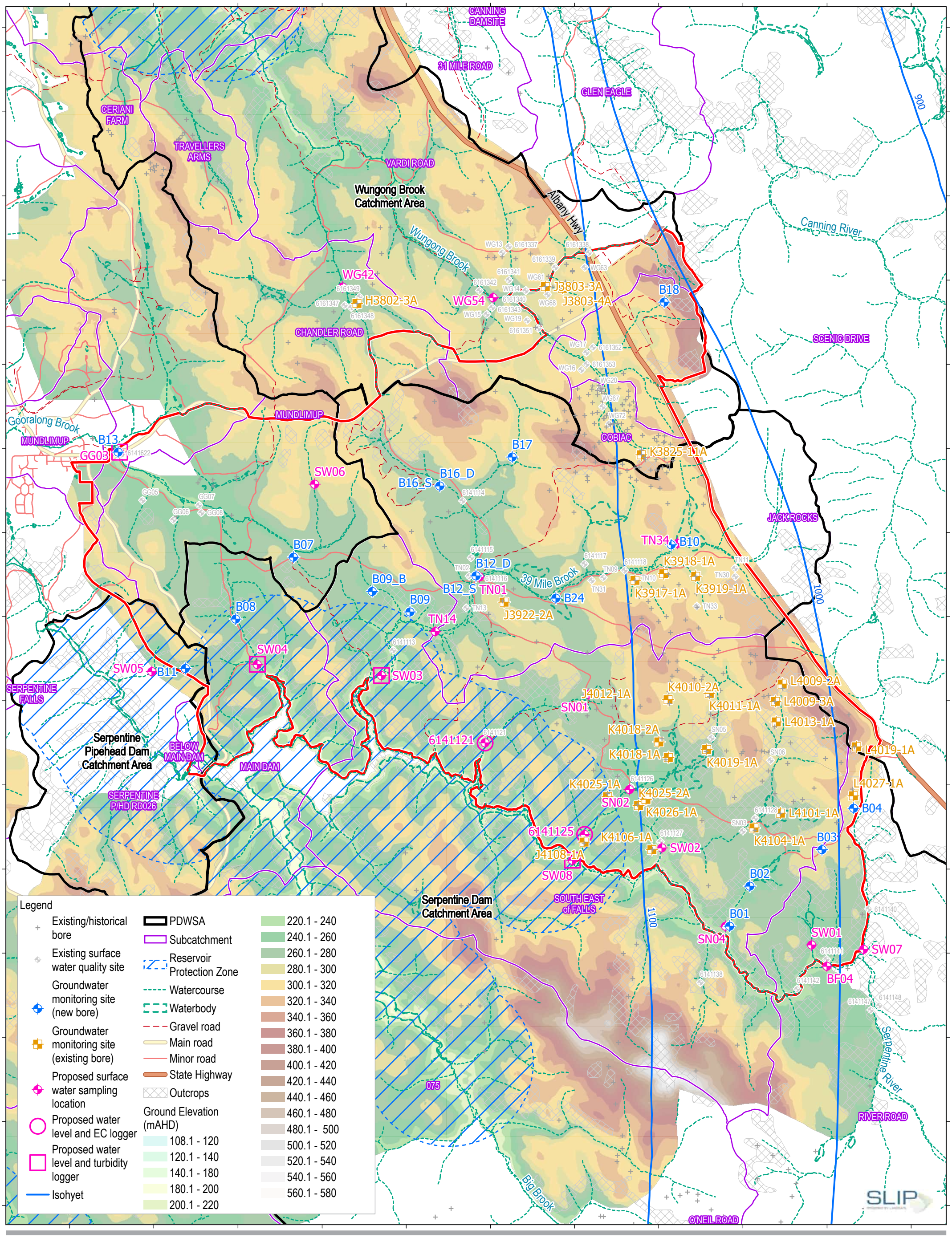
Figure A-2 Holyoake Water Monitoring Locations

Table A-1 Myara North surface water monitoring locations

Location	Easting	Northing	Equipment installed	Justification
GG03	413190.9	6421909.9	Greenspan TS1000 Turbidity Diver logger	D/s of Gooralong Brook near study boundary (DWER site Gooralong Brook 12)
SW04	416450.5	6416874.1	Greenspan TS1000 Turbidity Diver logger	Direct flow into Serpentine Pipehead Dam
SW03	419412.8	6416599.7	Greenspan TS1000 Turbidity Diver logger	Downstream extent of 39 Mile Brook catchment
SW08	423950.5	6412210.6	Greenspan TS1000 Turbidity Diver logger	D/s of proposed Serpentine River conveyor crossing location
6141121	421874.4	6414994.9	Hobo U24 EC Diver logger	Banksia Gully (DWER site Serpentine 22) Mining in upper extent of catchment extends into 1100mm isohyet
6141125	424239.7	6412822	Hobo U24 EC Diver logger	Central tributary Goldmine Gully (DWER site Serpentine 26) Subcatchment crosses 1100 mm isohyet Mining proposed in lower and upper sections of catchment

Table A-2 Holyoake surface water monitoring locations

Location	Easting	Northing	Equipment installed	Justification
HSW05	423028.9	6386493.3	Greenspan TS1000 Turbidity Hobo U24 EC Diver logger	Northern Sth Dandalup tributary D/s of proposed conveyor crossing location
6141005	424590	6383874.7	Greenspan TS1000 Turbidity Hobo U24 EC Diver logger	Sth Dandalup – River. Location sited along western boundary of proposal area. Existing data: 1970s, EC and turbidity
HSW03	422906.6	6372191.4	Greenspan TS1000 Turbidity Hobo U24 EC Diver logger	Characterise discharge of southern proposal area to Swamp Oak Brook -> Murray River Located u/s of Lane Poole Reserve which has high social value



Paper Size ISO A3

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Kilometres

1:80,000

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Alcoa of Australia Limited
Hydrology Installation Report

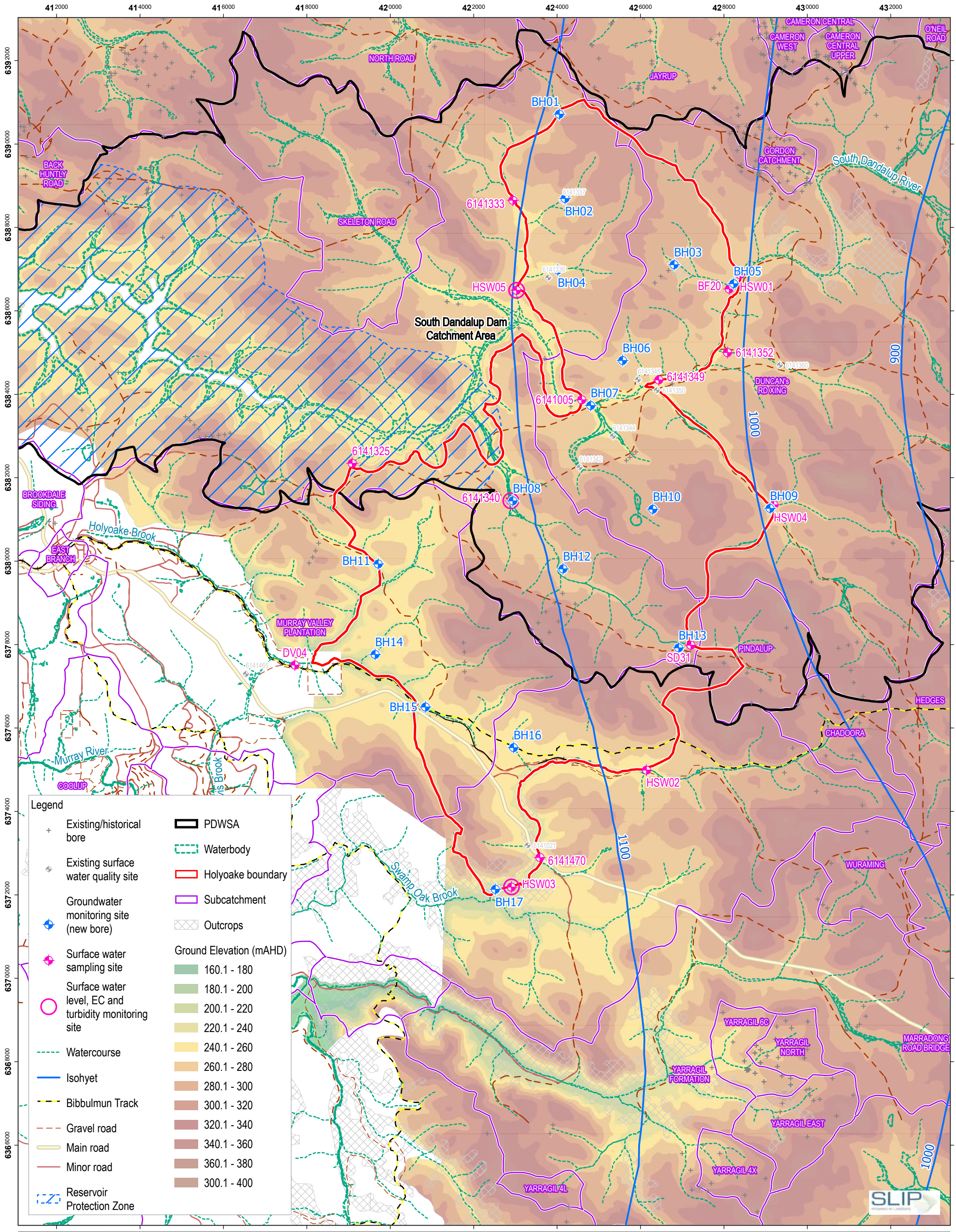
Myara North Water Monitoring Locations

Project No. **125120591**
Revision No. **0**
Date **02/12/2020**

FIGURE A-1

G:\61\12520591\GIS\Maps\Working\12520591-MAP-A-SW\12520591_Hydrology_Overview_PJH.aprx\12520591_A-1_SAQP_MyaraNorthWaterMonitoringLocations_RevA
Print date: 02 Dec 2020 - 16:21

Data source: GHD: Proposed sites - 20200825, Subcatchments - 20200624; Alcoa: Myara North Boundary - 20200618, LiDAR Elevation - 20200626, Reservoir Protection Zone, Isohyet - 20200225, Streams - 20200617; GA: SRTM - 20200526; DWER: Existing Monitoring Sites - 20200629; DoW: PDWSA - 20160607; Landgate: Roads - 20190128, . Created by: pjhernandez



Paper Size ISO A3

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Kilometres

1:80,000

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 50

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GHD

Alcoa of Australia Limited

Hydrology Installation Report

Holyoake Water Monitoring Locations

Project No. **125120591**

Revision No. **0**

Date **02/12/2020**

FIGURE A-2

G:\61\12520591\GIS\Maps\Working\12520591-MAP-A-SW\12520591_Hydrology_Overview_PJH.aprx\12520591_A-2_SAQP_HolyoakeWaterMonitoringLocations_RevA

Print date: 02 Dec 2020 - 16:02

Data source: GHD: Proposed monitoring sites - 20200825, Subcatchments - 20200624; Alcoa: Myara North Boundary - 20200618, LiDAR Elevation - 20200626, Reservoir Protection Zone, Isohyet - 20200225, Streams - 20200617; GA: SRTM - 20200526; DWER: SW Monitoring Sites - 20200629; DoW: PDWSA - 20160607; Landgate: Roads - 20190128, . Created by: pjhernandez

Appendix B - Greenspan TS1000

AQUAMONIX
Measure. Monitor. Master.

OPERATION AND CONFIGURATION MANUAL

TS1000 TURBIDITY SENSOR

Version 2.2 (Issued June 2017)

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1 Introduction

1.1 System Description

Thank you for purchasing the Greenspan Turbidity Sensor Model TS1000. This manual provides a guide to the configuration, operation and maintenance of the sensor to provide long term reliable and accurate monitoring.

The TS1000 turbidity probes are designed for monitoring and process applications where turbidity levels of up to 1,000NTU may be encountered. Standard ranges are 100NTU, 400NTU and 1,000NTU. The TS1000 probes, with their integral wiper assembly, are designed for use where bio-fouling or sedimentation build-up is possible. The probes may be submerged to a depth of 100 meters (approx. 330 feet).

The TS1000 probe use 90° optics and employs infrared light in accordance with ISO7027. The optical system transmits a beam at a wavelength of 860nm. The effective working area around the sensor is approximately 50mm forward and 50mm circumference. The sensor uses a modulation technique that ensures almost total rejection of ambient light conditions as well as a microprocessor controlled differential sample and hold circuit for enhanced performance particularly at low turbidity levels.

Designed for applications where an analogue output is required. The sensor provides either a 4-20mA or 0-2.5V output. The sensor requires power from a DC source between 8 and 30 Volts. The wiper is activated by connecting the wiper control wire to ground for a brief pulse.

The sensor is packaged in an Acetal body, with Double O ring connections for the cable and sensor head. This fully submersible sensor design is rugged and well proven and can withstand the harsh conditions found in remote field applications.

1.2 How to Use the Manual

Along with this manual, there are several other documents that may assist in the successful configuration and operation of the Greenspan TS1000 Sensor. These should be maintained on file as a permanent reference as to the features, applications and use of the TS1000.

Greenspan TS1000 – Specifications Brochure

Greenspan TS1000 – Certificate of Conformance

Greenspan TS1000 – Quick Start Guide

1.3 Certification

Turbidity probes are assembled and tested in accordance with Greenspan's ISO 9001 Quality Certified System. Each Sensor is individually manufactured and certified against a traceable Standard.

Following calibration the sensors undergo a range of additional control processes to ensure that all specifications are consistent and documented.

- ***The instrument is visually inspected, marked and labelled.***
- ***The complete sensor calibration record is archived for reference, and batch number information is kept on file for statistical analysis.***
- ***An individual Certificate of Conformance is issued to the customer.***

1.4 Unpacking and Inspection

All Greenspan Sensors are made to order and are individually calibrated and inspected. This ensures that they leave the factory in a working condition. On receipt, the customer should inspect the packaging and contents for any signs of damage during transportation. The customer should also check that all items on the delivery note have been received.

Please contact the factory in case anything is missing or damaged. A full set of documentation including Certificate of Conformance, Quick Start Guide, and User Manual will be provided with all equipment – either in hard copy format or in electronic format on the USB shipped with the goods.

1.5 Serial Number

Checking the Model Number and Range

Before installing your Greenspan TS1000 sensor check the information on the label is correct to confirm you have received the instrument you have ordered. The label will look similar to this.

MODEL TS1000

RANGE 0 – xxxx NTU

S/N 012345

The customer is advised to keep a record of the serial numbers in case the sensor is lost or the label damage. Greenspan keeps records of all sensors sold including a calibration history.

1.6 Warranty Policy

Greenspan warrants all new products against defects in materials and workmanship for **12 months** from the date of invoice. Products that prove to be defective during the warranty period will be repaired or replaced at the discretion of Greenspan.

Under Greenspan warranty conditions; it is the responsibility of the customer to cover shipping charges back to the factory. Upon repair/replacement Greenspan will cover the return shipping charges to the customer.

This warranty does not apply to products or parts thereof which have been altered or repaired outside of the Greenspan factory or other authorised service centre; or products damaged by improper installation or application, or subjected to misuse, abuse neglect or accident. This warranty also excludes items such as reference electrodes and Dissolved Oxygen membranes that may degrade during normal use.

Greenspan will not be liable for any incidental or consequential damage or expense incurred by the user due to partial or incomplete operability of its products for any reason whatsoever or due to inaccurate information generated by its products.

All Warranty service will be completed as soon possible. If delays are unavoidable customers will be contacted immediately.

Any sensor should not be dismantled unless under instruction from Greenspan Technical Service staff. Incorrect handling will void the warranty.

1.7 Factory Service & Repair

The correct choice of sensor and assistance with field installation can be provided by Greenspan and their sales offices. A correct choice of equipment, together with technical advice and field experience should result in long term success in the field. **Greenspan Technical Services** is dedicated to customer support and provides assistance in the selection, installation, deployment and commissioning of sensors with a full range of consulting services. All Greenspan products are designed, developed and manufactured in Australia and can be supplied at short notice.

If for some reason sensors are required to be returned to our factory or your sales representative, please note the model and serial number, Describe the problem, including how and under what conditions the instrument was being used at the time of malfunction. Clean the product and cable. Decontaminate thoroughly if used in toxic or hazardous environment. Carefully pack product in original packaging if possible & include a statement certifying product and cable have been decontaminated with supporting information. Products returned for repair must be accompanied by a completed GRA (Goods Return Advice) form. All sensors returned for service and repair work must be properly decontaminated prior to return. A cleaning charge may be applied to sensors that require further decontamination. Service work will not commence until the quotation has been accepted by the customer. A purchase order for all repair and service work will be required before work is carried out.

2 Sensor Overview

2.1 Theory of Measurement

Turbidity is the measurement that indicates the clarity of water due to fine suspended particles. In the environment, turbidity is often due to clay or silt. These fine particles have the ability to scatter light. The TS1000 has a light source that is projected into the water. A detector measures the light that has been scattered at 90 degrees to the source. As the number of particles increase, more light is scattered and sensed by the detector and the higher the turbidity reading.

2.2 Applications

Applications in which the Greenspan TS1000 can be used include:

- Monitoring of streams and rivers.
- Monitoring of water storage bodies including stratification studies.
- Intermediate and final effluent treatment monitoring.
- Hydrological run off studies.
- Ground and bore water analysis.
- Drinking water filtration efficiency.
- Industrial process monitoring.
- Sludge and dredge monitoring.

