

REPORT

Western Ridge – Eastern Syncline Baseline Assessment

PFAS and TRH Groundwater Baseline Assessment

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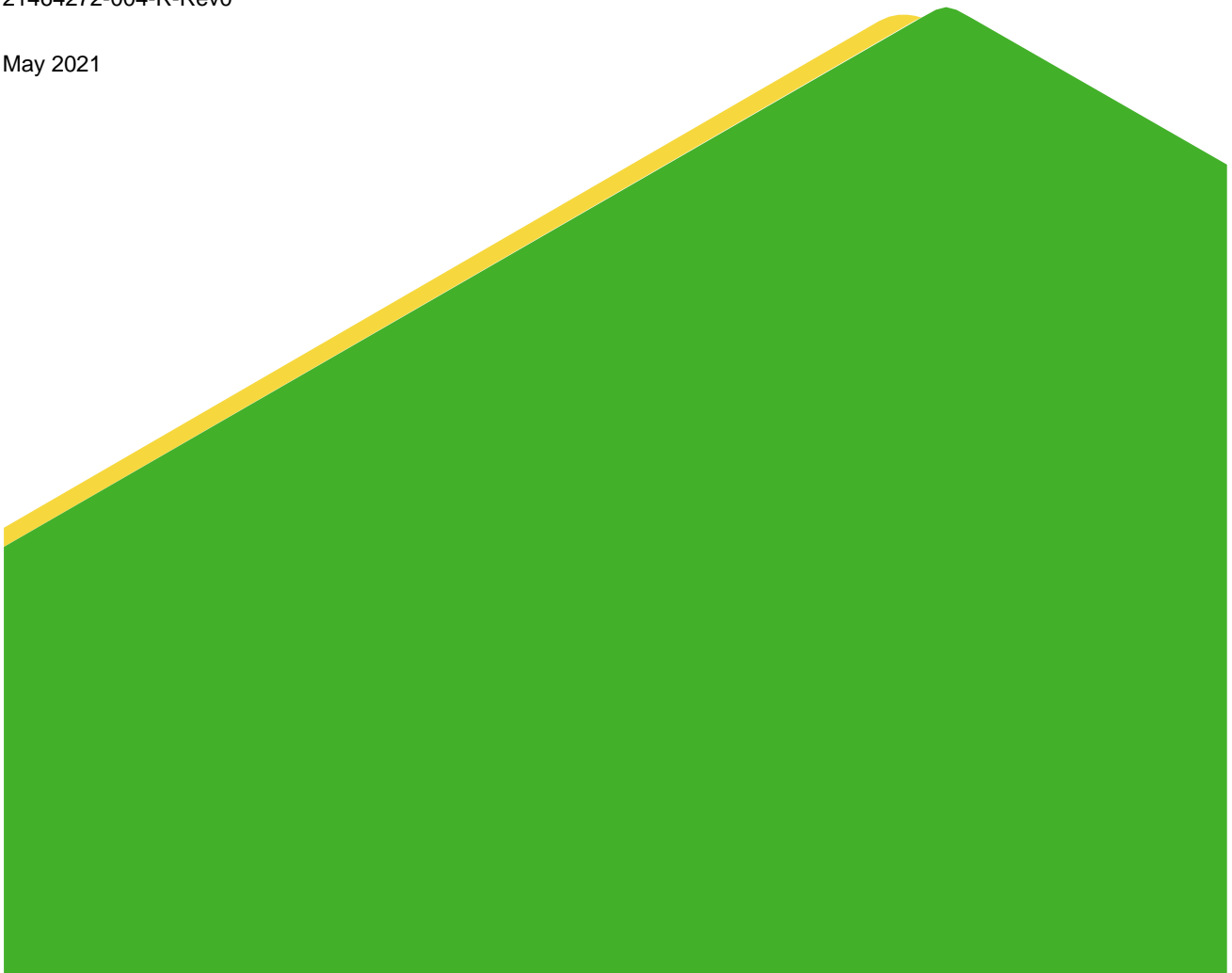
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Table of Contents

1.0 INTRODUCTION	1
2.0 BACKGROUND	1
3.0 OBJECTIVES	1
4.0 SCOPE OF WORKS	1
5.0 SITE OVERVIEW	1
5.1 Site Identification	2
5.2 Site Description	2
5.3 Climate	2
5.4 Hydrogeological Setting	3
5.4.1 Geology	3
5.4.2 Topography and Surface Water Drainage	3
5.4.3 Aquifer	3
5.5 Groundwater Abstraction	3
6.0 PREVIOUS LAND USE	3
7.0 ANALYTICAL SCHEDULE	4
8.0 ASSESSMENT CRITERIA	4
9.0 GROUNDWATER SAMPLING METHODOLOGY	4
9.1 Sampling Quality Assurance and Quality Control (QA/QC)	5
9.2 PFAS Sampling Considerations	5
10.0 RESULTS	6
10.1 Groundwater Levels and Field Parameters	6
10.2 Analytical Results	7
10.2.1 Summary	7
11.0 QUALITY ASSURANCE/QUALITY CONTROL	7
11.1 Fieldwork Program	7
11.2 Laboratory Quality Data Assessment	8
11.2.1 Holding Time	8
11.2.2 Laboratory Control Spike	8
11.2.3 Surrogates	8

11.2.4 Matrix Spikes8

11.2.5 Duplicates8

11.2.6 Method Blanks8

11.2.7 Laboratory QC Sample Frequency9

11.3 Summary9

12.0 CONCLUSIONS AND RECOMMENDATIONS9

12.1 Conclusions9

12.2 Recommendations9

13.0 IMPORTANT INFORMATION9

14.0 CLOSING9

15.0 REFERENCES9

TABLES

Table 1: Site Identification2

Table 2: Groundwater Assessment Criteria4

Table 3: Summary of Groundwater Levels (April 2021) and Borehole Details6

Table 4: Summary of Groundwater Field Parameters – April 20216

Table 5: Summary of Field QA/QC Compliance7

TABLES (AFTER REPORT)

- Table A: Western Ridge – Eastern Syncline Groundwater PFAS Analytical Results
- Table B: Western Ridge – Eastern Syncline Groundwater Organic Analytical Results
- Table C: Groundwater Relative Percentage Differences
- Table D: Trip Blanks

FIGURES (AFTER REPORT)

- Figure 1: Site Location
- Figure 2: Site Plan
- Figures 3A – 3D: Historical Imagery

APPENDICES

APPENDIX A

Well Construction Logs

APPENDIX B

Field Sheets

APPENDIX C

Calibration Certificates

APPENDIX D

Laboratory Certificates

APPENDIX E

Important Information

1.0 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHP) engaged Golder Associates Pty Ltd (Golder) to conduct a groundwater baseline assessment of per- and poly-fluoroalkyl substances (PFAS) and total recoverable hydrocarbons (TRH) at the Western Ridge exploration area (the site). For this baseline assessment purposes, Western Ridge site is divided into three zones: the Western Ridge Crusher Study (WRCS), the Eastern Syncline, and Afghan Springs. This report presents the baseline findings for the Eastern Syncline area (the study area) conducted in April 2021. The baseline assessment for the WRCS and the Afghan Springs areas are provided under separate covers.

The location plan is presented in Figure 1 and a site plan is presented in Figure 2.

2.0 BACKGROUND

BHP intends to develop the Western Ridge for active mining. The site is located west of the Mount Whaleback mine site where PFAS and TRH contamination have been identified within the groundwater. Therefore, BHP requires a baseline assessment of PFAS and TRH concentrations in the groundwater at the Western Ridge prior to development for mining.

3.0 OBJECTIVES

The objective of the baseline assessment was as follows:

- To evaluate the concentrations of PFAS and TRH in the groundwater at the site to establish a baseline, using the existing bores at the site.

This baseline assessment is not to meet environmental assessment requirements as set out in the Department of Water and Environmental Regulation (DWER) Contaminated Sites Guidelines and the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 (ASC NEPM). However, the methodologies applied for this assessment are generally consistent with the above guidelines.

This report presents the findings of the baseline assessment for the Eastern Syncline area only.

4.0 SCOPE OF WORKS

The scope of works conducted at the study area included the following:

- Obtain groundwater samples using Hydrasleeve® from three existing groundwater monitoring wells:
 - WSR0765RM
 - WSR0280RM
 - WSR0266REM
- Submit groundwater samples to NATA-accredited environmental testing laboratories for PFAS (to meet the 99% species protection criteria) and TRH analyses.
- Preparation of a factual report (this report) to present baseline PFAS and TRH contamination at the Eastern Syncline area.

5.0 SITE OVERVIEW

The site overview information below has been obtained through a desktop review, including from the BHP 'Western Ridge and OB29/30/35 Detailed Hydrogeological Assessment' (BHP, 2020). Additional information obtained during the site visit has also been included. This section covers the bigger Western Ridge exploration area and not specifically focus on the Eastern Syncline area.

5.1 Site Identification

The Western Ridge exploration area is located approximately 2 km southwest of the Mount Whaleback mine site, both of which are owned and operated by BHP. These mine sites are located approximately 5 to 7 km west of the Newman Township and approximately 1,200 km north-east of Perth, in the Pilbara region of Western Australia. The Eastern Syncline area is located in the eastern portion of the Western Ridge exploration area, as presented in Figure 1 and displayed in more detail on Figure 2.

The site identification details are summarised in Table 1 below.

Table 1: Site Identification

Item	Description	
Site Location	Approximately 5 to 7 km west of Newman	
Allotment/DP	Crown Land, Lot 101 on Deposited Plan 220388 and Lot 100 on Plan 220355	
Local Government Authority	Shire of East Pilbara	
Zoning	Rural	
Previous Land Use	Rural	
Proposed Land Use	Mining tenement	
Eastern Syncline Boundary Coordinates	<i>Easting (m)</i>	<i>Northing (m)</i>
	766051.3214	7407964.887
	765957.9788	7409508.813
	766191.8121	7410776.535
	772550.2274	7410681.508
	772489.4985	7407825.181

5.2 Site Description

The topography of the Western Ridge is undulating with raised elevation to the north (Bill's Hill and Mount Helen) running east to west and raised elevation to the south (Silver Knight) as displayed in Figure 1.

The Eastern Syncline area is predominantly covered by native vegetation with unsealed roads and drill pads from past and current exploration activities throughout the area. Some observed access tracks and areas of drill related clearing have been rehabilitated.

It is important to note that the Western Ridge site is located within a Priority 1 drinking water catchment area (DoW, 2014), which has the fundamental water quality objective of risk avoidance to protect the drinking water source.

5.3 Climate

The Newman Airport weather station (007176) is the nearest weather station to the site and is located approximately 12 km away from the site. The data indicated the mean maximum temperature range is from 22.9°C (July) to 39.1°C (December) and the mean minimum temperature range is from 6.4°C (July) to 25.0°C (January). The mean annual rainfall is 332.6 mm, with the highest mean rainfall during February (71.0 mm) and the lowest during September (3.9 mm). January and February were recorded as the wettest months, with higher mean rainfall data than the remaining months.

The Pilbara climate and subsequent rainfall is typically dominated by the influence of subtropical highs located to the south of the Pilbara. During summer (November to April) the high-pressure cell moves further south, resulting in the Pilbara receiving approximately 70% of its annual precipitation during these summer months. Annual precipitation figures for these zones are much less than the annual potential evaporation (BHP, 2020).

The Pilbara is characterised by high local evaporation rates and a generally low soil infiltration capacity. This results in recharge occurring exclusively during major rainfall events (15-25 mm/d). The closest station that records evaporation is the Wittenoom BoM station, located approximately 190 km north-west of Newman. Annual average evaporation for Wittenoom is 3,142 mm/year, which exceeds annual rainfall by as much as 2,800 mm/year.

5.4 Hydrogeological Setting

5.4.1 Geology

The geological conditions in the region can be summarised as:

- The Silver Knight and Eastern Syncline are mainly hosted by the upper Marra Mamba members, but mineralisation of the overlying Wittenoom and underlying Jeerinah formations can also be seen in the orebodies.
- Bill's Hill and Mount Helen orebodies are hosted in the mineralised Brockman iron formation. The orebody aquifer is usually well delineated by the extent of the high-grade ore (assumed high permeability), with a halo of lower grade ore (assumed moderate permeability) around it.