2.3 Instrument Details

2.3.1 Sensor Design

The Greenspan TS Sensor consists of the following primary elements:

- Turbidity head with lens and integral wiper
- Acetal Body Material
- Double O-ring connections
- Data cable with moulded cable entry

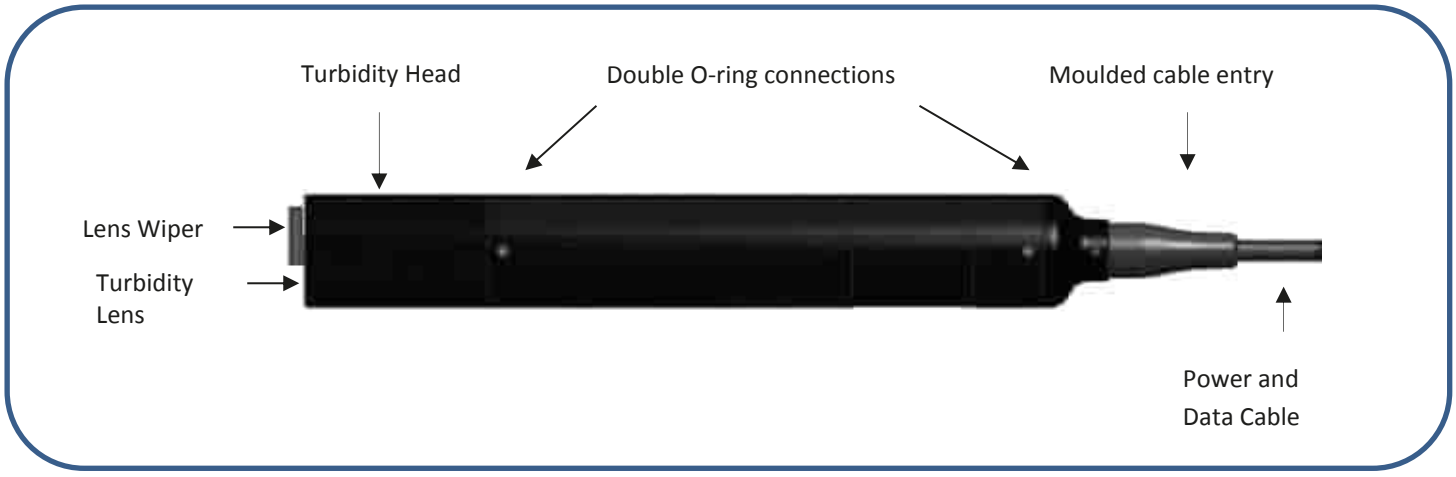
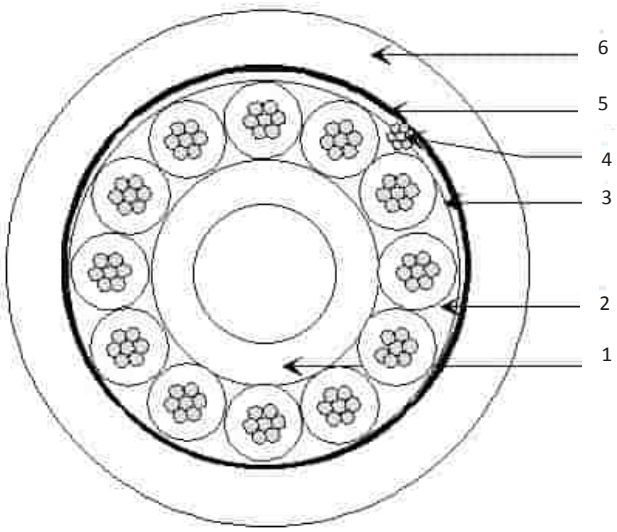


Figure 1 – TS1000 Primary Elements

2.4 Cable Details

All Greenspan Sensors utilise a specially designed Polyurethane Cable. The cable contains 12 x conductors, 1 x drain wire, and an internal vent tube. The outer jacket is made from UV stabilized Polyurethane and is suitable for all external, underwater or harsh environment applications. This common cable construction is utilized for vented and non-vented sensors and all Greenspan Water Quality Sensors. Cables are generally factory fitted at time of manufacture in specified lengths. Cables can be joined or repaired in the field providing a waterproof connection can be maintained. Alternatively, cables can be terminated in waterproof junction boxes where cabling to other devices or longer cable runs are required.



Cable Construction

1 –**Vent Tube:** Polyamide
[redacted]size ID x OD) 2.40 x 3.20 mm

2 - **12 x Conductors**
[redacted]7 x 0.20 mm Tinned Copper
[redacted]Section = 0.22mm2 AWG24
[redacted]nsulation: Polypropylene
[redacted]size) = 1.10 mm ± 0.05 mm

3 - **Tape:** Polyester

4 – **Drain Wire:** 7x0.20 TinCu

5 - **Tape:** Polyester Aluminium

6 - **Jacket:** Polyurethane black,
[redacted]size OD) 8.05 mm ± 0.15

2.4.1 Mechanical Specifications

- Specially Manufactured Greenspan Cable with 12 cores and Internal Vent
- High chemical resilience and abrasive resistance
- Conductor cross section : AWG 24,
- Electrical Resistance 9 ohm per 100m (per conductor)
- Operating temperature: 85°C (max.),
- Bending radius (static) : 6 ,
- Bending radius (dynamic) 12.
- Max Operating voltage : 250V
- Jacket Printing (white colour each meter)
- Conductor colour codes : green, yellow, white, black, brown, turquoise, violet, pink, red, blue, grey
- Tensile Strength is sufficient to self-suspend the Greenspan Sensor to depths of 300m.
- Long term creep due to temperature effects or tensile loading is negligible.

The moulded cable is fitted to the sensor using a double o ring seal and located using 2 x grub screws. The length of the cable is not critical to the long term calibration and operation of the sensor (provided the electrical requirements such as minimum supply voltage are maintained).

2.5 Sensor Factory Calibration

The sensor is assembled and calibrated to the required range in accordance with the Greenspan's ISO9001:2008 Quality System.

- Sensors are calibrated using AMCO CLEAR® TURBIDITY STANDARD, for ANALITE ISO 7027 PROBES.
- An extensive range of final calibration and inspection tests are carried out on every sensor.
- The sensor is visually inspected and packed, ready for despatch.
- The complete calibration records, sensor history and batch number are placed on file and archived.

3 Sensor Operation

3.1 Wiring & Connections

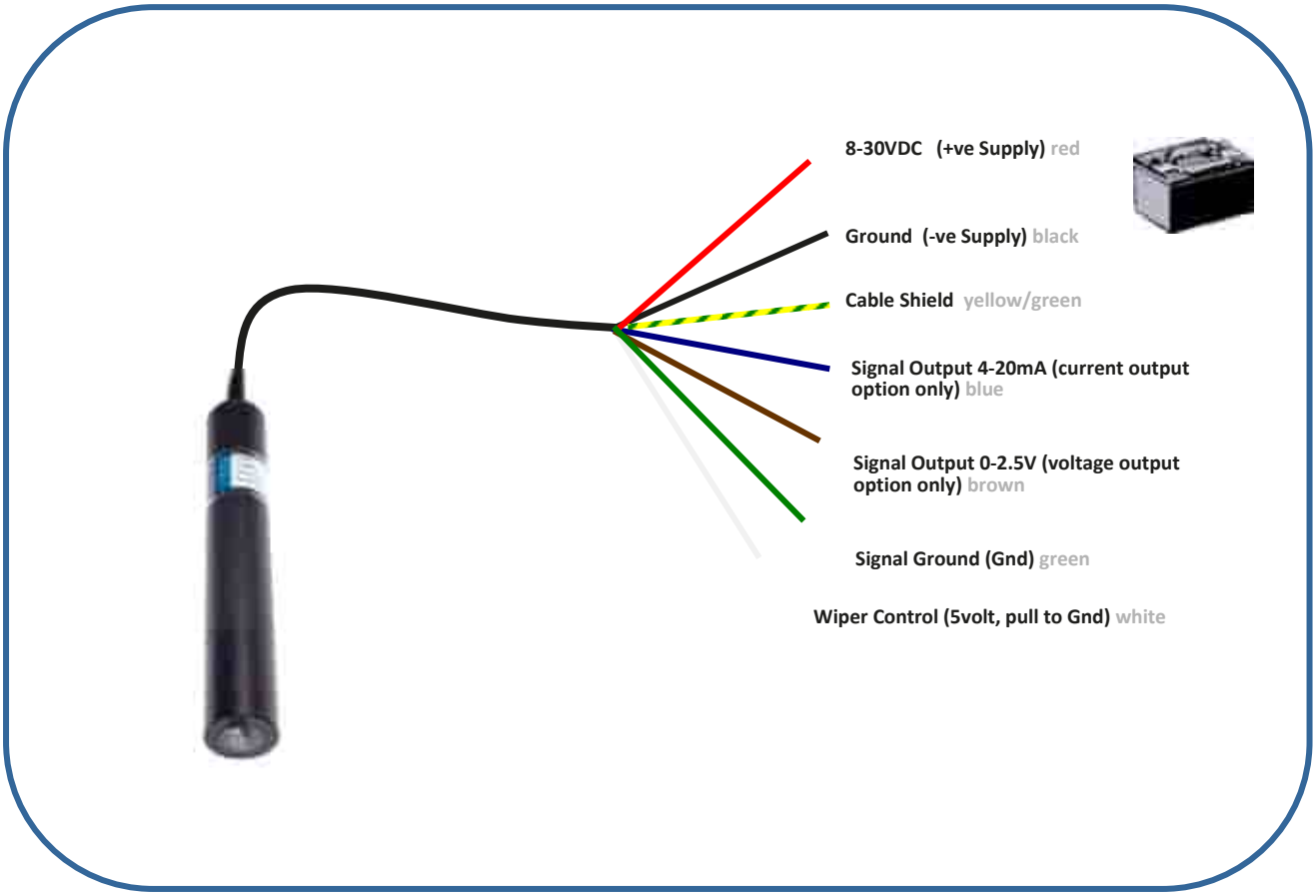


Figure 2 – TS1000 Sensor Connection

4 Calibration & Maintenance

4.1 Quick Check and Re-Calibration

To maintain high quality control over monitoring programs, it is recommended turbidity calibration is checked every 3-6 months. The TS1000 has no facility to adjust the analogue outputs. If any gain or offset correction is required the factors should be entered into the datalogger or measuring device. Alternatively sensors may be returned to an authorised Greenspan agent for re-calibration.

The sensor can be checked by use of known laboratory Turbidity standards. Sensors are calibrated using AMCO CLEAR® TURBIDITY STANDARD, for ANALITE ISO 7027 PROBES.

The claimed advantages of these standards are-

- Safe, non-toxic and disposable
- Easy-to-use/No dilutions or preparations
- Accurate to 1% lot-to-lot
- Available in a wide range of values
- Stable/does not settle out of suspension
- Guaranteed One Year Shelf Life
- N.I.S.T. Traceable

4.1.1 Quick check

1. Remove the sensor from the water, ensure the sensor is clean. Dirty optics could be a key source of calibration errors.
2. Connect the sensor to a DC power source and a meter to measure the sensor output.
3. Place the sensor in clean water so that the sensor face is at least 50mm clear of the bottom of the container. Record the measured output value.
4. The Turbidity value should read Zero +/- 3% of the full scale range of the sensor (eg. 4mA +/- 0.48mA for the current output or 0V +/- 75mV for the voltage output).
5. Place the sensor in a full scale Turbidity solution so that the sensor face is at least 50mm clear of the bottom of the container. Record the measured output value.
6. The Turbidity value should read +/- 3% of the full scale range of the sensor (eg. 20mA +/- 0.48mA for the current output or 2.5V +/- 75mV for the voltage output).
7. This confirms that the sensor electronics has remained stable and no further action should be required if the sensor is within +/- 3 % FS.

Calculating Gain and Offset Correction Factors

Most dataloggers or SCADA devices have the ability to enter gain (or multiplier) and offset factors to correct for small changes in the sensor output. If the quick check values are outside allowable tolerances, correction factors can be calculated and entered into the measuring device or used to post process any data recorded.

The gain correction can be calculated with the formula-

Gain correction = (expected reading at Full Scale – expected reading at Zero) /

(Reading at Full Scale – Reading at Zero)

The offset correction can be calculated with the formula –

Offset correction = expected value at Zero – (reading at Zero x Gain correction)

E.g. A quick check was done on a TS1000 with the current output connected to an ammeter. The results recorded were 3.28 mA at Zero (clean water) and 18.96 mA at Full scale.

Gain correction = (20 – 4) / (18.96 – 3.28)

= 16 / 15.68

= 1.0204

Offset correction = 4 – (3.28 x 1.0204)

= 0.653

4.1.2 Wiper Replacement

The effectiveness of the wiper in maintaining a clean optical surface will eventually be compromised, the time being dependent on the water under investigation and the number of wiping cycles carried out. We recommend periodic inspection of the wiper pad to determine if the material is deteriorating or is impregnated with material from bio-fouling.

The wiper is a consumable item. Wiper packs containing a wiper and a hex key are available as a standard accessory. The Greenspan part number is 5TW-001 (pictured below left)

5TW-001 Turbidity Wiper Kit

To change the wiper, loosen the set screw in the wiper arm until the wiper assembly can be removed from the wiping shaft. Place a new wiper assembly on the shaft with the set screw aligned squarely with the flat on the wiping shaft. Gently press the wiper arm down until the wiper arm hits the stop on the shaft. The wiper pad should now be compressed to roughly one half its original thickness. Tighten the set screw - do not over tighten.

NOTE: It is imperative that the set screw be fastened squarely aligned onto the flat on the shaft otherwise proper operation will be affected.

CAUTION: Do not over tighten the set screw or manually attempt to rotate the wiper arm once set onto the shaft. Any attempt to manually rotate the wiper may cause gearbox damage and void the warranty.

5 Installation

5.1 Field Deployment Considerations

The sensor should always be completely submerged and positioned such that the possibility of air bubbles, becoming entrapped, which may cause errors, on the sensor face is minimised.

The sensor head should be periodically inspected for fouling, and can be cleaned with fresh water and damp cloth. In marine environments crustaceans may need removal at regular intervals.

Sensors should generally be installed such that they can be easily and safely removed for cleaning, servicing, replacement of the wiper etc. For environmental applications the sensor can often be mounted inside a section of PVC or steel pipe which enters the water body. The sensor can then be slid down inside the pipe until the sensor head just protrudes into the water body. This provides a high degree of protection for the sensor from environmental (sunlight, heat, flood debris etc) as well as from other influences such as Cattle, vandalism etc. Most sediment transport occurs during storm events and flood conditions. Protection from floating debris damage is an important consideration along with adequate tethering of sensors.

Another widespread application of the sensors is to hang the sensors in the water body from a fixed structure or a floating buy or pontoon. Generally in lakes or estuary applications the sensor can hang on its own cable, and easily retrieved for routine servicing.

5.2 Wiper control

The TS1000 wiper is activated by connecting the wiper control wire to ground. This is usually done by connecting the wiper control wire to a switching device e.g. Relay or FET. The switching device can be controlled by the datalogger or SCADA system. The recommended time to connect the wiper control to ground is between 50ms – 4S.

5.3 How often should the wiper be activated?

The frequency of wiping will depend on the environmental conditions where the sensor is installed. Waters with high biological activity or high suspended organic or inorganic materials will require more frequent wiping to keep the optics clean. However, excessive wiping will increase power consumption and wear of the wiper.

5.4 Cabling Considerations

Care should be taken with installation and field servicing to ensure the cable is not subjected to persistent pulling snagging or severe compression. Cyclic loading of the cable should also be avoided through careful sensor deployment. Additional stilling wells or mounting brackets may be required to prevent sensor movement which may cause long term cable movement. Where cable runs are required which may be subject to environmental effects (heat, water movement, sunlight, flood debris etc.) it is advisable to protect the sensor cable inside a slightly larger diameter conduit such as PVC, steel or polyethylene. This also allows the sensor cable to be pulled out – should a sensor change-over be required at the site. Maximum cable runs up to several hundred meters are possible without affecting electrical signals.

5.5 Typical Sensor Installations

1. Edge of river/stream/lake embankment.
2. Side of boat/vessel.
3. Mounted within a stilling well off stream from main flow.
4. Mounted within drainage channels/pipes.
5. Suspended from dam walls or floating pontoon.
6. Sensor anchored to bed of lake/stream.

5.6 Field Installation must ensure:

- The sensor is anchored or held in position or located so it is not subject to any movement during normal operations.
- Sensor is protected from direct sunlight to avoid high temperature fluctuations
- Sensor is protected against high turbulence and possible debris loading during flow events

5.7 Other Considerations

Environmental compatibility should be checked before using the sensors and advice sought from Greenspan if any doubt exists. The sensor utilises some 316 stainless components that are suitable in a majority of situations but care should be taken against possible corrosion in high Chloride, Sulphate or Ferric solutions. The sensor should always be totally immersed under the water to ensure that the sensor is at water temperature and to also avoid any possible anodic/cathodic action taking place on the components at the water-air interface. If using clamps to mount the sensor – these should be of a type that evenly clamps the sensor body without excessive loading that could damage the sensor body.

5.8 Guidelines for cleaning equipment

The sensor may be cleaned using a soft cloth, mild detergents and warm water. If the sensor shows signs of marine growth a light biocide can be used to clean and kill any biological growth on the sensor.