5.4.2 Topography and Surface Water Drainage

The site is located within the Whaleback Creek catchment. The main drainage features are the Whaleback Creek, and its southern tributary which drains the Western Ridge area (referred to as Southern Creek). The Whaleback Creek drains into the Fortescue River, upstream of Ethel Gorge. The Gorge is located downstream (north) of Ophthalmia Dam at the confluence of Homestead, Shovelanna, and Warrawandu Creeks, which merge within the Fortescue River and flow through the Ophthalmia Range in a northerly direction (BHP, 2020).

5.4.3 Aquifer

There are two main aquifer types (BHP, 2020):

- 1) The regional aquifers; which generally comprise weathered dolomite of the Paraburdoo Member of the Wittenoom Formation, which occurs in sub-crop along the Whaleback and Southern Creek valleys.
- 2) The orebody aquifers; which comprise the mineralised Brockman Iron Formation that make up the Bill's Hill and Mount Helen orebodies and the mineralised Marra Mamba that make up Silver Knight and Eastern Syncline orebodies.

5.5 Groundwater Abstraction

Groundwater abstraction at the Western Ridge is currently regulated through the RiWI Act 5C License to Take Water GWL170659(3), which allows the annual abstraction of 45,000 kL/a to be used for exploration drilling operations as well as dust suppression for earthworks and construction purposes only (BHP, 2020).

In order to achieve progressive dewatering to allow mining below the water table, BHP is seeking to amend the 5C licence in the near future.

6.0 PREVIOUS LAND USE

Golder is of the understanding that the area has no known previous land use except for exploration activities and hydrogeological drilling purposes. This is supported by the available historical aerial photographs of the site (see Figures 3A – 3D), which did not indicate any major historical activities or infrastructures at the site.

Based on *pers comm.* Andrew Cottrell (BHP hydrogeologist), April 2021, the Afghan Springs pools were historically used for stock water purposes. There were previously some infrastructures in the area for keeping cattle, i.e., water tanks. Andrew also indicated that there has been a creek diversion, approximately 12 to 24 months ago, which can also be seen on the historical aerial photographs. He indicated that there is no known potentially contaminating activities or events reported at the Western Ridge site.

Golder considers that exploration and hydrogeological assessment activities have the potential to introduce contamination. However, the impacts are likely to be minimal and with groundwater levels considerably deep, contamination impacts to groundwater from site activities on and above ground are considered to be unlikely. It is important to note that the use of additives during drilling (i.e., drilling muds and/or glue for the PVC casing installation of the bores) may result in cross-contamination to the groundwater samples collected and give false positives with regards to PFAS and TRH in groundwater.

7.0 ANALYTICAL SCHEDULE

Groundwater samples collected were analysed for PFAS, which comprised the 28 PFAS suite with appropriate limit of reporting (LOR) for comparison against the 99% species protection level. In addition, groundwater samples were also analysed for TRH and benzene, toluene, ethylbenzene, xylenes, and naphthalene (BTEXN) analyses.

8.0 ASSESSMENT CRITERIA

A summary of the relevant groundwater assessment criteria is provided in Table 2.

Table 2: Groundwater Assessment Criteria

Potential Receptor	TRH, BTEXN	PFAS/PFOA
Human Health	ASC NEPM HSL-D* DER (2014) Drinking Water Health Value**	PFAS National Environmental Management Plan (NEMP) 2.0 (2020) Human Health guideline values: - Drinking water quality guideline value**, and - Recreational water quality guideline value*
Ecological	ANZG (2018) Fresh Water 95%*	PFAS NEMP 2.0 (2020) Ecological water quality guideline values: - Freshwater 99% species protection – high conservation value system*, and - Freshwater 95% species protection – slightly to moderately disturbed system*

Note: * Assessment criteria was selected based on the current and the intent future land use for the site. 99% species protection level for PFAS has also been adopted to account for potential bioaccumulation.

** Assessment criteria was selected as the site is located within a Priority 1 drinking water catchment area.

9.0 GROUNDWATER SAMPLING METHODOLOGY

The groundwater sampling was undertaken between 13 and 17 April 2021 by two Golder field personnel.

Groundwater samples were collected from three of the existing groundwater wells within the Eastern Syncline area. Groundwater wells WSR1500RM, WSR1507RM, and WSR0378RM were dry, WSR0420RM could not be located (possibly destroyed) and HWSR0002P was an inactive production bore with infrastructure and therefore these wells could not be sampled. The three wells which were sampled, WSR0765RM, WSR0280REM and WSR0266REM, were selected to assess the area laterally. While this baseline assessment is limited by the availability of existing bores, Golder considers that the locations of the bores selected are sufficient to provide a 'snapshot' of PFAS and TRH concentrations in groundwater at the site, which is the intention of this baseline assessment. Groundwater well construction logs are provided in Appendix A.

The groundwater monitoring wells were sampled using HDPE Hydrasleeves® (Super/SkinnySleeve). Prior to sampling, an electronic water level meter (BHP supplied 1550T2 BHP 200 m) was used to assess the standing water level (SWL). The SWL measurements are displayed in Appendix B.

In general, the HDPE Hydrasleeves® were set to target the well screen, at approximately 3 to 5 m below the groundwater level. For monitoring wells with well screen deeper than the groundwater level, the HDPE Hydrasleeves® were set at approximately 1 m below the top of the screen level. The HDPE Hydrasleeves® were then left for at least a 24-hour period where possible to allow the groundwater, within the well column, to stabilise. The HDPE Hydrasleeves® were then retrieved and the groundwater transferred directly into laboratory supplied bottles using Hydrasleeves® straws.

Groundwater field parameters (pH, reduction-oxygen potential (redox), conductivity, temperature, and dissolved oxygen (DO)) were measured using a calibrated YSI water quality meter (19L1002399) by placing the probes into a small aliquot of retrieved groundwater which was poured from the Hydrasleeves® into a container for measurement. Field groundwater monitoring sheets are provided in Appendix B. The YSI calibration certificate and daily bump checks are provided in Appendix C.