6 Appendix A -Additional Information

6.1 TS1000 Specifications

Measurement Technique	90° Infra-red (ISO7027)		
Standard ranges available (factory set)	100NTU,	400NTU	1000NTU
Resolution	0.1 NTU	0.2 NTU	0.3 NTU
Linearity	± 1%	± 1%	± 3%
Temperature Coefficient	±0.2%/°C	±0.1%/°C	±0.1%/°C
Sensor Outputs	4-20mA or 0-2.5V DC		
Calibration Standard	APS AEPA polymer solutions 100NTU, 400NTU, 1000NTU		
Cable Type	Polyurethane sheathed cable, OD 8mm, aramid reinforced moulded entry, bare wire connection		
Cable Lengths	10, 20, 30, 50, 100, 150m (32, 65, 100, 165, 325, 490 FT)		
Non-standard cable lengths	Yes (Extra cable moulding time may be required)		
Power Supply	8-30Vdc (at sensor)		
Power ESD Protection	2000 volts		
Current Consumption	Sensor 15-40mA while operating Plus extra 30-35mA while wiping		
Sensor warm up time	10 seconds		
Wiper arrangement	Disposable foam pad on PVC arm. Field replaceable		
Wiper Control	Pull control wire to GND momentarily Pulse time required >50ms, and <4 sec		
Wiper Time	< 8 seconds (1 revolution)		
Operating Temperature	0-50°C		
Depth rating (water column)	100m		
Storage Temperature	-5°C - +60°C		
Weight	500g plus cable weight (665g per 10m length)		
Dimensions (L x OD)	417.5mm x 47mm (16.44” x 1.85”)		
Wetted Materials	UPVC, acetal, 316 passivated stainless steel, polyurethane, viton		

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19a New Dookie Rd,
Shepparton, VIC 3630

Western Australia:
Ph: (08) 9477 1188
1/30 Oxleigh St,
Malaga, WA 6090

Appendix C - Hobo U24-001

HOBO® Conductivity Loggers

Conductivity monitoring for freshwater and stable saltwater applications

HOBO Conductivity Loggers are convenient, rugged, and cost-effective data loggers for a variety of freshwater and saltwater monitoring applications.

The HOBO U24-001 model provides high-accuracy conductivity data in freshwater environments, for applications such as environmental impact monitoring, stormwater management, and water quality studies.

The HOBO U24-002-C model is for saltwater environments with relatively small changes in salinity (±5,000 µS/cm) such as saltwater bays, or to detect salinity events such as upwelling, rainstorm, and discharge events. This logger can also be used to gather salinity data for salinity compensation of HOBO U26 Dissolved Oxygen logger data. **Note:** This logger is not intended for monitoring salinity levels in waters with widely changing salinities as it can have significant measurement error and drift in those environments.

Supported Measurements: Conductivity, Salinity, Temperature

Key Advantages:

- Non-contact capacitive sensor provides long life
- Easy access to sensor for cleaning and shedding air bubbles
- HOBOware Pro software provides compensation for fouling using calibration points from the start and end of each deployment
- Optical interface provides high-speed, reliable data offload in wet environments
- Compatible with HOBO Waterproof Shuttle for easy and reliable data retrieval

Minimum System Requirements:

*HOBO Base Station or HOBO Waterproof Shuttle required.
[1]Coupler included with HOBO Base Station or HOBO Waterproof Shuttle.

For complete information and accessories, please visit: **www.onsetcomp.com**

Part number	**U24-001** Conductivity	**U24-002-C** Conductivity/Salinity
Memory	18,500 temperature and conductivity measurements when using one conductivity range; 14,400 sets of measurements when using both conductivity ranges (64 kbytes)	
Conductivity Calibrated Measurement Ranges	Low Range: 0 to 1,000 µS/cm Full Range: 0 to 10,000 µS/cm	Low Range: 100 to 10,000 µS/cm High Range: 5,000 to 55,000 µS/cm
Conductivity Calibrated Range – Temperature Range	5° to 35°C (41° to 95°F)	
Specific Conductance Accuracy (in Calibrated Range using Conductivity Assistant and Calibration Measurements)	Low Range: 3% of reading, or 5 µS/cm Full Range: 3% of reading, or 20 µS/cm, whichever is greater	Low Range: 3% of reading or 50 µS/cm, whichever is greater High Range: 5% of reading, in waters within a range of ±3,000 µS/cm; waters with greater variation can have substantially greater error
Conductivity Resolution (typical)	1 µS/cm	2 µS/cm
Conductivity Drift	Less than 3% sensor drift per year	Up to 12% sensor drift per month. Use monthly start & end-point calibration to compensate
Temperature Accuracy (in Calibrated Range)	0.1°C (0.2°F)	
Temperature Resolution	0.01°C (0.02°F)	
Response Time	1 second to 90% of change (in water)	
Measurement and Operating Range	0° to 36°C (32° to 97°F) -non-freezing	-2° to 36°C (28° to 97°F) -non-freezing
Sample rate	1 second to 18 hrs, fixed or multiple-rate sampling with up to 8 user-defined sampling intervals	
Time Accuracy	± 1 minute per month	
Battery	3.6 Volt lithium battery, life: 3 years (at 1 minute logging), typical	
Maximum Depth	70 m (225 ft)	
Dimensions	3.18 cm diameter x 16.5 cm, with 6.3 mm mounting hole (1.25 in diameter x 6.5”, ¼ in hole)	
CE compliant	Yes	

Contact Us

Sales (8am to 5pm ET, Monday through Friday)
- Email sales@onsetcomp.com
- Call 1-508-759-9500
- In U.S. toll free 1-800-564-4377
- Fax 1-508-759-9100

Technical Support (8am to 8pm ET, Monday through Friday)
- Contact Product Support onsetcomp.com/support/contact
- Call 1-508-759-9500
- In U.S. toll free 1-877-564-4377

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Appendix D – Diver

PRODUCT MANUAL

Diver

Eijkelkamp
Soil & Water

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I www.eijkelkamp.com

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1 Introduction

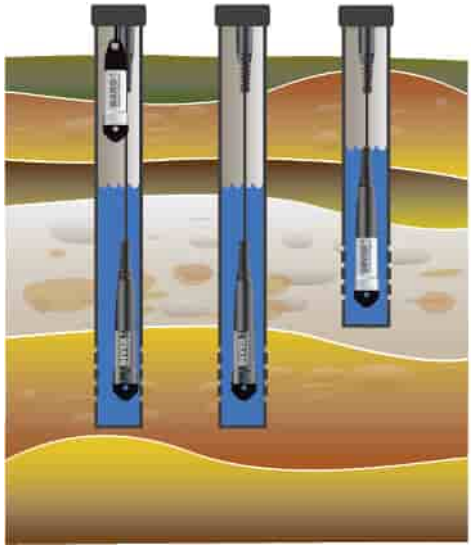
1.1 About this Manual

This manual contains information about Van Essen Instruments' Divers®. It contains a description of the Mini-Diver (DI5xx), Micro-Diver (DI6xx), Cera-Diver (DI7xx), Baro-Diver (DI500) and the CTD-Diver (DI27x). The number in brackets designates the Diver model.

This section contains a brief introduction to the Diver's measurement principles, an instrument designed to measure groundwater levels and temperatures. Furthermore, a brief description of the software that can be used in combination with the Divers is provided. The next section contains the technical specifications for each type of Diver. The following section covers the installation of Divers in monitoring wells and in surface waters. This is followed by a description of how to maintain a Diver. The next section discusses conductivity measurements using the CTD-Diver and conductivity calibration. The last section includes the answers to frequently asked questions.

1.2 Operating Principle

The Diver is a datalogger designed to measure water pressure and temperature. Measurements are subsequently stored in the Diver's internal memory. The Diver consists of a pressure sensor designed to measure water pressure, a temperature sensor, memory for storing measurements and a battery. The Diver is an autonomous datalogger that can be programmed by the user. The Diver has a completely sealed enclosure. The communication between Divers and Laptops/field devices is based on optical communication.



The Divers measures the absolute pressure. This means that the pressure sensor not only measures the water pressure, but also the air pressure pushing on the water surface. If the air pressure varies, the measured water pressure will thus also vary, without having to vary the water level.

1.3 Measuring Water Levels

All Divers establish the height of a water column by measuring the water pressure using the built-in pressure sensor. As long as the Diver is not submerged in water it measures atmospheric pressure, just like a barometer. Once the Diver is submerged this is supplemented by the water's pressure: the higher the water column the higher the measured pressure. The height of the water column above the Diver's pressure sensor is determined on the basis of the measured pressure.

To measure these variations in atmospheric pressure a Baro-Diver is installed for each site being measured. The barometric compensation for these variations in atmospheric pressure can be done using the Diver-Office software. It is also possible to use alternative barometric data such as data made available online.

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The compensated values can be related to a reference point such as the top of the monitoring well or a vertical reference datum, for example the Ordnance Datum Newlyn (ODN).

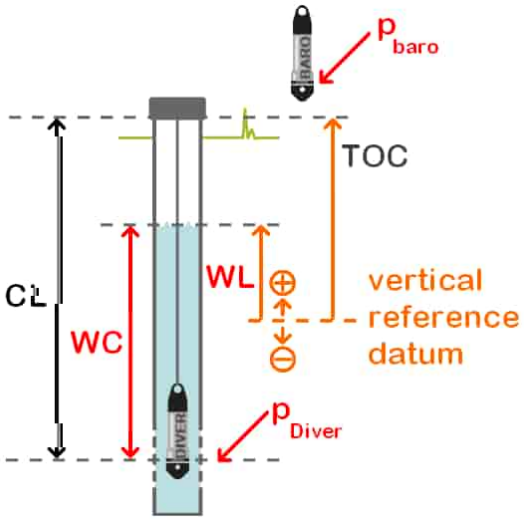
Theory

This section explains how to calculate the water level in relation to a vertical reference datum using the Diver and Baro-Diver's measurements.

The figure below represents an example of a monitoring well in which a Diver has been installed. In this case we are therefore interested in the height of the water level (WL) in relation to the vertical reference datum. If the water level is situated above the reference datum it has a positive value and a negative value if it is situated below the reference datum.

The top of casing (TOC) is measured in relation to the vertical reference datum and is denoted in the diagram below as TOC cm. The Diver is suspended with a cable with a length equal to CL cm.

The Baro-Diver measures the atmospheric pressure (p_{baro}) and the Diver measures the pressure exerted by the water column (WC) and the atmospheric pressure (p_{Diver}).



The water column (WC) above the Diver can be expressed as:

$$WC = 9806.65 \frac{p_{Diver} - p_{baro}}{\rho \cdot g} \quad (1)$$

where p is the pressure in cmH_2O, g is the acceleration due to gravity (9.81 m/s^2) and ñ is the density of the water (1,000 kg/m^3).

The water level (WL) in relation to the vertical reference datum can be calculated as follows:

$$WL = TOC - CL + WC \quad (2)$$

By substituting WC from equation (1) in equation (2) we obtain:

$$WL = TOC - CL + 9806.65 \frac{p_{Diver} - p_{baro}}{\rho \cdot g} \quad (3)$$

If the cable length is not exactly known, it can be determined using a manual measurement. From the figure below it is clear that the manual measurement (MM) is taken from the top of casing to the water level. The value of the water level is positive unless, in exceptional circumstances, the water level is situated above the top of casing.

The cable length can now be calculated as follows:

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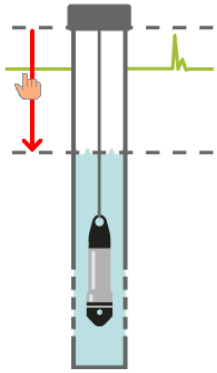
$$CL = MM + WC \quad (4)$$

where the water column (WC) is calculated on the basis of the measurements taken by the Diver and the Baro-Diver.



Comments:

- If the pressure measured by the Diver and the Baro-Diver is measured at different points in time, it is necessary to interpolate. The software automatically performs this interpolation.
- It is possible to enter manual measurements into the software. The software subsequently automatically calculates the cable length.

Example:

The top of casing is measured to be 150 cm above the Ordnance Datum Newlyn (ODN). TOC = 150 cm. The cable length is not exactly known and is therefore measured manually. It turns out to be 120 cm: MM = 120 cm.

The Diver measures a pressure of 1,170 cmH_2O and the Baro-Diver measures a pressure of 1,030 cmH_2O. Substituting these values into equation (1), results in a water column of 140 cm above the Diver: WC = 140 cm.

Substituting the values of the manual measurement and the water column in equation (4) results in the following cable length: CL = 120 + 140 = 260 cm.

The water level in relation to the ODN can now be easily calculated using equation (2): WL = 150 – 260 + 140 = 30 cm above ODN.

1.4 Measuring Temperature

All Divers measure the groundwater temperature. This can, for example, provide information about groundwater flows. This also makes it possible to determine the diffusion of (polluted) water.

The temperature is measured using a semiconductor sensor. This sensor not only measures the temperature, but also uses the value of the temperature to at the same time compensate the pressure sensor and electronics (incl. the crystal clock) for the effects of temperature.

1.5 Diver models

Various types of Divers are available. All Divers measure the absolute pressure and temperature. The summary below explains the differences between the various Diver types.

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Mini-Diver This is the basic Diver, manufactured using a stainless steel (316 L) casing with a 22 mm diameter. The Mini-Diver is capable of storing a maximum of 24,000 measurements (date/time, pressure and temperature).

Micro-Diver This is the smallest Diver with a diameter of 18 mm and a stainless steel (316 L) casing. The Micro-Diver is capable of storing a maximum of 48,000 measurements. This Diver is suitable for pipes with a diameter of at least 20 mm (0.787 in).

Cera-Diver This Diver comes with a 22 mm diameter ceramic casing and is suitable for use in brackish and salt water or in other aggressive environments. The Cera-Diver is capable of storing a maximum of 48,000 measurements.

CTD-Diver In addition to taking pressure and temperature measurements, this Diver also measures the water's conductivity. The 22 mm diameter ceramic casing is suitable for brackish or saltwater applications as well as in aggressive environments. The CTD-Diver is capable of storing a maximum of 48,000 measurements.

Baro-Diver This Diver measures atmospheric pressure and is used to compensate for the variations in atmospheric pressure measured by the other Divers. This Diver can also be used for measuring shallow water levels up to 1 meter. The stainless steel (316 L) casing has a diameter of 22 mm. The Baro-Diver is capable of storing a maximum of 24,000 measurements.

The Micro-Diver, Cera-Diver and CTD-Diver incorporate a greater range of functionality than the Mini-Diver and Baro-Diver. These last two Divers only offer a fixed measurement option. This means that the Diver takes measurements on the basis of user-defined intervals.

The other Divers offer the following measurement options:

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- Pre-programmed pump tests or user-defined pump tests.
- Average values over a specified time period.
- An event-based option. In this case the Diver only stores measurements once the percentage variation limit set for the pressure or conductivity (CTD-Diver) measurement is exceeded. This percentage variation can be specified by the user.

For applications in surface waters it is possible to average the values over a specified period. The average values are then stored. The effects of waves are 'averaged out' this way.

If the memory of the Diver is full, the Diver will stop measuring. The Diver has a non-volatile memory which means that the data is preserved if for whatever reason the battery is empty.

1.6 Diver-Office Software

Diver-Office is a software package used in conjunction with every type of Diver described in this manual. The latest version of Diver-Office can be downloaded from www.vanessen.com.

Diver-Office operates under all current versions of Microsoft Windows and is easy to install on a laptop or PC.

The Diver-Office makes it possible to communicate with the Divers and/or to start/stop them. The measurement data recorded by the Divers can be read out at any time. You have the option of reviewing, compensating for variations in atmospheric pressures, printing or exporting the measurement data to various file formats for processing by other software. All values and settings are stored in a database. Furthermore, the raw Diver data is also stored as a file.

The software program's manual contains additional information about the operation of Diver-Office.

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2 Technical Information

The Diver is a datalogger housed in a cylindrical casing with a suspension eye at the top. The suspension eye can be unscrewed and is designed to install the Diver into the monitoring well and protects the optical connector. The electronics, sensors and battery are installed maintenance-free into the casing. The Diver may not be opened. In case of any complaints, please contact your supplier.

The name of the datalogger, the model number, the measurement range and the serial number (SN) are clearly identified on the side of the Diver. This information is burnt-in using a laser and is consequently chemically neutral and inerasable.

2.1 Calibration Procedure

The Diver uses a pressure sensor and is calibrated in centimetres water column (cmH2O). The conversion factor from mbar to cmH2O is:

1 mbar = 1.01972 cmH_2O or 1 cmH_2O = 0.980665 mbar

The calibration procedure involves calibrating and verifying the calibration of each individual diver. Firstly the calibration is done. Each Diver is immersed in a water bath. Subsequently, this bath is adjusted to 5 different temperatures, 10, 20, 30, 40 and 50 °C. At each temperature 6 rising and 6 falling pressures are created at 0, 20, 40, 60, 80, 100% of the measuring range. These pressures are created by a calibrated pressure calibrator. The pressures measured by the Diver are then analysed and processed and then stored in a look-up table within the Diver. Each diver has his own unique table. To verify the calibration, a calibration check is performed. During this check five rising and falling pressures are created, namely 10, 30, 50, 70, 90% of the measuring range, at 15 and 35 °C. Finally the Diver is checked against the given specifications.

2.2 Manufacturer's Certificate

The Diver passes calibration if it meets all specifications. A manufacturer's or calibration certificate is available upon request.

2.3 Specifications

Aside from the Baro-Diver for atmospheric pressure and temperature measurements, there are 12 Diver versions for pressure and temperature measurements and three CTD-Diver versions for pressure, temperature and conductivity measurements. The summary below summarises the measurement ranges of the water columns that the Divers are capable of measuring:

Mini-Diver:

- Up to 10 metres (DI501)
- Up to 20 metres (DI502)
- Up to 50 metres (DI505)
- Up to 100 metres (DI510)

Micro-Diver:

- Up to 10 metres (DI601)
- Up to 20 metres (DI602)
- Up to 50 metres (DI605)
- Up to 100 metres (DI610)

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Cera-Diver:

- Up to 10 metres (DI701)
- Up to 20 metres (DI702)
- Up to 50 metres (DI705)
- Up to 100 metres (DI710)

CTD-Diver:

- Up to 10 metres (DI271)
- Up to 50 metres (DI272)
- Up to 100 metres (DI273)

Baro-Diver:

- Barometric variations (DI500)

2.4 Baro-Diver, Mini-Diver, Micro-Diver and Cera-Diver

The above Diver models meet the following general specifications:

	Mini-Diver	**Micro-Diver**	**Cera-Diver**
Diameter	Ø 22 mm	Ø 18 mm	Ø 22 mm
Length (incl. suspension eye)	~ 90 mm	~ 88 mm	~ 90 mm
Weight	~ 55 gram	~ 45 gram	~ 50 gram
Protection class	IP68, 10 years continuously submerged in water at 100 m		
Storage/Transport temperature	-20 °C to 80 °C (affects battery life)		
Operating temperature	0 °C to 50 °C		
Material			
Casing	316L stainless steel (active substance no. 1.4404)	316L stainless steel (active substance no. 1.4404)	Zirconia (ZrO_2)
Pressure sensor	Alumina (Al_2O_3)		
Suspension eye/ nose cone	Nylon PA6 glass fibre reinforced 30%		
O-rings	Viton®		
Communication	Optically separated		
Memory capacity	24,000 measurements	48,000 measurements	48,000 measurements
Memory	Non-volatile memory. A measurement consists of date/time/pressure/temperature		
Sample interval	0.5 sec to 99 hours		

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	Mini-Diver	Micro-Diver	Cera-Diver
Sampling options			
Fixed interval	Yes	Yes	Yes
Event-based	No	Yes	Yes
Pump test (to be configured by user)	No	Yes	Yes
Averaging	No	Yes	Yes
Battery life*	8-10 years, depending on use		
Theoretical capacity	5 million measurements 2000× memory readouts 2000× programming		
Clock accuracy	Better than ± 1 minute per year at 25 °C		
	Better than ± 5 minutes per year within the calibrated temperature range		
CE marking	EMC in accordance with the 89/336/EEC directive Basic EN 61000-4-2 standard		
Emissions	EN 55022 (1998) + A1 (2000) + A2 (2003), Class B		
Immunity	EN 55024 (1998) + A1 (2000) + A2 (2003)		
Certificate number	06C00301CRT01	06C00300CRT01	06C00299CRT01

2.5 CTD-Diver

The CTD-Diver meets the following general specifications:

Diameter	Ø 22 mm
Length	135 mm incl. suspension eye
Weight	~ 95 gram
Material casing	Zirconia (ZrO_2)
Protection class	IP68, 10 years continuously submerged in water at 100 m
Memory capacity	48,000 measurements
Sampling rate	1 sec to 99 hours
Sampling options	
Fixed interval	Yes
Event-based	Yes
Pump test (to be configured by user)	Yes
Averaging	Yes

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Conductivity	
measurement range	(0 – 120) mS/cm
accuracy	±1% of reading with a minimum of 10 µS/cm
resolution	0.1% of reading with a minimum of: - 1 µS/cm for 30 mS/cm range - 10 µS/cm for 120 mS/cm range
Battery life*	8-10 years, depending on use
Theoretical capacity	2 million measurements 500× memory readouts 500× programming
CE marking	EMC in accordance with the 89/336/EEC directive Basic EN 61000-4-2 standard
Emissions	EN 55022 (1998) + A1 (2000) + A2 (2003), Class B
Immunity	EN 55024 (1998) + A1 (2000) + A2 (2003)

The other parameters are identical to the Cera-Diver.

* **The Diver is always active.** The leakage current of the integrated battery is dependent on the temperature. If the Diver is used, stored or transported for extended periods of time under high temperature, this will adversely affect the life of the battery. The battery's capacity at lower temperatures is reduced, but this is not permanent. This is normal behaviour for batteries.

** The accuracy of the clock is highly dependent on temperature. The clock is actively compensated for temperature in all models.

2.6 General

Transport	Suitable for transportation by vehicles, ships and airplanes in the supplied packaging.
Resistance to vibration	In accordance with MIL-STD-810.
Mechanical shock test	In accordance with MIL-STD-810, for light-weight equipment.

2.7 Temperature

The following specifications apply to the Mini, Micro, Cera, CTD-Diver and Baro-Diver for temperature measurements:

Measurement range	-20 °C to 80 °C
Operating Temperature (OT)	0 °C to 50 °C (for Baro-Diver: -10 °C tot 50 °C)
Accuracy (max)	± 0.2 °C
Accuracy (typical)	± 0.1 °C
Resolution	0.01 °C
Response time (90% of final value)	3 minutes (in water)

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2.8 Pressure

The specifications for atmospheric and water pressure measurements vary by type of Diver. The specifications below apply at operating temperature.

Mini-Diver	**DI501**	**DI502**	**DI505**	**DI510**	**Unit**
Water column measurement range	10	20	50	100	mH_2O
Accuracy (max)	± 2.5	± 5	± 12.5	± 25	cmH_2O
Accuracy (typical)	± 0.5	± 1	± 2.5	± 5	
Long-term stability	± 2	± 4	± 10	± 20	cmH_2O
Resolution	0.2	0.4	1	2	cmH_2O
Display resolution	0.058	0.092	0.192	0.358	cmH_2O
Burst pressure	15	30	75	150	mH_2O

Micro -Diver	**DI601**	**DI602**	**DI605**	**DI610**	**Unit**
Water column measurement range	10	20	50	100	mH_2O
Accuracy (max)	± 3	± 6	± 15	± 30	cmH_2O
Accuracy (typical)	± 1	± 2	± 5	± 10	
Long-term stability	± 3	± 6	± 15	± 30	cmH_2O
Resolution	0.2	0.4	1	2	cmH_2O
Display resolution	0.058	0.092	0.192	0.358	cmH_2O
Burst pressure	15	30	75	150	mH_2O

Cera -Diver	**DI701**	**DI702**	**DI705**	**DI710**	**Unit**
Water column measurement range	10	20	50	100	mH_2O
Accuracy (max)	± 2	± 4	± 10	± 20	cmH_2O
Accuracy (typical)	± 0.5	± 1	± 2.5	± 5	
Long-term stability	± 2	± 4	±10	± 20	cmH_2O
Resolution	0.2	0.4	1	2	cmH_2O
Display resolution	0.058	0.092	0.192	0.358	cmH_2O
Burst pressure	15	30	75	150	mH_2O

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CTD-Diver	DI271	DI272	DI273	Unit
Water column measurement range	10	50	100	mH_2O
Accuracy (max)	± 2	± 10	± 20	cmH_2O
Accuracy (typical)	± 0.5	± 2.5	± 5	
Long-term stability	± 2	± 10	± 20	cmH_2O
Resolution	0.2	1	2	cmH_2O
Display resolution	0.058	0.092	0.358	cmH_2O
Burst pressure	15	75	150	mH_2O

Baro -Diver	DI500	Unit
Water column measurement range	150	mH_2O
Accuracy (max)	± 2	cmH_2O
Accuracy (typical)	± 0.5	
Long-term stability	± 2	cmH_2O
Resolution	0.1	cmH_2O
Display resolution	0.058	cmH_2O
Burst pressure	15	mH_2O

2.8.1 Water column measurement range

The height of water above the Diver that can be measured.

2.8.2 Accuracy (max)

Accuracy is the proximity of measurement results to the true value. Algebraic sum of all the errors that influence the pressure measurement. These errors are due to linearity, hysteresis and repeatability. During the Diver calibration process a Diver is rejected if the difference between the measured pressure and the applied pressure is larger than the stated accuracy.

2.8.3 Accuracy (typical)

At least 67% of the measurements during the calibration check are within 0.05% FS of the measurement range.

2.8.4 Long-term stability

The stability of the measurement over a period of time when a constant pressure is applied at a constant temperature.

2.8.5 Resolution

The smallest change in pressure that produces a response in the Diver measurement.

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2.8.6 Display resolution

The smallest increment in pressure that the Diver can measure.

2.8.7 Burst pressure

The pressure at which the Diver pressure sensor will fail.

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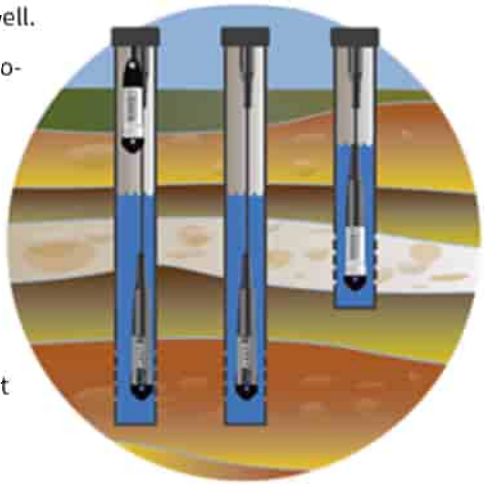
3 Diver Installation and Maintenance

3.1 Introduction

In practice the Diver is usually suspended in a monitoring well.

The illustration to the right depicts a set of Divers and a Baro-Diver for compensating for barometric pressure.



In addition to the regular Divers, a Baro-Diver that acts as a barometer and records atmospheric pressure is installed at each measurement site. Atmospheric pressure data must be used to compensate the pressure measurements recorded by the Divers for variations in atmospheric pressure. A Baro-Diver, designed for taking atmospheric pressure measurements, is recommended for this purpose. In principle, a single Baro-Diver is sufficient for an area with a radius of 15 kilometres (depending on terrain conditions. Also see Appendix I *'Use of Divers at elevations'*).

The following describes how to install the Divers and Baro-Diver.

3.2 Installation in a Monitoring Well

Divers are normally installed below water level in a monitoring well. The depth at which a Diver can be suspended is dependent on the instrument's measurement range. Further information about the Diver's range is contained in the Section *'Technical Information'*.

First determine the length of the non-stretch suspension cable on the basis of the lowest groundwater level. Provide for the required additional length for attaching the cable to the Diver and the length of the suspension eye at the upper end when you cut the wire to size.

Next use wire clips to attach the ends of the cable to the monitoring well's end cover and the Diver's suspension eye, respectively.

To determine the distance of the pressure sensor in the monitoring well requires the precise length of the cable to be known, to which the distance to the location of the pressure sensor in the Diver must be added to obtain the overall operating length. This is depicted in the diagram below.

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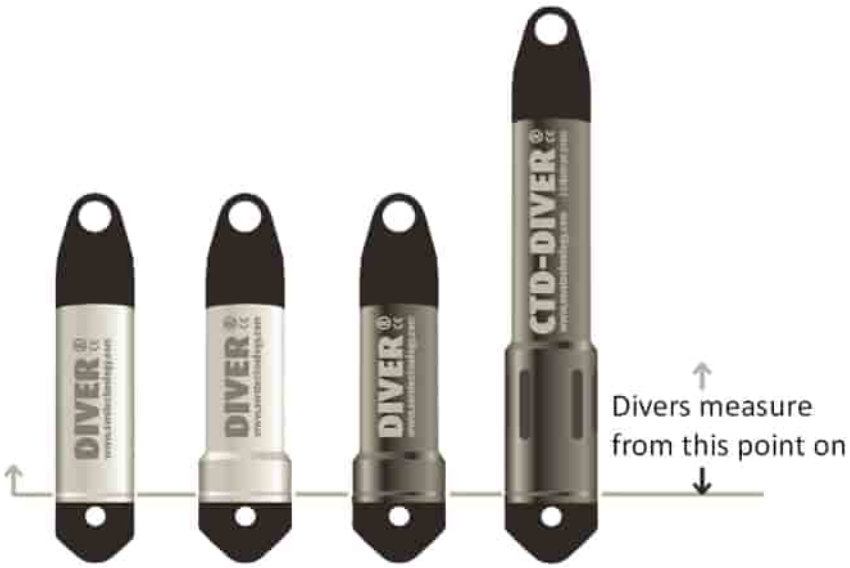

It is also possible to install the Diver with a Diver Data Cable (DDC). This cable allows you to read out the Diver at the top of the monitoring well by using a USB interface cable.

Diver suspended by steel wire

Diver suspended by DDC

Note: When the Diver is installed, it is possible for the groundwater level to be temporarily elevated. The reverse is true when the Diver is removed. The groundwater level may then be temporarily lowered.

If the cable length is not exactly known, it can, for example, be calculated using the Diver-Office and a manual measurement (measuring tape measurement from the top of casing) (manual measurement + Diver measurement – Baro-Diver reading = cable length).

The following must be taken into consideration in installing a CTD-Diver:

- Preferably do not install in very tight fitting piping.
- The C value readings are most accurate (most reliable) when the through flow of the water to be measured is unimpeded.
- The preference is for CTD-Divers to be suspended at screen height.

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- In contrast to 'regular' Divers, the position within the monitoring well in relation to the screen affects the measurements. Here too the following dictum applies: the greater the through flow the more reliable the measurement.
- The monitoring well is made of non-metal containing material.
- Ions released from the walls of the monitoring well can/will affect the measurements.
- Glued monitoring wells: it is known that certain glue types affect measurements.
- Since CTD-Divers and Cera-Divers are used in brackish and salt water, it is not recommended to use stainless steel wiring. Stainless steel wire and mounting clamps can rust which may cause the Diver to fall into the well.

3.3 Installation in surface water

If a Diver is to be used in surface waters it is important that there is sufficient circulation around the Diver's sensors. Water flows prevent the pipe from silting up and ensures that the Diver in fact measures the surrounding water rather than the stagnating water in the monitoring well itself. We recommend that a monitoring well of at least 2" is used, of which the openings must be kept clear of, for example, algae and plant growth as much as possible.

If a steel pipe is used (see pictures) with a 1" monitoring well installed inside the pipe, allow the Diver's extremity to protrude somewhat beyond the end of the pipe so that the Diver's sensors also come into contact with the water at this point.

Install the fixing post to which the monitoring well is attached so that the Diver benefits from the maximum water depth and flow, for example in the middle of the ditch. To prevent vandalism, a steel pipe with a steel cap that can be locked can be used.

Position the Divers deep enough so that they remain below a possible ice layer.

This picture shows a Diver whose sensor protrudes from below the monitoring well. A thinner monitoring well has been placed into the steel pipe in which the Diver can be installed.

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3.4 The use of Divers at Elevation

Divers can be used at any elevation ranging from 300 metres below sea level to 5,000 metres above sea level. Appendix I contains further information on the use of Divers at elevations.

3.5 Baro-Diver

The Baro-Diver must be installed in such a way that it only measures atmospheric pressure under all conditions. A location that is not subject to rapid temperature variations is preferred.

3.6 Use in Seawater

Do not use a Mini-Diver or Micro-Diver in seawater.

The Mini-Diver and Micro-Diver are made of 316L stainless steel. This material is not suited for brackish and/or seawater because it is subject to corrosion/crevice corrosion. Corrosion is caused by the salt content, and can be enhanced by temperature and the other substances in the water.

We recommend that you select the Cera-Diver and/or CTD-Diver for use in semi-saline water and/or seawater. These Divers are made of ceramic materials that are able to withstand semi-saline water and/or seawater.

3.7 Diver Maintenance

In principle, the Diver does not require any maintenance. When required, the casing can be cleaned with a soft cloth. Calcium and other deposits can be removed with white vinegar. The flow-through opening can also be rinsed with water and/or white vinegar.

Note: only use diluted acid solutions if the Diver is seriously dirtied and other cleansers are not effective.

Never use any hard brushes, abrasives or sharp objects for cleaning the Diver and always rinse it properly with clean water after cleaning, particularly near the flow-through openings. Do not use any powerful jets. This could damage the pressure sensor.

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4 CTD-Diver

4.1 Measuring Conductivity

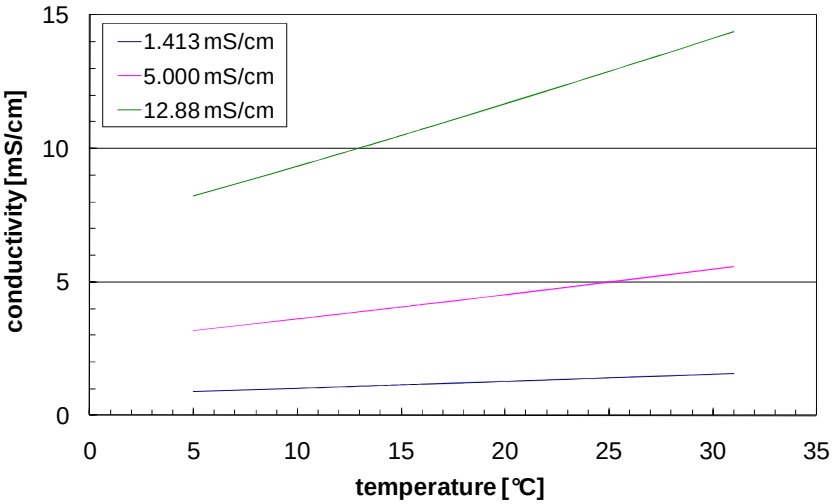
In addition to water levels and temperature, the CTD-Diver also measures the water's electrical conductivity in millisiemens per centimetre (mS/cm). A change in conductivity may be caused by for example changes in water flow, or increasing/decreasing pollution or salinization.

The CTD-Diver measures the conductivity of a solution. The CTD-Diver can be programmed by the user to measure either the true conductivity or the specific conductivity. The specific conductivity is defined as the conductivity as if the temperature is 25 °C. This setting must be programmed prior to starting the CTD-Diver.

The conductivity is measured using a 4-electrode measuring cell. This type of measuring cell is relatively insensitive to sensor fouling, thus keeping maintenance to a minimum. *The measuring cell combined with the selected measurement method results in an electrolysis-free measurement system.*

Example

The conductivity of a liquid depends on the type of ions in the liquid and to a significant degree on the liquid's temperature. This dependency is indicated on the packaging of the calibration liquids, for example. The diagram below displays the conductivity as a function of temperature for three different calibration liquids. The specified value of the calibration liquid is the conductivity of the liquid at 25 °C.



As a rule of thumb it can be assumed that conductivity varies by 2% for each 1 °C change in temperature. This means that a calibration liquid rated at 5 mS/cm (at 25 °C) still only has a conductivity of approximately 4 mS/cm at 15 °C.

The table below lists a number of typical conductivity values for various types of water.