New nitrile gloves were worn while preparing the HDPE Hydrasleeves® for deployment and during retrieval. Samples were placed in laboratory supplied eskies and cooled with bags of ice (ice bricks were not used). Between each location, the water level meter was decontaminated with a Liquinox/water solution and deionised water, to reduce the potential of cross contamination.

Groundwater samples were dispatched under chain-of custody (CoC) procedures to ALS (primary laboratory) and Eurofins (secondary laboratory) which are both NATA-accredited laboratories. The CoCs and laboratory certificates are included in Appendix D.

9.1 Sampling Quality Assurance and Quality Control (QA/QC)

The following quality assurance control measures were undertaken during the sampling program:

- Field duplicate or triplicate samples were collected at a minimum rate of 20% (10% duplicates and 10% triplicates).
- Primary and duplicate samples were submitted to NATA-accredited laboratory ALS Environmental. Triplicate samples collected were submitted to an alternate NATA-accredited laboratory Eurofins.
- Water samples were collected whilst wearing a new pair of disposable nitrile gloves for each sample.
- Samples collected were placed in laboratory-supplied bottles appropriate for the relevant analyte.
- No rinsate samples were collected as no non-dedicated sampling equipment was used.
- Trip blanks were submitted for analysis at a rate of one per esky.
- Samples collected in the field were placed in an esky with ice in bags (no ice bricks were used) and delivered to the NATA-accredited laboratories for analysis.

9.2 PFAS Sampling Considerations

Due to the widespread use of PFAS compounds in everyday items, the following considerations were implemented by field staff prior and during the collection of samples as per guidance provided by Department of Water and Environmental Regulation (DWER) *Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances* (2017):

- 1) No new clothing, or clothing with rain or waterproof coatings/treated fabric.
- 2) No food or snack containers wrapped with non-compliant materials.

- 3) No Teflon® containing or coated field equipment.
- 4) No Teflon® lined lids on the laboratory supplied sample bottle.
- 5) No Decon or detergent decontamination solutions. Liquinox® was used for decontaminating equipment.
- 6) No ice bricks for sample storage.
- 7) No PFAS containing sun cream.

10.0 RESULTS

10.1 Groundwater Levels and Field Parameters

Groundwater monitoring wells were gauged using an electronic water level meter prior to sampling and groundwater parameters obtained from a sample aliquot using a YSI water quality meter. The depth to groundwater and bore installation details are summarised in Table 3 and the groundwater field parameters recorded of the sampled wells are presented in Table 4.

Table 3: Summary of Groundwater Levels (April 2021) and Borehole Details

Well ID	Depth to Groundwater (m btoc)	Top of PVC Pipe Survey Level (m AHD)	Groundwater Level (m AHD)	Top of Screened Interval (m AHD)	Base of Screened Interval (m AHD)
WSR0280REM	184.42	697.68	513.26	511.3	493.3
WSR0378RM	Dry	586.84	-	520.50	496.50
WSR0420RM	n/a	577.83	-	517.48	499.48
WSR0765RM	95.73	603.57	507.84	519.19	501.19
WSR1500RM	Dry	-	-	519.19	513.19
WSR0266REM	>200	743.457	<543.46	533.1	473.1
WSR1507RM	Dry	-	-	519.70	507.70

Notes: n/a = not accessible/could not locate
 m btoc = metre below top of casing
 m bgl = metre below ground level

It is noted that the water level is above the screen interval for multiple wells. While having the well screen lower than the groundwater level is not ideal, given there is no known previous land use with the exception for exploration and hydrogeological assessment activities, light non-aqueous phase liquid (LNAPL) impacts in groundwater are not expected. Additionally, groundwater level is considerably deep (>90 m bgl) and subsequently contamination impacts in groundwater from the minimalistic nature of the site activities are unlikely. Therefore, these selected wells are considered to be suitable for the baseline assessment purposes; however, for future environmental and contaminated sites assessment works, Golder recommends the installation of groundwater monitoring wells that meet the requirements as set out in the DWER and NEPM guidelines.

Table 4: Summary of Groundwater Field Parameters – April 2021

Well ID	pH	Temperature (°C)	Redox (mV)	DO (%)	Specific Conductivity (µS/cm at 25°C)	Notes
WSR0280REM	7.29	29.9	59.1	4.90	864	Sample was clear, no odour/sheen, low turbidity.
WSR0765RM	6.94	30.0	169.3	4.61	947	Sample was cloudy yellow, no odour/sheen, medium turbidity.
WSR0266REM	7.18	28.8	53.1	2.40	758	Sample was cloudy pale orange, no odour/sheen, medium turbidity.

10.2 Analytical Results

The following section summaries the laboratory analytical results. The results are presented in Tables A and B at the end of this report and the laboratory reports are displayed in Appendix D.

PFAS

There were no detections of PFAS above the LOR within the samples obtained.

TRH

There were no detections of TRH or BTEX above the LOR within the samples obtained.

10.2.1 Summary

There is no known previous land use (except for exploration activities and hydrogeological drilling purposes) and the results from this groundwater baseline assessment indicate that there is no PFAS or TRH above the LOR and no exceedance of adopted assessment criteria.

11.0 QUALITY ASSURANCE/QUALITY CONTROL

The quality assurance/quality control (QA/QC) procedures adopted during this project are based on the ASC NEPM, DER 2014 guidelines (DER 2014), AS 4482.1 – 2005 (Standards Australia 2005), AS 4482.2 – 1999 (Standards Australia 1999), and PFAS NEMP (HEPA, 2020).

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

The precision of the results for each analyte between the primary sample and the field duplicate/triplicate is determined by calculating the RPD. A quantitative measure of the accuracy of the analytical results reported is made by calculating the RPDs in accordance with the procedure described in AS 4482.1 – 2005 using the below calculation.

$$\%RPD = \frac{|A - B|}{\frac{A + B}{2}} \times 200$$

For the purposes of this assessment and in accordance with guidance in the NEPM 2013, an RPD less than or equal to 30% represents good correlation between laboratory results. Where the RPD is greater than 30% and the analytical results are less than five times the LOR, the precision and accuracy are also considered acceptable because the accuracy of laboratory analyses decreases as concentrations approach the LOR.