Type	Conductivity [mS/cm]
Tap water	0.2 – 0.7
Groundwater	2 - 20
Seawater	50 - 80

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4.2 Factory Calibration

Each CTD-Diver is calibrated for pressure, temperature and conductivity:

1. First the CTD-Diver is calibrated for pressure and temperature. This process is identical for each Diver and is described in the chapter calibration procedure.
2. Then the factory calibration of the conductivity sensor is performed. The CTD-Diver immersed in a 6 ascending conductivity values. The exact value of the conductivity of the liquid is determined with a calibrated reference sensor.
3. During the calibration check of the conductivity sensor, the CTD-Diver is immersed in 6 conductivity fluids: (0.15, 0.9, 3.0, 12, 35 and 75) mS/cm. The values measured by the CTD-Diver are compared to the reference values, this determines whether the deviation is within the limits of the specifications.

The factory calibration is stored permanently in the CTD-Diver.

4.3 Field calibration

The conductivity sensor is, in contrast to the pressure and temperature sensor, sensitive to pollution. Therefore, it is advisable to check the sensor regularly. A simple verification consists of two steps. Firstly, take the CTD-Diver out of the well and shake it dry. Then take an actual reading, the reading should be 0 mS/cm. The reading may be slightly higher if the conductivity sensor is not completely dry. Second, immerse the CTD-Diver in a conductivity calibration solution. Ensure, that there are no air bubbles trapped inside the conductivity measurement cell. Take another actual reading and compare with the value of the calibration solution. Note: if the CTD-Diver is set to read Conductivity, i.e. not Specific Conductivity ensures that the reading is corrected for temperature.

If the deviation is greater than the specified accuracy it is recommended to recalibrate the CTD-Diver. It is important to note that this calibration should be performed in an environment with a stable temperature. It is necessary to make use of good reference fluids and clean tools in order to perform a proper and reliable recalibration.

The conductivity accuracy specification of the CTD-Diver for the full 0-120 mS/cm measurement range can only be achieved if the CTD-Diver is calibrated at all four calibration points (1.413; 5; 12.88 and 80 mS/cm).

If you choose to use the CTD-Diver in a specific application, you may decide to perform the calibration on no 1 or 2 points. This means that the CTD-Diver meets the specifications in that particular measurement range. The CTD-Diver may deviate somewhat from the specifications outside the calibrated measurement range.

Example: If the CTD-Diver is used in a measurement range of 2-3 mS/cm, perform the user calibration at 1.413 and/or 5 mS/cm. The CTD-Diver will consequently be within the specifications for the 1.413 to 5 mS/cm measurement range.

If the user calibration is later carried out at the four calibration points, then the CTD-Diver will once again meet its specifications for the full measurement range.

The procedure for calibrating a CTD-Diver can be found in the Diver-Office software manual.

Note: When the CTD-Diver has not been used for an extended period of time take the following steps prior to calibration. Program the CTD-Diver with a one minute sample interval and start the CTD-Diver. Immerse the CTD-Diver in tap water for a period of at least 24 hours.

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Important:

Prior to each reference measurement and/or calibration, the CTD-Diver must be thoroughly rinsed in demineralised water. After it has been rinsed it may not be touched by bare hands since the reference liquid can easily become contaminated by residual contaminants and/or residual salts left on hands. This invalidates a reference measurement/calibration since the reference has become distorted. This effect is highest at the lowest values.

Erroneous or improper calibration can also **negatively** affect the accuracy of the CTD-Diver.

Cleanliness during calibration is very important. All salt residues adhering to the CTD-Diver will negatively affect the accuracy of the calibration liquid. **This is why this calibration solution may never be used twice.**

Temperature differences can also cause errors (extended acclimatization is a required).

In such cases it is recommended that the factory calibration be restored.

4.4 Specific Conductivity

The specific conductivity of an electrolyte solution is defined as the conductivity if the solution is at a certain – reference – temperature. The specific conductivity is an indirect measure of the presence of dissolved solids such as chloride, nitrate, phosphate, and iron, and can be used as an indicator of water pollution.

The following equation is used for calculating the specific conductivity K_{Tref} from the measured conductivity K.

$$K_{Tref} = \frac{100}{100+\theta(T-T_{ref})} \cdot K \qquad (5)$$

where:

K_{Tref} = Specific conductivity at T_{ref}

K = Conductivity at T

T_{ref} = Reference temperature (25 °C)

T = Sample temperature

θ = Temperature coefficient (1.91 %/°C)

The temperature coefficient used in the CTD-Diver is 1.91 %/°C and the reference temperature is 25°C. The setting to measure conductivity or specific conductivity can be programmed into the CTD-Diver by the user.

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5 FAQ

This section contains an overview of questions frequently received from our customers and our answers to them. If you do not find the answer you are looking for in this FAQ, please contact Van Essen Instruments.

Q: *How do I install my Diver?*

A: Most Divers are installed underwater in a monitoring well. The depth at which you can suspend a Diver depends on the instrument's measurement range. Determine the lowest possible water level measured from the top of the casing (or another reference point) prior to the installation. If the Diver is at least suspended at this depth, it is then certain that the Diver always measures the water level.

B: The Diver can be suspended from a Diver Data Cable (DDC) or from a non-stretch steel cable by means of a suspension eye. Attach the Diver to the monitoring well cover and the suspension eye with two cable clips.

Q: *How do I connect a Diver to my computer?*

A: The way in which a Diver is connected to a computer depends on the way in which the Diver is installed in the monitoring well.

A Diver hanging in the monitoring well suspended from a cable must first be removed from the monitoring well before it can be read out. The Diver is read using a computer and reading unit:

Connect the reading unit to your computer via the USB port. The required drivers are supplied. These are automatically installed using the Diver-Office software. The software can be downloaded from www.vanessen.com.

2. Unscrew the Diver's suspension eye.

3. Insert the Diver upside down into the reading unit (see above).

A Diver suspended from a Diver Data Cable (DDC) can be left hanging in the well. This Diver can be read out with a computer using an interface cable:

1. Connect the DDC interface cable to the computer.

2. Unscrew the protective cap from the end of the DDC.

3. Connect the connector on the interface cable to the end of the DDC.

4. Read out the Diver measurements using one of our programs.

5. Unscrew the DDC's interface cable.

6. Replace the protective cap on the DDC.

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Q: *Is a Diver limited to being used at sea level?*

A: No, Divers can be used from 300 m below sea level to 5,000 m above sea level.

Q: *Do you always need two Divers for measuring a single monitoring well?*

A: No, but at least one Baro-Diver to monitor barometric pressure must be included in each network. For example, 20 Divers and one Baro-Diver would have to be installed for a network with 20 monitoring wells. We recommend installing one surplus Baro-Diver as a backup for larger networks. This is dependent on geographical conditions.

Q: *What is the radius from the Divers within which the Baro-Diver should be placed to ensure proper compensation for atmospheric pressure?*

A: The rule of thumb on open terrain, at approximately the same elevation one Baro-Diver is required within a maximum radius of 15 km.

Q: *What is the formula for converting the results of the Divers/Baro-Diver measurements from cmH_2O (e.g. 1,020.74 cmH_2O) to atmospheric pressure (mbar)?*

A: The Divers/Baro-Diver measure in cm water column (cmH_2O). To convert the measured cm water column to atmospheric pressure, it must be multiplied by 0.980665. In this example: 1,020.74 × 0.980665 = 1,001 mbar.

Q: *What is the Diver's battery's lifespan?*

A: The battery's lifespan is dependent on many factors, for example its temperature exposure, measurement interval, data reading and programming cycles and the type of Diver.

Given past experience, a maximum lifespan of 10 years is considered standard under 'typical' use. Typical use means that, among other things, Divers are not exposed to extreme temperatures over extended periods of time, the measurement sampling rate is not set at 1 second, a download is not requested by modem every hour, etc.

Example:

1 measurement per hour over a period of 10 years produces 87,600 measurements.

1 measurement every 15 minutes over a period of 10 years produces 350,400 measurements.

Q: *Is it possible to use the Divers in seawater?*

A: The Mini and Micro-Divers are made of 316L stainless steel. This material is not suitable for use in seawater. The Cera-Diver and CTD-Diver are made of zirconia, a ceramic material. This material does not corrode in seawater and these Divers can therefore be used in seawater. Van Essen Instruments explicitly selected a 'non-metal' for the Diver types required for use in aggressive environments (such as seawater). Any metal will eventually corrode in an environment that is too aggressive or due to the lack of oxygen. The zirconia used in the Cera-Diver and CTD-Diver is extremely resistant to corrosion. The ceramic (Alumina) pressure sensors exhibit the same properties. The Viton o-rings have been selected for their favourable properties in this environment.

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Q: *How do I clean the Diver when it is very dirty?*

A: If your Diver is very dirty, it can easily be cleaned with white distilled vinegar.

A diluted phosphoric acid solution may also be used for ceramic Diver types.

Place the Diver in the solution for some time. Always thoroughly rinse the Diver with clean water after cleaning, especially near the flow through openings. If necessary, use a soft cloth to remove any deposits. Never use any hard brushes, abrasives or sharp objects to clean your Diver.

Q: *Must the Diver be calibrated?*

A: No, this is not necessary. Van Essen Instruments calibrates the Divers before they are delivered. A factory calibration certificate can be supplied as part of the production process.

The Divers can only be calibrated by Van Essen Instruments. In case of doubt, the user can perform a control measurement locally.

B: For the CTD-Diver, a user calibration can be carried out for the C channel. See the user manual for the software used (e.g., Diver-Office) for more information.

Warning:

A conductivity calibration is a delicate matter. How the CTD-Diver is cleaned prior to the calibration, temperature-related matters and how the calibration liquid is handled are all very important. It is not recommended to calibrate the CTD-Diver in the field.

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6 Appendix I – Use of Divers at Elevation

Divers can be used at any elevation ranging from 300 metres below sea level to 5,000 metres above sea level. It is however recommended that all Divers and the Baro-Diver forming part of the same network be used at the same elevation (whenever possible).

The relationship between atmospheric pressure variations and elevation is exponential, rather than linear:

$$P_H = P_0 \cdot e^{-(M \cdot g \cdot H)/(R \cdot T)}$$

where

P_H = atmospheric pressure at elevation height H

P_0 = atmospheric pressure at reference height

$M = 28.8 \cdot 10^{-3}$ kg/mol (molecular mass of air)

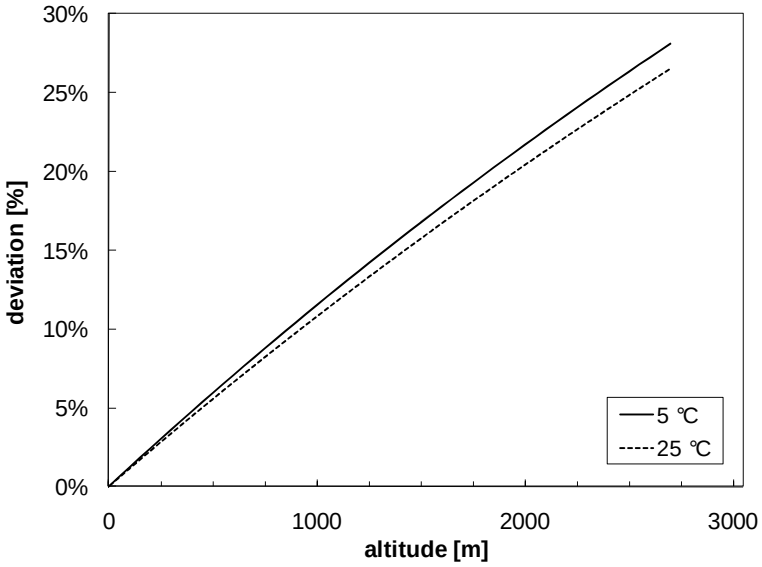
$g = 9.81$ m/s^2 (standard gravity)

H = height in metres

R = 8.314 J/mol/K (gas constant)

T = temperature in Kelvin

If the Baro-Diver is placed at a different elevation in relation to the other Divers in a measurement network, it is possible for a deviation to occur in the barometrically compensated data due to the relationships referred to above. The graph below illustrates the deviation in the barometric data as a function of the variation in elevation at 5 °C and 25 °C.



To determine the relative barometric pressure deviation relative to P_0 at 5 °C (T = 278.15°K) at a height differential of H, the above referenced formula can be used:

$$(P_H - P_0) / P_0 = 1 - e^{-(M \cdot g \cdot H)/(R \cdot T)} \times 100\% \quad (6)$$

By substituting the data a relative deviation of 1.2 % at a height differential of 100 m is obtained. At a height differential of 1,000 m this increases to 11.5 %.

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We therefore recommend that all Divers and the Baro-Divers in a network be placed such that the mutual height differentials are minimised.

If necessary, multiple Baro-Divers can be deployed to avoid the abovementioned problems.

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Appendix E – Bore logs (Myara North)

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B01

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 427679, 6410639
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 264
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 7.70	**Logged By** AO
Date Drilled 11/09/2020 - 11/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Clayey gravel. Pea gravel and cobbles, 5-30mm sub rounded with significant silt and clay. Light brown, moist, loose .		264
0.5							263.5
1							263
1.5			Grout Depth: 0.0 - 3.0		Clay . Very stiff clay, plastic when moist. Minor iron cementing. Mottled white to bluish grey, slightly moist, stiff .		262.5
2							262
2.5							261.5
3			Slow release bentonite pellets Depth: 3.0 - 3.7				261
3.5							260.5
4		▽					260
4.5							259.5
5							259
5.5			Gravel pack: 3.2-6.4 mm. Depth: 3.7 - 7.7				258.5
6					Weathered dolerite. Weathered to extremely weathered medium grained dolerite. Significant silty and clay (weathering), red to brown, slightly moist, very stiff .		258
6.5							257.5
7							257
7.5					Dolerite. No sample - assumed fresh dolerite, wet, hard .		256.5
					Termination Depth at: 7.70 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B02

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 428185, 6411584
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 220
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 28.50	**Logged By** AO
Date Drilled 09/09/2020 - 09/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel, 2-20mm sub rounded with significant silt and clay. Light brown, moist, medium dense .		220
2					Caprock. Iron cemented caprock, with up to 20% fine grained sands. Red, slightly moist, dense .		218
4					Clayey silt. Sandy clayey silt. Beige, slightly moist, medium dense .		216
6					Sandy silt. Sandy silt with minor sand (fine grained). White, slightly moist, medium dense .		214
8					Clayey silt. Clayey silt with minor sand (fine grained). White/ red, slightly moist, medium dense .		212
10			Grout Depth: 0.0 - 19.0				210
12					Silty clay. Silty clay. Medium plasticity. Reddish., moist, soft .		208
14							206
16		▽					204
18							202
20			Slow release bentonite pellets Depth: 19.0 - 21.2				200
22					Silty clay. Silty clay with minor coarse sand (quartz). Medium plasticity. Green., very moist, soft .		198
24			Gravel pack: 3.2-6.4 mm. Depth: 21.2 - 28.5				196
26					Silty clay. Silty clay with minor coarse sand (quartz). Medium plasticity. Beige., wet/saturated, soft/loose .	Saturated at 26.5, first groundwater collected (2L/min), pH = 7.3, TDS = 460 mg/L, EC = 716 uS/cm	194
28					Weathered granite. Extremely weathered granite, quartz rich, weakly cemented. White, saturated, medium dense .	Flow at 28.5 (3L/min), pH = 6.1, TDS = 734 mg/L, EC = 1124 uS/cm	192
					Granite. Granite, dry, hard .		
					Termination Depth at: 28.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B03

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 429880, 6412496
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 251.5
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 23.90	**Logged By** AO
Date Drilled 08/09/2020 - 08/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Top soil. Grey silty sand with organic matter. Medium grained, poorly graded, moist, soft/firm .	Drilled to 23.5m, after 1h no water present	251
1					Silty gravelly sand. Grey Silty gravelly sand, minor clay. Medium grained, poorly graded, moist, soft/firm .		250
2					Gravelly sandy silt. Transitioning to silty clay, grey to light orange, slightly moist, medium dense/firm .		249
3					Silty Clay. Silty clay, fine. Partly cemented. Light orange to white, dry, medium dense/firm .		248
4							247
5							246
6							245
7			Grout Depth: 0.0 - 14.5				244
8							243
9							242
10							241
11							240
12					Silty Clay. Silty clay, fine. Partly cemented. Light red to yellow/brown, dry, medium dense/firm .		239
13							238
14							237
15			Slow release bentonite pellets Depth: 14.5 - 16.7				236
16							235
17							234
18							233
19							232
20			Gravel pack: 3.2-6.4 mm. Depth: 16.7 - 23.9				231
21					Sandy Clay. Sandy Clay. Orange, moist, soft/firm .		230
22					Sandy clay. Sandy Clay. Blue/grey, moist, soft/firm .		229
23	DC				Dolerite, basement. Dolerite (core), one small fracture., dry, hard .(diamond)		228
24					Termination Depth at: 23.90 m		227

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B04

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 430635, 6413463
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 269
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 36.00	**Logged By** AO
Date Drilled 07/09/2020 - 08/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel, iron cemented, 2-20mm sub rounded with limited silt and clay. Brown, moist, loose .		268
2					Caprock. Caprock, weakly cemented, dark red to brown, moist, medium dense .		266
4					Silty Clay. Silty clay, fine. Partly cemented. Beige, slightly moist, medium dense/firm .		264
6							262
8					Silty Clay. Silty clay, fine, powdery. Not cemented. White, slightly moist, medium dense/firm .		260
10					Silty Clay. Silty clay with sand, fine. Not cemented. White. Becoming grainy , slightly moist, medium dense/firm .		258
12			Grout Depth: 0.0 - 23.5		Silty Clay. As above, red/white/brown, slightly moist, medium dense/firm .		256
14							254
16							252
18							250
20							248
22		▽					246
24			Slow release bentonite pellets Depth: 23.5 - 27.5				244
26							242
28					Sandy clay. As above, light yellow becoming grainy (fine sand) and moist, moist, medium dense/firm .		240
30			Gravel pack: 3.2-6.4 mm. Depth: 27.5 - 35.5		Clayey Gravel. Weathered rock/saprock. Weakly cemented coarse sand with significant clay at 30-31 and 32.5-33. Gravel is angular quartz and feldspar, wet/saturated, soft/firm .	Wet/saturated (3L/min), pH = 7.18, TDS = 208 mg/L, EC = 321 uS/cm	238
32							236
34			Backfill Depth: 35.2 - 36.0				234
36					Termination Depth at: 36.00 m	Collapse, well installed at 35.2 Water level 22.9 mbgl after air lifting.	

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B07

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 417332, 6419413
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 292
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 8.00	**Logged By** AO
Date Drilled 19/08/2020 - 19/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Top soil. Silty gravel, coarse 5-10mm, poorly graded. Brown, moist, medium dense .		292
0.5					Silty gravel. Course 10-30mm, poorly graded. Brown, moist, medium dense .		291.5
1					Silty gravel. Course 30-50mm, poorly graded. Red/brown, slightly moist, dense .		291
1.5			Grout Depth: 0.0 - 3.0		Clayey sand. Clayey sand with minor gravel, transitioning to fine sandy clay, plastic. Red to beige. , slightly moist, firm .		290.5
2							290
2.5					Lateritic caprock. Cemented sands and gravels. Red, dry, hard .		289.5
3					Sandy clay. Medium grained sands, poorly graded. Grey, slightly moist, firm .		289
3.5			Slow release bentonite pellets Depth: 3.0 - 4.0				288.5
4					Sandstone. Iron cemented sands and gravels. Red/yellow, dry, hard .		288
4.5							287.5
5		▽					287
5.5							286.5
6			Gravel pack: 3.2-6.4 mm. Depth: 4.0 - 8.0		Dolerite. Weathered dolerite. Iron stained, coarse grained, fractured. Grey/black, saturated, hard .	Diamond core from 6.5 m. Saturated, minor flow (0.01 L/s), pH = 7.44, TDS = 377 mg/L, EC = 576 uS/cm	286
6.5	DC				Dolerite. Fresh dolerite with minor fractures. Dark grey, saturated, very hard .(diamond)		285.5
7							285
7.5						End of hole in hard basement dolerite. Flow from above. (0.01 L/s), pH = 5.34, TDS = 352 mg/L, EC = 542 uS/cm	284.5
8					Termination Depth at: 8.00 m		284

Notes

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Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B08

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 415946, 6417938
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 223
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 13.10	**Logged By** AO
Date Drilled 04/09/2020 - 04/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.7		Ferricrete/caprock. Pea gravel, iron cemented, 2-20mm sub rounded with significant silt and clay. Light brown, moist, loose .		
1					Clay. Mottled clay, stiff, minor silt/sand iron cementing. Light brown to cream, slightly moist, stiff .		222
2							221
3			Slow release bentonite pellets Depth: 0.7 - 6.1		Gravelly clay. Clay, variably stiff, with up to 50% angular quartz gravel, weakly cemented/brittle. Cream, saturated/moist, medium dense .		220
4		▽					219
5					Clayey gravel (Saprock). Saprock, gravel quartz, angular, weakly cemented, with clay/silt. White, saturated, medium dense .		218
6							217
7						Flow at 7 m (5L/30sec), pH = 7.04, TDS = 422 mg/L, EC = 585 uS/cm	216
8						Flow at 8.5 m (5L/30sec), pH = 6.5, TDS = 349 mg/L, EC = 555 uS/cm	215
9					Clayey gravel (Saprock). As above, increase in iron mineralisation, mottled. Brittle becoming hard. Brown, saturated, medium dense .		214
10			Gravel pack: 3.2-6.4 mm. Depth: 6.1 - 13.			Flow at 10 m (1L/s), pH = 6.4, TDS = 448 mg/L, EC = 694 uS/cm	213
11						Drop in flow 11-12m with more silty rock structur	212
12							211
13					Quartzite/metamorphic?. Quartz dominant rock. Very fine grained/glassy. Significant mafic minerals. Very hard with depth. White/dark brown, saturated, hard .	End of hole flow (1L/s), pH = 6.8, TDS = 422 mg/L, EC = 650 uS/cm	210
					Termination Depth at: 13.10 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B09

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420093, 6418114
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 230
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 3.20	**Logged By** AO
Date Drilled 28/08/2020 - 28/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.3		Silty sand. Medium grained sand, sub angular, with significant pea gravel. Light brown. , moist, loose .		230
0.2							229.8
0.4			Slow release bentonite pellets Depth: 0.3 - 0.5				229.6
0.6							229.4
0.8							229.2
1	DC				Granite. Fresh to slightly weathered granite, coarse grained. Minor sub vertical fracture at 2.4m, moist, hard .(diamond)		229
1.2							228.8
1.4							228.6
1.6							228.4
1.8							228.2
2		▽					228
2.2							227.8
2.4							227.6
2.6							227.4
2.8							227.2
3			Gravel pack: 3.2-6.4 mm. Depth: 0.5 - 3.2				227
3.2						Minor seepage only from airlift (<1L/min), pH = 7.3, TDS = 399 mg/L, EC = 615 uS/cm	226.8
3.4					Termination Depth at: 3.20 m		226.6
3.6							226.4
3.8							226.2

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B09_B

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 419196, 6418601
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 255
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 8.90	**Logged By** AO
Date Drilled 10/09/2020 - 10/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel and cobbles, 5-30mm sub rounded with significant silt and clay. Light brown, moist, loose .		254.5
0.5			Grout Depth: 0.0 - 1.8				
1							254
1.5					Sandy silt. Coarse sand and brown to white silt, slightly moist, stiff .		253.5
2							253
2.5							252.5
3			Slow release bentonite pellets Depth: 1.8 - 5.0		Sandy silt. Sandy silt with minor clay. Red/ white/beige, slightly moist, stiff .		252
3.5							251.5
4							251
4.5							250.5
5							250
5.5							249.5
6							249
6.5							248.5
7			Gravel pack: 3.2-6.4 mm. Depth: 5.0 - 8.9				248
7.5					Sandy silt. Weathered granite, quartz rich. Brown to white, wet/saturated, firm .	Wet/saturated, water level recorded at 7.55 m bgl	247.5
8		▽					247
8.5							246.5
9					Termination Depth at: 8.90 m		246
9.5							245.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B10

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426297, 6419709
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 292
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 21.50	**Logged By** AO
Date Drilled 25/08/2020 - 26/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Pea gravel, fine grained cemented clasts 2-15mm, sub rounded. Silt matrix 20%. Light brown, moist, very loose .		292
1							291
2					Ferricrete/caprock. Iron cemented caprock. Significant silt/uncemented. Brown, moist, hard .		290
3					Ferricrete/caprock. As above, less cemented, moist, very stiff .		289
4					Silty clay. Clay with significant silt and minor sands. Light brown, dry/slightly moist, soft/firm .		288
5							287
6			Grout Depth: 0.0 - 12.		Silty clay. Clay with significant iron cementation. Red, dry/slightly moist, soft/firm .		286
7							285
8					Silty clay. As above. Colour change to red/brown, dry/slightly moist, soft/firm .		284
9							283
10							282
11		▽			Silty clay. As above. Grading to pink/orange, slightly moist, soft/firm .		281
12			Slow release bentonite pellets Depth: 12. - 14.		Silty clay. As above. Minor cemented white mottled clays, occasionally gravelly. Red/brown, very moist, firm .		280
13							279
14							278
15							277
16							276
17			Gravel pack: 3.2-6.4 mm. Depth: 14. - 21.		Gravelly clay. Clay with variably cemented gravels, mottled red/white. Increasingly hard with depth and rock texture, wet, very stiff .		275
18							274
19							273
20						Very hard at 21.5m, basement. Very minor seepage. (1L/2 mins), pH = 7.8, TDS = 357 mg/L, EC = 546 uS/cm	272
21			Backfill Depth: 21. - 21.				271
					Termination Depth at: 21.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B11

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 414746, 6416766
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 257
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 14.10	**Logged By** AO
Date Drilled 04/09/2020 - 04/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.5		Gravel. Pea gravel, iron cemented, 2-20mm sub rounded with significant silt and clay. Light brown, moist, loose .		
1					Ferricrete/caprock. Strongly cemented caprock, massive, dark red to brown, slightly moist, hard .		256
2					Silty clay. Clay, generally firm. Occasional gravel/iron cemented mottled. Light brown, cream with depth, moist, firm .		255
3						Becoming wet at 3m	254
4			Backfill Depth: 0.5 - 7.5				253
5							252
6							251
7		▽					250
						Saturated at 7.5	
8			Slow release bentonite pellets Depth: 7.5 - 10.				249
9					Gravelly clay. Brittle cemented quartz gravel and sand with 40% clay/weathered quartz. White to cream, moist, soft/firm .		248
10					Clayey sand. Coarse grained angular quartz sand, with significant silt and clay. Occasionally iron cemented zones. Red to dark brown, saturated, soft/firm .	Flow at 10m, slop only (<1L/10 secs), pH = 6.3, TDS = 84 mg/L, EC = 125 uS/cm	247
11						Flow at 11.5m (4L/15 secs), pH = 5.3, TDS = 140 mg/L, EC = 215 uS/cm	246
12			Gravel pack: 3.2-6.4 mm. Depth: 10. - 14.		Gravelly clay. Extremely weathered rock/saprock. Weakly cemented gravel with significant clay. Gravel is angular quartz and feldspar. Iron stained, brown, saturated, soft/firm .		245
13							244
14			Backfill Depth: 14. - 14.		Granite?. Refusal. No sample. Likely granite, , .	Flow at 14m (1 L/s), pH = 5.4, TDS = 131 mg/L, EC = 190 uS/cm	243
					Termination Depth at: 14.10 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B12_D

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 421673, 6418956
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 228
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 24.50	**Logged By** AO
Date Drilled 20/08/2020 - 21/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Gravel. Gravel 5-50mm, with minor sand and silt. Red, saturated, Loose .	Minor flow in perched unit. (<0.01 L/s), pH = 6.13, TDS = 59 mg/L, EC = 92.5 uS/cm	228
1		▽			Sandy clay. Clay with medium to fine grained sands and silts, poorly graded. Light Beige/brown, slightly moist, medium dense .		227
2							226
3					Silty clay. As above, increase in clay, light beige. , moist, medium dense .		225
4					Sandy clay. As above, minor increase in sand. Light brown/reddish brown, moist, medium dense .		224
5							223
6							222
7							221
8			Grout Depth: 0.0 - 16.				220
9					Sandy clay. As above, some cementing of sands, minor gravel. Light brown, saturated, soft .		219
10						Minor flow at 11m, possibly from above. (7L/min), pH = 5.65, TDS = 364 mg/L, EC = 560 uS/cm	218
11							217
12							216
13					Sandy clay. As above, slight increase in sands/gravel 1-5mm. , wet, soft .		215
14							214
15					Silty/gravelly clay. As above, minor cementing and gravels. Occasionally very firm and dry. , moist, medium dense .		213
16			Slow release bentonite pellets Depth: 16. - 17.				212
17							211
18							210
19							209
20			Gravel pack: 3.2-6.4 mm. Depth: 17. - 24.				208
21						Flow in weathered basement/sands. (40L/min), pH = 6.26, TDS = 416 mg/L, EC = 642 uS/cm	207
22							206
23					Granite. Coarse sand, and weathered granite, iron stained, weakly cemented. , wet, medium dense .		205
24					Granite. Fresh granite. Minor iron staining. , wet, hard .		204
					Termination Depth at: 24.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B12_S

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 421673, 6418956
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 223
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 3.50	**Logged By** AO
Date Drilled 21/08/2020 - 21/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.2		Gravel. Gravel 5-50mm, with minor sand and silt. Red, saturated, Loose .		222.
0.2							
0.4			Slow release bentonite pellets Depth: 0.2 - 0.5				222.
0.6							222.
0.8							222.
1					Sandy clay. Clay with medium to fine grained sands and silts, poorly graded. Light Beige/brown, slightly moist, medium dense .	Minor flow in perched unit. (<0.01 L/s), pH = 6.13, TDS = 59 mg/L, EC = 92.5 uS/cm	222
1.2							221.
1.4		▽					221.
1.6							221.
1.8					Silty clay. As above, increase in clay, light beige. , moist, medium dense .		221.
2			Gravel pack: 3.2-6.4 mm. Depth: 0.5 - 3.5				221
2.2							220.
2.4							220.
2.6							220.
2.8							220.
3							220
3.2							219.
3.4							219.
3.6					Termination Depth at: 3.50 m		219.
3.8							219.

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B13

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 413149, 6421902
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 228
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 18.50	**Logged By** AO
Date Drilled 31/08/2020 - 31/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Clayey gravel. Pea gravel, iron cemented, 2-20mm sub rounded with significant silt and clay. Light brown, wet/moist, loose .		228
1							227
2		▽			Sandy clay. Clay with significant fine to medium grained sand/silt, cemented in parts, clay increasing with depth. Light brown. , moist, soft .		226
3							225
4			Grout Depth: 0.0 - 7.5		Sandy clay. As above, becoming cream to white, moist, soft .		224
5						Minor flow from 5.5m (3L/30 sec), pH = 7.5, TDS = 154 mg/L, EC = 227 uS/cm	223
6							222
7					Gravelly clay. Kaolinitic clay, with up to 40% quartz sand and gravel, angular. Partly cemented. White, saturated, soft .	Flow increasing with depth, gravel zones (5L/12 sec), pH = 7.3, TDS = 144 mg/L, EC = 220 uS/cm	221
8			Slow release bentonite pellets Depth: 7.5 - 8.5				220
9							219
10					Gravelly clay. As above, increase in feldspar gravel, brown, saturated, medium dense .		218
11							217
12							216
13			Gravel pack: 3.2-6.4 mm. Depth: 8.5 - 18.				215
14					Silty gravel. Feldspar and quartz angular gravel and weakly cemented/fractured rock, angular to blocky, with significant sand and minor clay. Light brown, saturated, medium dense .	High flow 14-16m in fractures and gravels (1 L/s), pH = 5.5, TDS = 133 mg/L, EC = 205 uS/cm	214
15							213
16							212
17							211
18					Quartzite. Quartz and feldspar rock. Massive with milky to opaque zones, highly fractured, hard with depth. Brown, saturated, very dense .		210
					Termination Depth at: 18.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B16_D

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420800, 6421112
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 264
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 17.50	**Logged By** AO
Date Drilled 27/08/2020 - 28/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH				Clayey gravel. Pisolitic/pea gravel, well rounded, 2-15mm with 30% silt and fine graved sand. Light brown, moist, loose .		264
1							263
2					Clay. Kaolinitic clay, partly stiff. Minor sand 1.5-2.0m, uniform from 2m. , slightly moist, soft/firm .		262
3							261
4			Grout Depth: 0.0 - 8.5				260
5							259
6							258
7							257
8		▽					256
9			Slow release bentonite pellets Depth: 8.5 - 10.				255
10						First water strike, seepage only	254
11					Sandy clay. Clay with fine grained to coarse grained sand and iron cemented silt/gravel. Mottled red to white. , saturated, soft/firm .		253
12							252
13						Good flow (4L/30 sec), pH = 6.1, TDS = 420 mg/L, EC = 650 uS/cm	251
14			Gravel pack: 3.2-6.4 mm. Depth: 10. - 17.				250
15					Gravelly sand. Weakly cemented sand and gravel, coarse grained sand to 2 mm, sub angular, felsic and quartz. With significant slit and clays. Extremely weathered granite. Brown to white, saturated, firm .		249
16							248
17					Granite. Slightly weathered to extremely weathered curse grained granite, quartz dominant. , saturated, hard .	End of hole flow in weathered granite (8L/30 sec), pH = 6.06, TDS = 455 mg/L, EC = 686 uS/cm	247
					Termination Depth at: 17.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B16_S

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420800, 6421112
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 264
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 4.00	**Logged By** AO
Date Drilled 28/08/2020 - 28/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.1		Clayey gravel. Pisolitic/pea gravel, well rounded, 2-15mm with 30% silt and fine graved sand. Light brown, moist, loose .		263.8
0.2			Slow release bentonite pellets Depth: 0.1 - 0.5				263.6
0.4							263.4
0.6							263.2
0.8							263
1							262.8
1.2							262.6
1.4					Clay. Kaolinitic clay, partly stiff. Minor sand 1.5-2.0m, uniform from 2m. , slightly moist, soft/firm .		262.4
1.6							262.2
1.8							262
2			Gravel pack: 3.2-6.4 mm. Depth: 0.5 - 4.0				261.8
2.2							261.6
2.4							261.4
2.6		▽					261.2
2.8							261
3							260.8
3.2							260.6
3.4							260.4
3.6							260.2
3.8							260
4					Termination Depth at: 4.00 m		259.8

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B17

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422519, 6421796
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 280
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 10.70	**Logged By** AO
Date Drilled 26/08/2020 - 26/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.9		Gravel. Course grained pisolitic/pea gravel, with silt and sand. Red/brown, moist, very loose .		280
0.5					Ferricrete/caprock. Iron cemented caprock, cemented gravel concretions. Very hard, slightly moist, hard .		279.5
1							279
1.5							278.5
2			Slow release bentonite pellets Depth: 0.9 - 3.5		Silty/sandy clay. Clay with significant fine grained to medium grained sand and minor gravel. Sand and gravel is cemented lithic fragments, angular. Light brown/cream, moist, soft .		278
2.5							277.5
3							277
3.5							276.5
4							276
4.5							275.5
5							275
5.5							274.5
6							274
6.5							273.5
7		▽	Gravel pack: 3.2-6.4 mm. Depth: 3.5 - 10.				273
7.5					Silty sand. Cemented sands, iron and partly cemented sands, with significant silt/minor clay, moist, stiff .		272.5
8							272
8.5							271.5
9					Gravelly clay. Extremely weathered granite/saprock, quartz rich, weakly cemented. White, wet, firm .		271
9.5						Seepage at 10m. (2L/30 sec), pH = 8.2, TDS = 157 mg/L, EC = 233 uS/cm	270.5
10					Gravel/Granite. Course grained angular quartz (2.4mm) with significant cream clays. Very hard at 10.7 in fresh granite, saturated, hard .	Flow increasing in gravel/granite refusal (5L/30 sec), pH = 6.2, TDS = 170 mg/L, EC = 263 uS/cm	270
10.5							269.5
					Termination Depth at: 10.70 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B18