11.1 Fieldwork Program

RPD results are presented in Table C and trip blank results are presented in Table D at the end of this report. Field QA/QC procedures and compliance during the assessment are summarised in Table 5.

Table 5: Summary of Field QA/QC Compliance

QA/QC Element	Requirement	Requirement Adhered to?	Information/Data Acceptable?
Equipment calibration	Where relevant, all field equipment is to be calibrated by the equipment supplier and certification provided	Yes (Appendix C)	Yes
Sampling methods	All sampling methods outlined in the methodology must be adhered to.	Yes	Yes
Record keeping	Detailed records of field activities were maintained with the use of daily record sheets, and quality control sample registers.	Yes	Yes

QA/QC Element	Requirement	Requirement Adhered to?	Information/Data Acceptable?
Chain of custody documentation	The CoC documentation was completed for each batch of samples, identifying the names of the samplers, the type of sample, the collection date and the analyses performed.	Yes	Yes
Sample labelling	Samples were properly labelled, showing reference number, sample ID, date of collection and sampler.	Yes	Yes
Sample containers	Samples were collected in appropriate laboratory-supplied containers with suitable preservation methods (where required).	Yes	Yes
Sample storage and transport	Samples were stored in a chilled, insulated container immediately after sampling and delivered to the laboratory with CoC documentation.	Yes	Yes (See Note 1)
Analysis of trip blanks	No contamination of trip blanks reported.	Yes	Yes
Decontamination	Reusable field equipment (i.e., water level meter) were appropriately decontaminated using potable water and Liquinox® solution between each sampling location.	Yes	Yes
Soil duplicate samples	Duplicate and triplicate samples were collected for analysis by the primary and secondary laboratories, respectively (at a frequency of at least one pair per 10 samples).	Yes	Yes
	Relative percent difference (RPD) assessment to adhere to the following protocols: <ul style="list-style-type: none"> ■ 1-5 x laboratory LOR: no limit; ■ >5 x laboratory LOR: 0-30%. 	Yes	Yes

Note 1: Samples were all sent in an insulated container (esky) on ice. However, the ideal temperature could not be maintained throughout transport and elevated temperature inside the esky was noted upon receipt by the laboratory. The temperature of samples on arrival at the laboratory was reported at 21.9°C. This elevated temperature was associated with the remote nature of the site and the heat experienced by the site conditions in the Pilbara, which may affect the results.

11.2 Laboratory Quality Data Assessment

All samples were submitted to NATA-accredited laboratories in Perth for laboratory analysis. Laboratory QA/QC analysis were reviewed to assess data integrity and confirm reliability of the analytical data. Laboratory QA/QC analysis results were compared to laboratory acceptance criteria.

11.2.1 Holding Time

No analysis holding time outliers were reported.

11.2.2 Laboratory Control Spike

No laboratory control outliers were reported.

11.2.3 Surrogates

No surrogate recovery outliers were reported.

11.2.4 Matrix Spikes

No matrix spike outliers were reported.

11.2.5 Duplicates

No duplicate outliers were reported.

11.2.6 Method Blanks

No method blank value outliers were reported.

11.2.7 Laboratory QC Sample Frequency

Laboratory QC samples frequency outliers were reported for laboratory duplicates for PFAS analysis. Only one laboratory duplicate sample was analysed out of 6 primary samples (9.09%), which did not meet the 10% target. Note that samples not collected by Golder were included in the frequency rate calculation. The one laboratory duplicate analysed was collected by Golder and the 10% target criteria would have been met if no other non-Golder samples included in the frequency rate calculation.

As stated in Section 11.2.5, no duplicate outliers were reported in this duplicate sample; therefore, these laboratory QC sample frequency outliers are not considered to have significant impact on the overall data quality or outcome of the investigation.

11.3 Summary

A review of the field and laboratory QA/QC data and procedures confirms an acceptable level of compliance with the general requirements and DQOs. As such, there is an acceptable level of confidence in the data upon which the conclusions in this report have been made.

12.0 CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

The following conclusions are drawn from the data obtained during the baseline assessment:

- There were no detections of PFAS above the laboratory LOR within the samples obtained.
- There were no detections of TRH or BTEX above the laboratory LOR within the samples obtained.
- No exceedance of adopted assessment criteria was reported for any contaminants analysed as part of this groundwater baseline assessment.

12.2 Recommendations

It is considered that the site is suitable to be developed for active mining from contaminated sites perspective.

13.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled – “Important Information Relating to this Report”, which is included in Appendix E of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder has under the contract between it and its client.

14.0 CLOSING

Should you have any queries concerning this report, please do not hesitate to contact the under-signed.

15.0 REFERENCES

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Signature Page

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**Table A: Western Ridge - Eastern Syncline
Groundwater PFAS Analytical Results**

Per- and polyfluoroalkyl substances (PFAS)																																		
	Perfluorodecane sulfonic acid (PFDS)	N-Methyl PFO sulfonamidoethanol (MeFOSE)	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	Perfluorooctanoic Acid (PFOA)	Perfluorooctane sulfonic acid (PFOS)	Perfluorohexane sulfonic acid (PFHxS)	Sum of PFHxS and PFOS (lab reported)	Sum of WA DER PFAS (n=10)	Sum of PFASs (n=28 - Lab Reported)	Perfluorobutanoic acid (PFBA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorodecanoic acid (PFDA)	Perfluoropentanoic acid (PFPeA)	Perfluorononanoic acid (PFNA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorotridecanoic acid (PFTriDA)	Perfluorododecanoic acid (PFDoDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorobutane sulfonic acid (PFBS)	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	N-Ethyl PFO sulfonamide (EFOSA)	N-Ethyl PFO sulfonamidoethanol (EiFOSE)	N-Methyl PFO sulfonamide (MeFOSA)	Perfluorooctane sulfonamide (FOSA)	N-ethyl-PFO sulfonamidoacetic acid (EiFOSAA)			
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
LOR	0.0005	0.001	0.0005	0.0005	0.0002	0.0005	0.0002	0.0002	0.0002	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0005	0.0005			
PFAS NEMP 2.0 2020 95% Eco Fresh Water				220	0.13																													
PFAS NEMP 2.0 2020 99% Eco Fresh Water				19	0.00023																													
PFAS NEMP 2.0 2020 Drinking Water				0.56	0.07	0.07	0.07																											
PFAS NEMP 2.0 2020 Recreational Water				10	2	2	2																											