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426132, 6425488
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 339
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 8.20	**Logged By** AO
Date Drilled 26/08/2020 - 26/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AH		Grout Depth: 0.0 - 0.4		Gravelly sand. Course grained sand/lateritic gravel, with significant silt. Light brown, moist, loose .		339
0.5			Slow release bentonite pellets Depth: 0.4 - 1.0				338.5
1					Sandy clay. Medium grained sand 30-50% with iron cemented nodules. Brown, , medium dense .		338
1.5							337.5
2					Ferricrete/caprock. Iron cemented caprock, with up to 50% fine grained sands, significant silty clay white to brown, increasing with depth. Brown, moist, firm .		337
2.5							336.5
3							336
3.5							335.5
4		▽	Gravel pack: 3.2-6.4 mm. Depth: 1.0 - 7.8				335
4.5					Silty clay. Stiff clay, mottled white to light brown, dry/slightly moist, firm/soft .		334.5
5							334
5.5							333.5
6							333
6.5					Sandy clay. Clay with significant quartz sand, occasionally cemented and remnant rock fabric. Yellow/light brown, moist, stiff .		332.5
7							332
7.5					Granite. Coarse grained, quartz rich. Significant iron staining. Fresh with depth. Grey, moist, hard .	Basement granite, very minor seepage only. No flow	331.5
8			Backfill Depth: 7.8 - 8.2				331
8.5					Termination Depth at: 8.20 m		330.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL B24

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 423558, 6418439
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 255
Site Myara North	**Drill Method** Air	**Collar RL** TBC
Location Myara North	**Total Depth (m)** 24.90	**Logged By** AO
Date Drilled 21/08/2020 - 25/08/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
1	AH		Grout Depth: 0.0 - 9.5		Silty/gravelly clay. Clay with significant gravel, sand and silt. Gravel is ferricrete/pea gravel to 40mm. Light brown. , moist, loose .		254
2		▽			Ferricrete/caprock. Iron cemented caprock. Vuggy to 20mm. Minor clay. Red/brown, moist, hard .		253
3					Silty clay. Mottled clay with silt. Red brown to white, moist, firm/soft .		252
4					Clay. Plastic clay, with minor sand and silt (Saprolitic clay). White to light grey, moist, firm/soft .		251
5							250
6						Seepage at 7m. Very silty. (10L/4mins), pH = 6.2, TDS = 172 mg/L, EC = 265 uS/cm	249
7							248
8							247
9							246
10			Slow release bentonite pellets Depth: 9.5 - 11.		Silty clay. Clays with minor iron cementing. Becoming mottled clay. Grey to red/brown, moist/dry, firm/soft .	Seepage at 10m. (1L/min), pH = 5.3, TDS = 165 mg/L, EC = 253 uS/cm	245
11							244
12					Clay. Plastic clay, minor silt. Mottled. Cream. Dry in parts. , moist/dry, firm/soft .		243
13							242
14					Clay. Plastic clay, minor silt. Minor iron cementing. Red/brown, moist, firm/soft .		241
15							240
16							239
17			Gravel pack: 3.2-6.4 mm. Depth: 11. - 24.				238
18							237
19							236
20					Gravelly clay. Extremely weathered rock, clays and cemented clays. Significant quartz in clay matrix. , saturated, dense .		235
21							234
22							233
23							232
24					Granite. Weathered granite. Brittle to hard. Quartz dominant. Iron stained. White to grey. , saturated, hard .	EOH in granite. Minor flow. (4L/min), pH = 5.22, TDS = 261 mg/L, EC = 387 uS/cm	231
25					Termination Depth at: 24.90 m		230

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

Appendix F – Chip tray photographs (Myara North)

B01: 0-7.7m

B02: 0-28.5m

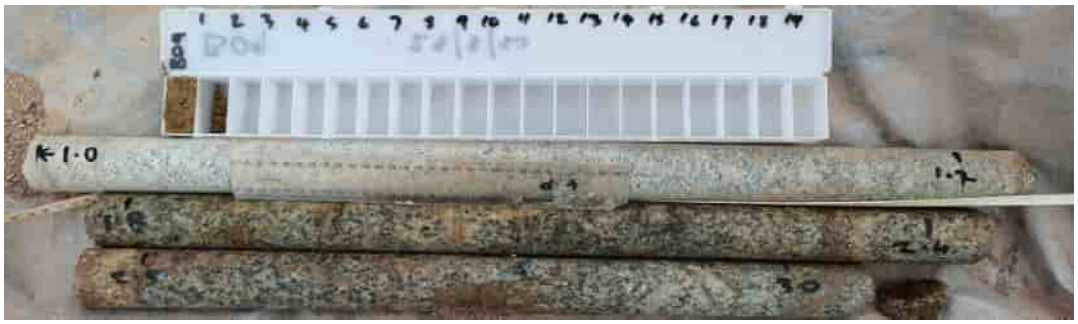
B03: 0-23.9m

B04: 0-36m

B07: 0-8m

B08: 0-13.1m

B09: 0-3.2m



B09B: 0-8.9m

B10: 0-21.5m

B11: 0-14m

B12: 0-24.5m

B13: 0-18.5m

B16: 0-17.5m

B17: 0-10.7m

B18: 0-8.2m

B24: 0-14.3m

Appendix G – Borelogs (Holyoake)

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH01

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424054, 6390718
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 259
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 29.50	**Logged By** AO
Date Drilled 12/10/2020 - 13/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Topsoil, silty sand, with minor pea gravel, brown. , moist, loose .		258
2					Caprock/clayey gravel. Lateritic caprock, iron cemented, fine grained, with 40% clay and silty clay. Brown, slightly moist, very stiff .		256
4					Clay/Silty clay. White clay/silty clay. Stiff at first, then powdery. White, dry, soft .		254
6							252
8		▽	Grout Depth: 0.0 - 16.8		Silty clay. As above, transition to yellow/light brown, dry, soft .		250
10					Silty/Sandy clay. Silty clay with minor quartz angular sand. Pink to orange, very moist, soft .		248
12							246
14					Gravelly clay. Silty clay with significant quartz gravel and sand. Bands of angular quartz, milky to white. Sugary 13-13.5m. Occasionally rock texture. , saturated, soft/firm .	Minor flow	244
16							242
18			Slow release bentonite pellets Depth: 16.8 - 18.9		Clay/sandy clay. As above, increase in clay. Fine grained sand and gravel to 10%. Brown, saturated, soft/firm .	Flow increasing slightly	240
20					Quartz/clay. Quartz vein, milky to translucent quartz, dark mineral veins, with 30% clay, saturated, stiff .		238
22					Sandy clay. Silty clay with significant quartz gravel and sand. Occasionally weak rock structure. Sand to 30%. Light brown, saturated, medium dense .		236
24			Gravel pack: 3.2-6.4 mm. Depth: 18.9 - 29.5				234
26					Clayey gravel. Extremely weathered rock (granite assumed). Quartz and feldspar angular gravel. Firm with depth. Light brown., saturated, dense .		232
28						Flow increasing in basement gravels	230
30					Termination Depth at: 29.50 m	End of hole in transition to basement. No basement rock sampled.	

Notes

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Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH02

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424192, 6388696
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 260
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 17.50	**Logged By** EL
Date Drilled 02/10/2020 - 12/10/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm, brown, wet, loose .		
1					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		259
2					Clayey Silt. Pale brown, silt dominant fines, weakly cemented, dry, dry, soft .		258
3					Clayey Silt. White, silt dominant fines, strongly cemented, dry, dry, soft .		257
4							256
5			Grout Depth: 0.0 - 10.5		Clayey Silt. White, silt dominant fines, very weakly cemented, dry, dry, soft .		255
6							254
7					Clayey Silt. Red, silt dominant fines, weakly cemented, dry, increasing clay content with depth, dry, soft .		253
8							252
9							251
10					Silty Clay. Grey and brown, soft, moderate plasticity, moist, moist, soft .		250
11			Slow release bentonite pellets Depth: 10.5 - 11.5		Silty Clay. Brown, very moist, soft, high plasticity, highly weathered granite fragments (1-60mm), very moist, soft .		249
12		▽					248
13							247
14			Gravel pack: 3.2-6.4 mm. Depth: 11.5 - 17.7		Clayey Sand. Grey/brown, fine to coarse grained, well graded, poorly sorted, highly weathered granite/quartz, angular (1-25mm), wet, soft .		246
15					Silty Clay. Brown, clay dominant fines, soft, moderate plasticity, wet, soft .		245
16							244
17					Weathered Granite. Weathered quartz rich granite, medium grained,		243
					Termination Depth at: 17.50 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH03

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426806, 6387108
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 274
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 40.20	**Logged By** EL
Date Drilled 29/09/2020 - 30/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Sand. Pale grey to brown, fine to medium grained, poorly graded, well sorted, subangular/subrounded, wet, loose .		274
2					Sandy Clay. Brown, soft, moderate plasticity, moist, soft .		272
4					Clayey Silt. White, silt dominant fines, weak cementation, dry, soft .		270
6							268
8					Clayey Silt. Brown/orange, silt dominant fines, weak cementation, increasing clay content with depth, dry, soft .		266
10							264
12			Grout Depth: 0.0 - 24.0				262
14							260
16							258
18							256
20		▽			Silty Clay. Brown, clay dominant fines, weakly cemented, soft, moderate plasticity, moist, soft .		254
22							252
24			Slow release bentonite pellets Depth: 24.0 - 26.5		Clay. Brown, soft, moderate plasticity, minor granite and quartz fragments (1-5mm), wet, soft .		250
26						Flow increasing in the weathered basement, high yield	248
28					Highly weathered granite. Highly weathered quartz rich granite, very grainy (1-5mm, angular) in brown clay matrix, wet, hard .		246
30							244
32			Gravel pack: 3.2-6.4 mm. Depth: 26.5 - 40.2				242
34							240
36							238
38							236
40					Granite. Medium grained granite, weathered, high quartz component, wet, hard .		234
					Termination Depth at: 40.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH04

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424015, 6386978
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 242
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 29.70	**Logged By** EL
Date Drilled 01/10/2020 - 01/10/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm, brown, wet, loose .		
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		240
4					Clayey SAND. Pale brown, fine to coarse grained, well graded, poorly sorted, angular. Weathered quartz fragments, 1-50mm, moist, loose .		238
6					Clayey Silt. Pale yellow/cream, very weakly cemented, silt dominant fines, dry, soft .		236
8					Clayey Silt. White, silt dominant fines, uncemented, dry, soft .		234
10			Grout Depth: 0.0 - 19.0		Clayey Silt. Brown/red, silt dominant fines, weakly cemented, clay content increasing with depth, dry, soft .		232
12					Clayey Silt. Brown/red, silt dominant fines, weakly cemented, clay content increasing with depth, moist, soft .		230
14					Clayey Silt. Brown/red, silt dominant fines, weakly cemented, clay content increasing with depth, very moist, soft .		228
16		▽					226
18					Silty Clay. Brown, clay dominant fines, soft, moderate plasticity, increasing clay content with depth, very moist, soft .		224
20			Slow release bentonite pellets Depth: 19.0 - 22.0				222
22							220
24			Gravel pack: 3.2-6.4 mm. Depth: 22.0 - 29.7		Sandy Clay. Brown, very soft, moderate plasticity, clay dominant fines, wet, soft .		218
26					Clayey Sand. Highly weathered quartz (1-2mm), angular, fine to coarse grained, well graded, poorly sorted, wet, loose .		216
28					Sandy Clay. Brown, very soft, moderate plasticity, clay dominant fines, highly weathered quartz (1-2mm), angular, wet, soft .	Flow increasing in weathered basement, low yield	214
30					Clayey Sand. Highly weathered quartz (1-2mm), angular, fine to coarse grained, well graded, poorly sorted, wet, loose .		212
32					Highly weathered granite. Highly weathered quartz rich granite, very grainy (1-5mm, angular) in brown clay matrix, wet, hard .		210
34					Granite. Medium grained granite, weathered, high quartz component, wet, hard .		208
					Termination Depth at: 29.70 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH05

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 428234, 6386651
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 233
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 14.20	**Logged By** EL
Date Drilled 29/09/2020 - 29/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		
1					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		232
2					Clayey Gravel. Red/brown, brown, iron cemented gravel, subrounded, moist, loose .		231
3			Grout Depth: 0.0 - 4.8		Clayey Silt. Pale red, turning white at 3m, silt dominant fines, weak cementation, minor ferrite band at 4m, dry, soft .		230
4							229
5			Slow release bentonite pellets Depth: 4.8 - 6.9				228
6					Clayey Silt. Dark red, silt dominant fines, very weak cementation, dry, soft .		227
7							226
8					Clayey Silt. Orange, silt dominant fines, very weak cementation, moist, soft .		225
9					Silty Clay. Clay dominant fines, brown, soft, moderate plasticity, moist, soft .		224
10			Gravel pack: 3.2-6.4 mm. Depth: 6.9 - 14.				223
11		▽			Clay. Clay dominant fines, brown, high plasticity, soft, highly weathered granite and quartz fragments (2-3mm), angular, wet, soft .		222
12							221
13					Highly weathered granite. Highly weathered granite/quartz in a brown clayey matrix, fragments (4-10mm), angular, wet, hard .		220
14					Granite. Medium grained granite, unweathered, minor quartz component, wet, hard .	Flow increasing in the weathered basement, low yield	219
					Termination Depth at: 14.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH06

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 425573, 6384809
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 272
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 40.30	**Logged By** EL
Date Drilled 24/09/2020 - 25/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		272
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		270
4					Clayey Silt. silt dominant fines, very weak cementation pale brown getting lighter with depth to white, increasing clay content with depth, slightly moist, soft .		268
6							266
8					Clayey Silt. silt dominant fines, very weak cementation pale red, turning white (11-12.5), increasing clay content with depth, slightly moist, soft .		264
10							262
12							260
14			Grout Depth: 0.0 - 30.8				258
16					Silty Clay. clay dominant fines, very weak cementation, soft, moderate plasticity. Orange/dark red. Increasing clay content with depth, slightly moist, soft .		256
18							254
20							252
22					Silty Clay. Clay dominant fines, red/brown, with white clay clods + quartzite grains, soft, high plasticity, moist, soft .		250
24		▽			Silty Clay. Clay dominant fines, red/brown very grainy with quartzite in soft brown clayey matrix, wet, soft .		248
26							246
28							244
30			Slow release bentonite pellets Depth: 30.8 - 33.1				242
32							240
34							238
36			Gravel pack: 3.2-6.4 mm. Depth: 33.1 - 40.3		Highly weathered granite. Highly weathered quartz rich granite, very grainy in brown clay matrix, wet, soft .		236
38							234
40						Flow increasing in the weathered basement	232
					Termination Depth at: 40.30 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH07

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424805, 6383732
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 251
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 18.00	**Logged By** EL
Date Drilled 23/09/2020 - 23/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		
1							250
2					Clayey Silt. silt dominant fines, very grainy and high in quartzite, soft. Brown getting lighter with depth, moist, soft .		249
3					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, dry, hard .		248
4			Grout Depth: 0.0 - 8.7		Silty Clay. Dark red, soft with a moderate plasticity. weakly cemented. Turning pale brown/yellow from 4.5m with a ferrite band at 6m, dry, soft .		247
5							246
6							245
7					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, dry, hard .		244
8					Clayey Silt. silt dominant fines, weakly cementing, dark red/brown, slightly moist, soft .		243
9			Slow release bentonite pellets Depth: 8.7 - 10.		Silty Clay. clay dominant fines, weakly cementation, soft, moderate plasticity, dark red/brown, clay content increasing with depth, moist, soft .		242
10							241
11							240
12		▽					239
13							238
14			Gravel pack: 3.2-6.4 mm. Depth: 10. - 18.				237
15					Silty Clay. clay dominant fines, weak cementation, soft, moderate plasticity, dark red/brown, clay content increasing with depth. Highly weathered granite/quartzite at 13-14m. Colour change 16-17m(brown), wet, soft .		236
16							235
17					Clayey Silt. silt dominant fines, very weak cementation, brown, moist, soft .		234
18					Granite. Medium grained granite, unweathered, rich in quartz, wet, hard .	Flow decreasing with depth	233
19					Termination Depth at: 18.00 m		232

Notes

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Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH08

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422941, 6381445
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 246
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 19.00	**Logged By** AO
Date Drilled 17/09/2020 - 17/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Lateritic gravel and cobbles, 5-60mm, sub rounded. With silt and sand. Brown, moist, loose .		246
1					Caprock/duricrust. Fine grained cemented ferricrete/caprock. Increasing clay and silt with depth. Occasionally very hard. Light brown to brown, moist, hard .		245
2					Silty clay. Clay and silt, occasionally granular and weakly cemented. White, dry , soft/firm .		244
3							243
4			Grout Depth: 0.0 - 9.0		Clay/ferricrete. Clay and weakly cemented ferricrete/fine grained sand. Clays are iron stained. Ferricrete occasionally very hard. Red/brown, moist, very stiff .		242
5							241
6					Clay . Medium plasticity clay. White to mottled pink 6-8m. Darker with depth. Micaceous. Minor quartz increasing from 13m. Quartz vein at 13.5m. Light orange/brown, moist, soft .		240
7							239
8		▽					238
9			Slow release bentonite pellets Depth: 9.0 - 11.5				237
10							236
11							235
12							234
13						First seepage. Slop only	233
14							232
15			Gravel pack: 3.2-6.4 mm. Depth: 11.5 - 19.0				231
16							230
17							229
18					Granite. Weathered granite, course grained 2mm, quartz rich. Very hard with depth. Pink, wet, ver dense .	Flow increasing in weathered basement.	228
19					Termination Depth at: 19.00 m		227