Site ID	Location	Sampled Date	Lab Report	Perfluorodecane sulfonic acid (PFDS)	N-Methyl PFO sulfonamidoethanol (MeFOSE)	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	Perfluorooctanoic Acid (PFOA)	Perfluorooctane sulfonic acid (PFOS)	Perfluorohexane sulfonic acid (PFHxS)	Sum of PFHxS and PFOS (lab reported)	Sum of WA DER PFAS (n=10)	Sum of PFASs (n=28 - Lab Reported)	Perfluorobutanoic acid (PFBA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorodecanoic acid (PFDA)	Perfluoropentanoic acid (PFPeA)	Perfluorononanoic acid (PFNA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorotridecanoic acid (PFTriDA)	Perfluorododecanoic acid (PFDoDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorobutane sulfonic acid (PFBS)	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	N-Ethyl PFO sulfonamide (EFOSA)	N-Ethyl PFO sulfonamidoethanol (EiFOSE)	N-Methyl PFO sulfonamide (MeFOSA)	Perfluorooctane sulfonamide (FOSA)	N-ethyl-PFO sulfonamidoacetic acid (EiFOSAA)			
Eastern Syncline	WSR0266REM	16/04/2021	EP2104239	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.002	<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	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0005	<0.0005
Eastern Syncline	WSR0280REM	16/04/2021	EP2104239	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.002	<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	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0005	<0.0005
Eastern Syncline	WSR0765RM	17/04/2021	EP2104239	<0.0005	<0.001	<0.0005	<0.0005	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.002	<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	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0005	<0.0005

**Table B: Western Ridge – Eastern Syncline
Groundwater Organic Analytical Results**

	MAH							PAH	Total Recoverable Hydrocarbons												
	Benzene	Toluene	Ethylbenzene	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total BTEX	Naphthalene	TRH C ₅ -C ₉ Fraction	TRH C ₁₀ -C ₁₄ Fraction	TRH C ₁₅ -C ₂₈ Fraction	TRH C ₂₉ -C ₃₆ Fraction	TRH+C ₁₀ -C ₃₆ (Sum of total) (Lab Reported)	TRH+C ₁₀ -C ₄₀ (Sum of total) (Lab Reported)	TRH C ₆ -C ₁₀ Fraction F1	TRH C ₆ -C ₁₀ Fraction Less BTEX F1	TRH >C ₁₀ -C ₁₆ Fraction F2	TRH >C ₁₀ -C ₁₆ Fraction Less Naphthalene F2	TRH >C ₁₆ -C ₃₄ Fraction F3	TRH >C ₃₄ -C ₄₀ Fraction F4	
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
LOR	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.005	0.02	0.05	0.1	0.05	0.05	0.1	0.02	0.02	0.1	0.1	0.1	0.1	
DER (2014) Drinking Water Health Value	0.001	0.8	0.3			0.6															
ANZG (2018) Freshwater 95%	0.95				0.35			0.016													
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand																					
2-4m	5	NL	NL			NL		NL							6		NL				
4-8m	5	NL	NL			NL		NL							6		NL				
>8m	5	NL	NL			NL		NL							7		NL				
Site ID	Location	Sampled Date	Lab Report																		
Eastern Syncline - 21464272	WSR0266REM	16-Apr-21	EP2104239	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1
Eastern Syncline - 21464272	WSR0280REM	16-Apr-21	EP2104239	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1
Eastern Syncline - 21464272	WSR0765RM	17-Apr-21	EP2104239	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.005	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.1	<0.1

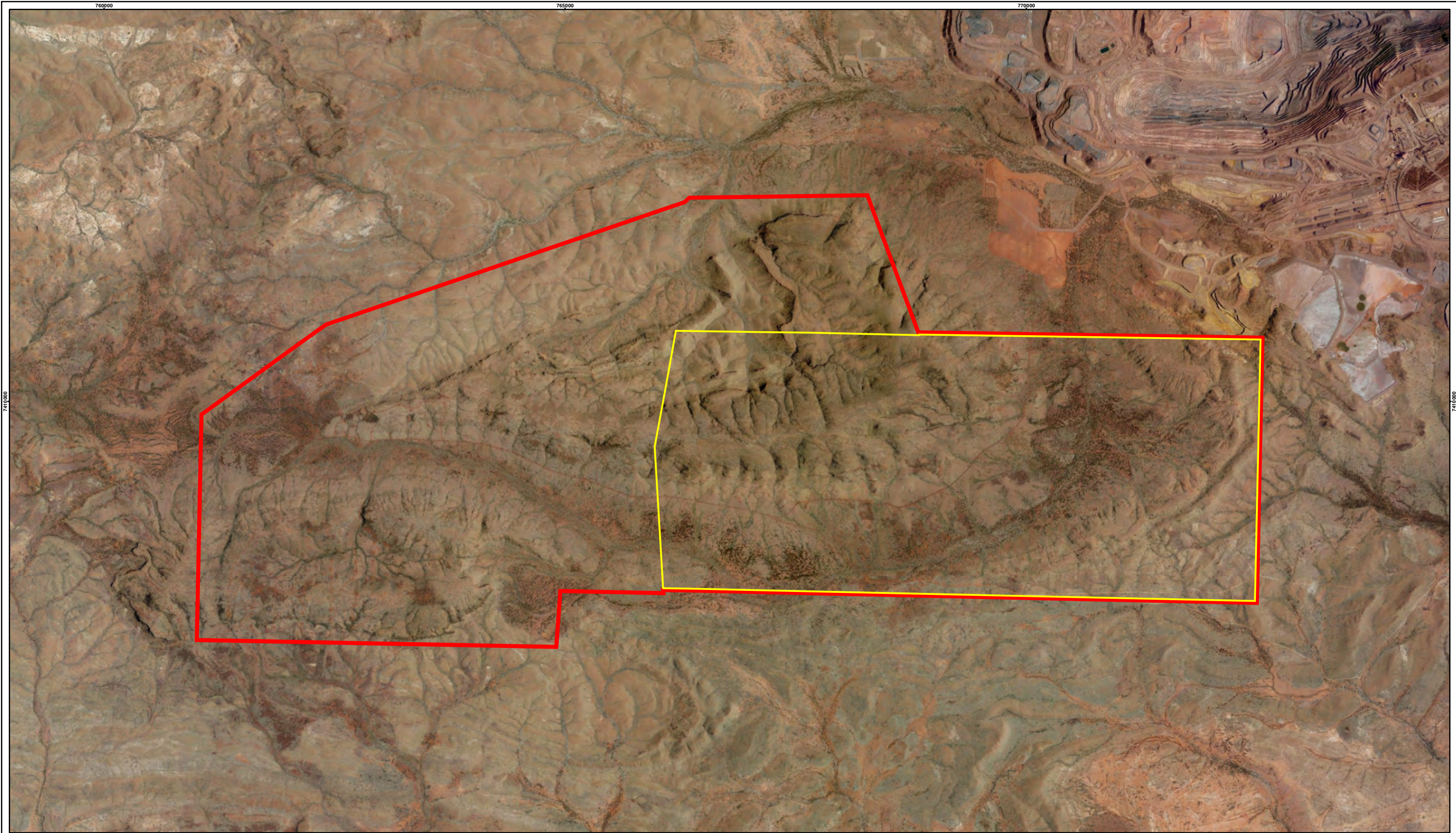
Note: NL indicates the HSL is not limiting



		RPD ≥30% and one or more values ≥5 × LOR		RPD ≥30% and both values <5 × LOR		RPD ≥30% due to differing LORs			
Chemical Group	Chemical Name	Units	LOR	EP2104239 WSR0280REM Primary 4/16/2021 17:00	EP2104239 FD03 Duplicate 4/16/2021 17:00	EP2104239 WSR0765REM Primary 4/17/2021 8:00	789512 WSR0765RM/59170421 TriPLICATE 4/17/2021 8:00	RPD	
Per- and polyfluoroalkyl substances (PFAS)	Perfluorodecane sulfonic acid (PFDS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	N-Methyl PFO sulfonamidoethanol (MeFOSE)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<0.001	<0.005	<30	
	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	µg/L	0.0005 : 0.005 (Interlab)	<0.0005	<0.0005	<0.0005	<0.005	<30	
	Perfluorooctanoic acid (PFOA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0002 : 0.001 (Interlab)	<0.0002	<0.0002	<0.0002	<0.001	<30	
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Sum of PFHxS and PFOS (lab reported)	µg/L	0.0002 : 0.001 (Interlab)	<0.0002	<0.0002	<0.0002	<0.001	<30	
	Sum of WA DER PFAS (n=10)	µg/L	0.0002 : 0.005 (Interlab)	<0.0002	<0.0002	<0.0002	<0.005	<30	
	Sum of PFASs (n=28 - Lab Reported)	µg/L	0.0002 : 0.005 (Interlab)	<0.0002	<0.0002	<0.0002	<0.005	<30	
	Perfluorobutanoic acid (PFBA)	µg/L	0.002 : 0.005 (Interlab)	<0.002	<0.002	<0.002	<0.005	<30	
	Perfluorohexanoic acid (PFHxA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorooctanoic acid (PFHpA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorodecanoic acid (PFDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluoropentanoic acid (PFPeA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorononanoic acid (PFNA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorotetradecanoic acid (PFTrDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorooheptane sulfonic acid (PFHpS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005 : 0.001 (Interlab)	<0.0005	<0.0005	<0.0005	<0.001	<30	
	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	N-Ethyl PFO sulfonamide (EtFOSA)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	N-Ethyl PFO sulfonamidoethanol (EtFOSE)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	N-Methyl PFO sulfonamide (MeFOSA)	µg/L	0.001 : 0.005 (Interlab)	<0.001	<0.001	<0.001	<0.001	<0.005	<30
	Perfluorooctane sulfonamide (FOSA)	µg/L	0.0005 : 0.005 (Interlab)	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	<30
N-ethyl-PFO sulfonamidoacetic acid (EtFOSAA)	µg/L	0.0005 : 0.005 (Interlab)	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	<30	
MAH	Benzene	mg/L	0.001	<0.001	<0.001	<0.001	N/A	-	
	Toluene	mg/L	0.002	<0.002	<0.002	<0.002	N/A	-	
	Ethylbenzene	mg/L	0.002	<0.002	<0.002	<0.002	N/A	-	
	Xylenes (m & p)	mg/L	0.002	<0.002	<0.002	<0.002	N/A	-	
	Xylene (o)	mg/L	0.002	<0.002	<0.002	<0.002	N/A	-	
PAH	Xylenes (Sum of total) (Lab Reported)	mg/L	0.002	<0.002	<0.002	<0.002	N/A	-	
	Total BTEX	mg/L	0.001	<0.001	<0.001	<0.001	N/A	-	
Total Recoverable Hydrocarbons	Naphthalene	mg/L	0.005 : 0.01 (Interlab)	<0.005	<0.005	<0.005	<0.01	<30	
	TRH C ₆ -C ₉ Fraction	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<30	
	TRH C ₁₀ -C ₁₄ Fraction	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<30	
	TRH C ₁₅ -C ₂₈ Fraction	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<30	
	TRH C ₂₉ -C ₃₆ Fraction	mg/L	0.05 : 0.1 (Interlab)	<0.05	<0.05	<0.05	<0.1	<30	
	TRH+C ₁₀ -C ₃₆ (Sum of total) (Lab Reported)	mg/L	0.05 : 0.1 (Interlab)	<0.05	<0.05	<0.05	<0.1	<30	
	TRH+C ₁₀ -C ₄₀ (Sum of total) (Lab Reported)	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<30	
	TRH C ₆ -C ₁₀ Fraction F1	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<30	
	TRH C ₆ -C ₁₀ Fraction Less BTEX F1	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<30	
	TRH >C ₁₀ -C ₁₆ Fraction F2	mg/L	0.1 : 0.05 (Interlab)	<0.1	<0.1	<0.1	<0.05	<30	
	TRH >C ₁₀ -C ₁₆ Fraction Less Naphthalene F2	mg/L	0.1 : 0.05 (Interlab)	<0.1	<0.1	<0.1	<0.05	<30	
	TRH >C ₁₆ -C ₃₄ Fraction F3	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<30	
TRH >C ₃₄ -C ₄₀ Fraction F4	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<30		