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH09

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 429106, 6381269
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 275
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 28.20	**Logged By** EL
Date Drilled 22/09/2020 - 23/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		274
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		272
4					Silty Clay. clay dominant fines, weakly cementing, pale red to white, firm, high plasticity, moist, firm .		270
6					Clayey Silt. Silt dominant fines, weakly cementing, pale brown/cream, dry, soft .		268
8					Silty Clay. Clay and silt, occasionally granular and weakly cemented. White, dry, soft .		266
10			Grout Depth: 0.0 - 19.1		Clayey Silt. Silt dominant fines, weakly cementing, brown/dark red, dry, soft .		264
12					Silty Clay. Clay dominant fines, weakly cementing, soft, moderate plasticity, moist, soft .		262
14		▽					260
16							258
18						Flow decreasing with depth - highest in the highly cemented clays	256
20			Slow release bentonite pellets Depth: 19.1 - 21.0		Clay. Brown clay, very soft, high plasticity weak cementation from 19.5m, wet, very soft .		254
22					Weathered granite. Medium grained granite, highly weathered with Strongly cemented hard clays, wet, hard .		252
24			Gravel pack: 3.2-6.4 mm. Depth: 21.0 - 282.		Weathered granite. Coarse grained, highly weathered granite, very gritty in a soft brown clay matrix, wet, hard .		250
26					Weathered granite. Highly weathered granite with weakly cemented hard clays, in very soft and very plastic clay matrix, wet, hard .		248
28					Termination Depth at: 28.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH10

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426113, 6381245
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 292
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 18.20	**Logged By** EL
Date Drilled 18/09/2020 - 21/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		
1					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, moist, hard .		291
2							290
3					Clayey silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. , slightly moist, soft .		289
4			Grout Depth: 0.0 - 9.0				288
5							287
6							286
7					Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		285
8					Clayey silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. , slightly moist, soft .		284
9			Slow release bentonite pellets Depth: 9.0 - 10.5				283
10					Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		282
11					Clayey silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. , slightly moist, soft .		281
12							280
13							279
14			Gravel pack: 3.2-6.4 mm. Depth: 10.5 - 18.2		Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		278
15					Silty sand. Fine grained sand and silt, angular, quartz. Possibly sandy with depth. Cream to red/brown., moist, loose .		277
16	DC				Weathered granite. Medium grained granite, moderately to well weathered, quartz veins. , wet, hard .		276
17		▽			Granite. Medium grained granite, unweathered, minor quartz component, wet, hard .(diamond)		275
18						No flow due to diamond core	274
					Termination Depth at: 18.20 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH11

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 419714, 6379933
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 258
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 33.00	**Logged By** AO
Date Drilled 15/10/2020 - 19/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Gravelly clay. Pea gravel 5-15mm, sub rounded with 40% clay and silt. Brown, wet/very moist, loose .		258
2					Caprock. Iron cemented caprock. 20% silt and clay. Brown, moist, hard .		256
4			Grout Depth: 0.0 - 8.2		Clay. Stiff clay, mottled cream to brown, slightly moist, soft/firm .		254
6					Silty clay/silt. Powdery silt to clay, occasionally partly cemented and iron stained. White, dry, loose .		252
8			Slow release bentonite pellets Depth: 8.2 - 10.5		Clayey silt. As above, becoming orange to brown, slightly moist, loose .		250
10		▽			Clay. Plastic clay with trace of fine grained sand. Brown to red, saturated, loose/medium dense .		248
12					Clay. As above, grading to orange. , very moist, loose/medium dense .		246
14					Clay. As above, grading to red/pink orange, very moist, loose/medium dense .		244
16			Gravel pack: 3.2-6.4 mm. Depth: 10.5 - 22.5		Clay. As above grading to light brown, very moist, loose/medium dense .		242
18							240
20							238
22							236
24							234
26							232
28			Backfill Depth: 22.5 - 33.0				230
30						High torque forcing end of hole. Moist clays to base from 8.5m. Dipped static in rods of 9m.	228
32							226
					Termination Depth at: 33.00 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH12

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 424142, 6379814
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 268
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 6.10	**Logged By** AO
Date Drilled 17/09/2020 - 18/09/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR		Grout Depth: 0.0 - 0.3		Silty gravel. Pea gravel with significant cobbles 5-50mm. Occasionally massive caprock. Dark brown, moist, loose/medium dense .		268
0.5							267.5
1			Slow release bentonite pellets Depth: 0.3 - 1.9		Clay. Stiff clay, plastic. Mottled cream. Quartz vein at 3.5m. , moist, medium dense .		267
1.5							266.5
2							266
2.5							265.5
3							265
3.5							264.5
4	AR	▽	Gravel pack: 3.2-6.4 mm. Depth: 1.9 - 6.1		Quartzite/Granite. Quartz rich granite. Quartz phenocrysts to 50mm. Large quartz vein at 4m. , moist, hard .(diamond)		264
4.5							263.5
5							263
5.5							262.5
6						No flow due to diamond core	262
6.5					Termination Depth at: 6.10 m		261.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH13

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 426917, 6377918
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 289
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 34.00	**Logged By** EL
Date Drilled 21/09/2020 - 22/09/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty Gravel. Pea gravel with significant cobbles 5-50mm. Light brown, moist, loose .		288
2					Caprock/silty gravel. Lateritic caprock, fine grained iron cemented. Occasionally massive, occasionally pisolitic 5-10mm. Brown, dry, hard .		286
4					Clayey Silt. Silt dominant fines, minor cementing. Light brown, lighter with depth. Light brown clay clods present from 5-6m, dry, soft .		284
6							282
8							280
10					Ferricrete/silt. Iron cemented silt/clay, weakly cemented. Red/brown, dry, very stiff .		278
12			Grout Depth: 0.0 - 24.5		Clayey Silt. Silt dominant fines, very weak cementing. Light brown, lighter with depth., moist, soft .		276
14					Silty Clay. Clay dominant fines, very weak cementing. Dark red/brown. White (with red mottles) clay clods present from 14-16m and 19m. Clay content increasing with depth, moist, soft .		274
16							272
18		▽					270
20					Silty Clay. Clay dominant fines, weak cementing. Brown/green. White (with red and black mottles (minor granite component?) clay clods @ 20m, moist, soft .		268
22							266
24			Slow release bentonite pellets Depth: 24.5 - 26.9				264
26							262
28			Gravel pack: 3.2-6.4 mm. Depth: 26.9 - 34.0		Silty Clay. Clay dominant fines, weak cementation, brown, very soft with moderate plasticity. Very granular with highly weathered quartz, wet, soft .		260
30							258
32					Weathered Granite. Medium grained granite, rich in quartz in a soft brown silty clay matrix, wet, hard .	Flow increasing in weathered basement	256
34					Mica Schist. dark grey schist with mica - layers easily broken with finger pressure, wet, hard .		254
					Termination Depth at: 34.00 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH14

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 419640, 6377768
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 224
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 38.60	**Logged By** DB
Date Drilled 14/10/2020 - 15/10/2020	**Diameter (mm)** 135	**Checked By** AO

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0					Gravel, red/brown, well graded, sub rounded, with orange, plastic clay, dry, loose .		224
2					Clay with fine gravel, dry, loose .		222
					Sandy clay, white, moist, moderate plasticity, with sub rounded quartz grains , moist, soft/firm .		
4					Clay with gravel. Clay, white/yellow mottled, with coarse, sub rounded quartz grains, moist, soft/firm .		220
6					Clay, white, moist, moderate plasticity, moist, soft/firm .		218
8					Sandy clay, red, moist, moderate to highly plastic, moist, soft/firm .		216
10					Clay with sand, indurated, weakly to moderately cemented, minor vugs, moist, soft/firm .		214
					Sandy clay, orange, moderate plasticity, moist, moist, soft/firm .		
12			Grout Depth: 0.0 - 22.7				212
					Clay (kaolinite), high plasticity, moist, soft/firm .		
14					Clay with trace sand, red/orange, moderate to high plasticity, saturated, soft/firm .		210
16							208
18							206
20		▽			Clay, orange, highly plastic, saturated, soft/firm .		204
22			Slow release bentonite pellets Depth: 22.7 - 25.3				202
24					Quartzite, saturated, hard .		200
					Clay, orange, highly plastic, saturated, stiff .		
26							198
28							196
						10L/min	
30					Granite, highly weathered, with quartz grains, saturated, hard .		194
32			Gravel pack: 3.2-6.4 mm. Depth: 25.3 - 38.6				192
34							190
36							188
38							186
					Termination Depth at: 38.60 m		

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH15

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 420847, 6376506
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 212
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 9.30	**Logged By** AO
Date Drilled 13/10/2020 - 14/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Silty gravel. Pea gravel, rounded, 10-20mm, with silt and sand. Dark brown, moist, loose .		212
0.5							211.5
1							211
1.5			Backfill Depth: 0.0 - 2.7				210.5
2					Clay. Stiff clay, grey to mottled. , dry, very stiff .		210
2.5							209.5
3			Slow release bentonite pellets Depth: 2.7 - 3.4				209
3.5							208.5
4							208
4.5					Silty clay. Transition from above into loose silty clay/silt. Powdery, white, dry, loose .		207.5
5							207
5.5							206.5
6			Gravel pack: 3.2-6.4 mm. Depth: 3.4 - 9.3				206
6.5	DC				Diorite/diabase/dolerite?. Sudden transition to fresh intrusive rock. Minor weathering for 50mm. Fine grained, dominance of quartz and dark minerals. Quartz bands of phenocrysts at 7m. Dark mineral phenocrysts at9-9.4m. Sub horizontal quartz veins. No open fractures. , dry, hard .(diamond)	Very minor moisture at top of basement rock.	205.5
7							205
7.5							204.5
8							204
8.5							203.5
9							203
9.5					Termination Depth at: 9.30 m		202.5

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH16

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422958, 6375535
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 261
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 34.00	**Logged By** AO
Date Drilled 19/10/2020 - 20/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
0	AR				Sand. Fine to medium grained sand. Quartz dominant. Light brown/grey, moist, loose .		260
2							
4					Clayey sand. As above with significant clay/silty to 40%, partly cemented/stiff. Grey, moist, stiff .		258
6					Silt. Powdery silt. Minor cementing and iron stained, trace to 10% fine grained quartz. White, slightly moist, soft .		256
8							254
10					Silt. As above, more floury, orange brown, slightly moist, soft .		252
12			Grout Depth: 0.0 - 25.5		Silt. As above, significant band of quartz, weakly cemented. White, slightly moist, stiff .		250
14					Silt. As above, floury silt, white, dry/slightly moist, loose .		248
16							246
18					Quartz. Possible pegmatite/quartz, white crystalline, friable, slightly moist, very stiff .		244
20					Silt/clay. Silt like above, becoming moist, minor quartz bands, weakly cemented in part. White to light orange, moist, soft .		242
22		▽					240
24						Becoming saturated in clays	238
26			Slow release bentonite pellets Depth: 25.5 - 27.5		Sandy clay. Grading from above with increase in quartz, gravel to and sand to 5 mm, angular. White to light brown, wet, stiff .		236
28							234
30			Gravel pack: 3.2-6.4 mm. Depth: 27.5 - 34.0				232
32					Gravelly clay. Grading from above with increase in quartz gravel to 10 mm, angular. White to light brown, wet, stiff .		230
34						Seepage only	228
					Termination Depth at: 34.00 m	End of hole, close to basement, difficult ~~drilling with clays/gravel blocking inner~~ tubes.	226

Notes

This log is not intended for geotechnical purposes.

Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

BOREHOLE LOG

ENVIRONMENTAL-GROUNDWATER

MONITORING WELL BH17

Client Alcoa of Australia	**Drill Co.** Proline	**Easting, Northing** 422522, 6372129
Project Alcoa Huntly Expansion	**Driller** Stuart Birnie	**Grid Ref** GDA94_MGA_zone_50
Project No. 12520591	**Rig Type** Comacchio Geo 305	**Elevation** 221
Site Holyoake	**Drill Method** Air	**Collar RL** TBC
Location Holyoake	**Total Depth (m)** 25.20	**Logged By** AO
Date Drilled 20/10/2020 - 20/10/2020	**Diameter (mm)** 135	**Checked By** AO/DB

Casing 50 mm CL18 PVC **Screen** 0.5 mm slots, CL18 PVC **Surface Completion** Monument cover

Depth (m)	Drilling Method	Water	Well Details	Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	COMMENTS/ ENVIRONMENTAL CONDITIONS Odours, staining, waste materials,separate phase liquids, imported fill, ash.	Elevation (m)
1	AR				Gravelly clay. Clay/silt/sandy clay with 20-40% pea gravel 5-30mm, weakly cemented. Dark brown, moist, loose .		220
2					Clay. Plastic clay, occasionally weakly cemented. Minor quartz gravel 2-10mm. Light brown, slightly moist, medium dense .		219
3							218
4					Ferricrete. Fine grained iron cemented sands, very hard in parts, slightly moist, loose/medium dense .		217
5					Silty clay. Silt and clay, with very minor cementing/iron staining. Pink to white, dry, loose .		216
6							215
7					Silty clay. As above, grading to orange, dry, loose .		214
8			Grout Depth: 0.0 - 15.7				213
9							212
10							211
11							210
12							209
13							208
14		▽					207
15							206
16			Slow release bentonite pellets Depth: 15.7 - 17.5		Clay. Grading from above, becoming moist, moist, loose .		205
17					Gravelly clay. Clay with up to 30% quartz gravel to 10mm. Angular, mostly friable, wet, loose/medium dense .		204
18							203
19							202
20						Minor seepage	201
21			Gravel pack: 3.2-6.4 mm. Depth: 17.5 - 25.2				200
22							199
23					Clay. As above, drop in quartz gravel, wet, loose/medium dense .		198
24							197
25						End of hole minor flow only. End due to difficult drilling in clays.	196
					Termination Depth at: 25.20 m		

Notes

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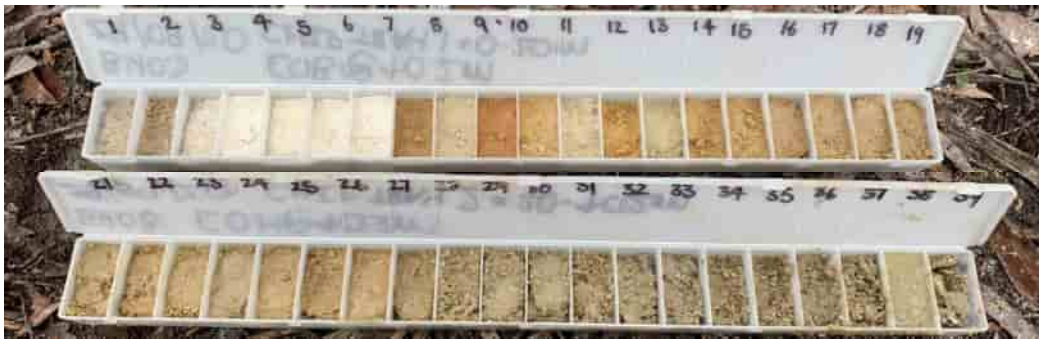
Drilling Abbreviations	Moisture Abbreviations	Consistency Abbreviations	
AH-Air Hammer, AR-Air Rotary, BE-Bucket Excavation, CC-Concrete Coring, DC-Diamond Core, FH-Foam Hammer, HA-Hand Auger, HE-Hand Excavation (shovel), HFA-Hollow Flight Auger, MR-Mud Rotary, NDD-Non Destructive Drilling, PT-Pushtube, SD-Sonic Drilling, SFA-Solid Flight Auger, SS-Split Spoon, WB-Wash Bore, WS-Window Sampler	D-Dry, SM-Slightly Moist, M-Moist, VM-Very Moist, W-Wet, S-Saturated	**Granular Soils** VL-Very Loose, L-Loose, MD-Medium Dense, D-Dense,VD - Very Dense	**Cohesive Soils** VS-Very Soft, S-Soft, F-Firm, ST-Stiff, VST-Very Stiff, H-Hard

Appendix H – Chip tray photographs (Holyoake)

BH01: 0-29.5m

BH02: 0-17.5m

BH03: 0-40.2m



BH04: 0-29.7m

BH05: 0-14.2m

BH06: 0-40.3m

BH07: 0-18m

BH08: 0-19m

BH09: 0-28.2m

BH10: 0-17.5m

BH11: 0-33m

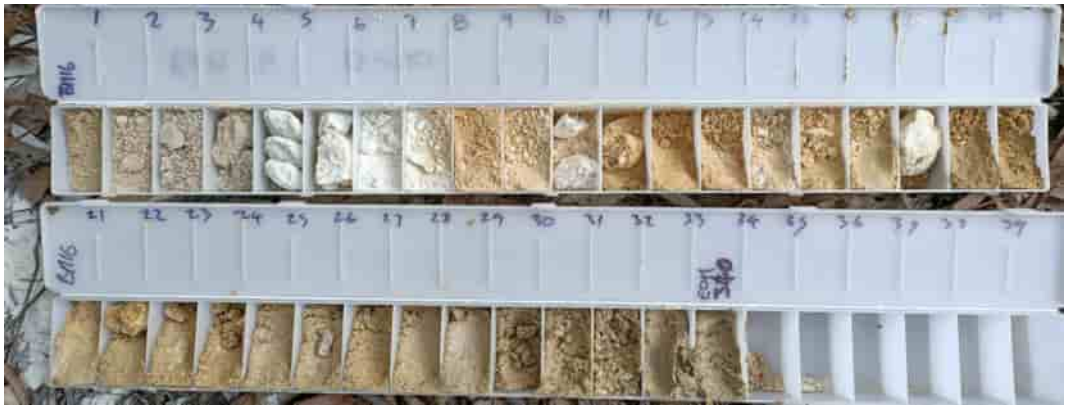
BH12: 0-6.1m

BH13: 0-34m

BH14: 0-38.6m

BH15: 0-9.3m

BH16: 0-34m



BH17: 0-25.2m

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