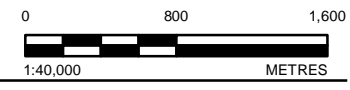
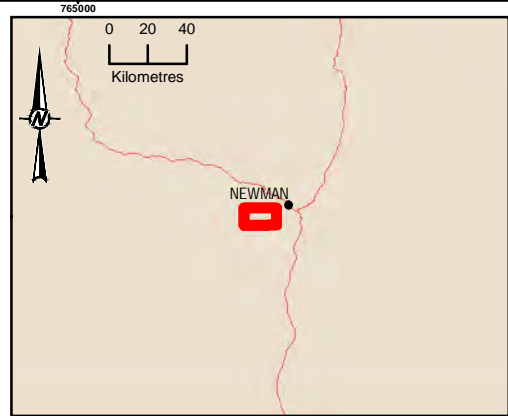
Note: N/A = Not Analysed

Lab Report Number	EP2104239	EP2104239
Field ID	TB318	TBW325
Sampled Date/Time	4/16/2021 15:00	4/16/2021 9:48
Sample Type	Trip Blank	Trip Blank

Chemical Group	Chemical Name	Units	LOR		
MAH	Benzene	mg/L	0.001		<0.001
	Toluene	mg/L	0.002		<0.002
	Ethylbenzene	mg/L	0.002		<0.002
	Xylenes (m & p)	mg/L	0.002		<0.002
	Xylene (o)	mg/L	0.002		<0.002
	Xylenes (Sum of total) (Lab Reported)	mg/L	0.002		<0.002
PAH	Total BTEX	mg/L	0.001		<0.001
	Naphthalene	mg/L	0.005		<0.005
Total Recoverable Hydrocarbons	TRH C ₆ -C ₉ Fraction	mg/L	0.02		<0.02
	TRH C ₆ -C ₁₀ Fraction F1	mg/L	0.02		<0.02
	TRH C ₆ -C ₁₀ Fraction Less BTEX F1	mg/L	0.02		<0.02
Per- and polyfluoroalkyl substances (PFAS)	Perfluorodecane sulfonic acid (PFDS)	µg/L	0.0005		<0.0005
	N-Methyl PFO sulfonamidoethanol (MeFOSE)	µg/L	0.001		<0.001
	N-methyl-PFO sulfonamidoacetic acid (MeFOSAA)	µg/L	0.0005		<0.0005
	Perfluorooctanoic Acid (PFOA)	µg/L	0.0005		<0.0005
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0002		<0.0002
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.0005		<0.0005
	Sum of PFHxS and PFOS (lab reported)	µg/L	0.0002		<0.0002
	Sum of WA DER PFAS (n=10)	µg/L	0.0002		<0.0002
	Sum of PFASs (n=28 - Lab Reported)	µg/L	0.0002		<0.0002
	Perfluorobutanoic acid (PFBA)	µg/L	0.002		<0.002
	Perfluorohexanoic acid (PFHxA)	µg/L	0.0005		<0.0005
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.0005		<0.0005
	Perfluorodecanoic acid (PFDA)	µg/L	0.0005		<0.0005
	Perfluoropentanoic acid (PFPeA)	µg/L	0.0005		<0.0005
	Perfluorononanoic acid (PFNA)	µg/L	0.0005		<0.0005
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.0005		<0.0005
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.0005		<0.0005
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.0005		<0.0005
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.0005		<0.0005
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.0005		<0.0005
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.0005		<0.0005
	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.0005		<0.0005
	4:2 Fluorotelomer sulfonic acid (4:2 FTSA)	µg/L	0.001		<0.001
	6:2 Fluorotelomer sulfonic acid (6:2 FTSA)	µg/L	0.001		<0.001
	8:2 Fluorotelomer sulfonic acid (8:2 FTSA)	µg/L	0.001		<0.001
	10:2 Fluorotelomer sulfonic acid (10:2 FTSA)	µg/L	0.001		<0.001
	N-Ethyl PFO sulfonamide (EtFOSA)	µg/L	0.001		<0.001
	N-Ethyl PFO sulfonamidoethanol (EtFOSE)	µg/L	0.001		<0.001
	N-Methyl PFO sulfonamide (MeFOSA)	µg/L	0.001		<0.001
	Perfluorooctane sulfonamide (FOSA)	µg/L	0.0005		<0.0005
	N-ethyl-PFO sulfonamidoacetic acid (EtFOSAA)	µg/L	0.0005		<0.0005



LEGEND
 WESTERN RIDGE STUDY AREA
 EASTERN SYNCLINE



NOTE(S)
 1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE(S)
 1. AERIAL IMAGERY SOURCED FROM © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2018)

CLIENT
BHP

CONSULTANT



YYYY-MM-DD	2021-05-03
DESIGNED	PW
PREPARED	AM
REVIEWED	CB
APPROVED	CB

PROJECT
PFAS BASELINE ASSESSMENT - EASTERN SYNCLINE

TITLE
HISTORICAL IMAGERY - 2014

PROJECT NO.	CONTROL	REV.
21464272	004-R	0

FIGURE
3D

PATH: B:\BHP_Billings\BHPa\08_PROJECTS\21464272_WaterQuality\02_PRODUCTION\003_R\21464272-003-R-F03_RevA_Eastern_Syncline.mxd PRINTED ON: 2021-05-03 AT: 4:05:38 PM

25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOOPED FROM (ISO A3)

APPENDIX A

Well Construction Logs

APPENDIX B

Field Sheets

APPENDIX C

Calibration Certificates

APPENDIX D

Laboratory Certificates

APPENDIX E

Important Information



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