ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1623644**	Page	: 1 of 8
Client	: **ORIGIN ENERGY RESOURCES LTD**	Laboratory	: Environmental Division Sydney
Contact	: [redacted]	Contact	: [redacted]
Address	: ORIGIN ENERGY RESOURCES LIMITED GPO BOX 148 BRISBANE QLD, AUSTRALIA 4001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: [redacted]	Telephone	[redacted]
Project	: BEETALOO GROUNDWATER MONITORING	Date Samples Received	: 21-Oct-2016 13:45
Order number	: 16231417	Date Analysis Commenced	: 21-Oct-2016
C-O-C number	: 19102016_SU_BEETALOO FB	Issue Date	: 02-Nov-2016 16:43
Sampler	: ----		
Site	: BEETALOO		
Quote number	: ----		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
[redacted]	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
[redacted]	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
[redacted]	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
[redacted]		Sydney Inorganics, Smithfield, NSW
[redacted]	Organic Coordinator	Sydney Organics, Smithfield, NSW
[redacted]	Lab technician	Sydney Inorganics, Smithfield, NSW
[redacted]	Metals Teamleader	Radionuclides, Fyshwick, ACT
[redacted]	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

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

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

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

- EG035: Poor matrix spike recovery was obtained for Mercury on sample ES1623644# 2 due to high matrix interference. Confirmed by re-analysis.
- EG020/ED093: LOR's have been raised for sample ID ES1623644 - #001, 2 & 3 due to matrix interference. (High Total Dissolved Solids)
- ED041G: LOR raised for (Sulfate analysis) on sample no:1, due to sample matrix.
- Gross Alpha and Beta Activity analyses are performed by ALS Fyshwick (NATA Accreditation number 992).
- EP050: The MBAS reported is calculated as LAS, mol wt ____342___.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- EA250 LSC : LOR for Gross Alpha and Beta raised due to high solid content
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentra ion of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	BET-PW001_Fe_11.5%	BET-PW001_Fe_12.15 %	BET-PW001_Fe_12.5%	----	----
			Client sampling date / time	15-Oct-2016 19:00	17-Oct-2016 09:00	19-Oct-2016 08:00	----	----
Compound	CAS Number	LOR	Unit	ES1623644-001	ES1623644-002	ES1623644-003	--------	--------
				Result	Result	Result	---	---
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.47	6.50	6.45	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	49000	50500	51100	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	38800	37400	39000	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	31800	32800	33200	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	4090	4110	4500	----	----
EA250: Gross Alpha and Beta Activity								
Gross alpha	----	0.05	Bq/L	8.82	6.31	8.38	----	----
Gross beta activity - 40K	----	0.1	Bq/L	15.4	7.55	8.31	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	506	474	472	----	----
Total Alkalinity as CaCO3	----	1	mg/L	506	474	472	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<10	26	38	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	18200	18300	18800	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	1220	1230	1360	----	----
Magnesium	7439-95-4	1	mg/L	253	252	269	----	----
Sodium	7440-23-5	1	mg/L	12100	11700	12300	----	----
Potassium	7440-09-7	1	mg/L	72	70	74	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.010	<0.010	<0.010	----	----
Boron	7440-42-8	0.05	mg/L	45.9	44.5	43.5	----	----
Barium	7440-39-3	0.001	mg/L	51.9	53.9	59.1	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.010	<0.010	<0.010	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0010	<0.0010	<0.0010	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	<0.010	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BET-PW001_Fe_11.5%	BET-PW001_Fe_12.15 %	BET-PW001_Fe_12.5%	----	----
				Client sampling date / time	15-Oct-2016 19:00	17-Oct-2016 09:00	19-Oct-2016 08:00	----	----
Compound	CAS Number	LOR	Unit		ES1623644-001	ES1623644-002	ES1623644-003	--------	--------
					Result	Result	Result	---	---
EG020F: Dissolved Metals by ICP-MS - Continued									
Chromium	7440-47-3	0.001	mg/L		0.042	0.030	0.033	----	----
Copper	7440-50-8	0.001	mg/L		<0.010	<0.010	<0.010	----	----
Manganese	7439-96-5	0.001	mg/L		2.38	2.24	2.43	----	----
Nickel	7440-02-0	0.001	mg/L		<0.010	<0.010	<0.010	----	----
Lead	7439-92-1	0.001	mg/L		<0.010	<0.010	<0.010	----	----
Selenium	7782-49-2	0.01	mg/L		<0.10	<0.10	<0.10	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.10	<0.10	<0.10	----	----
Zinc	7440-66-6	0.005	mg/L		<0.050	<0.050	<0.050	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		1.1	1.1	1.1	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.03	0.02	0.12	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		45.1	65.6	48.0	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		45.1	65.6	48.1	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.22	0.16	0.12	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		524	526	540	----	----
Total Cations	----	0.01	meq/L		610	593	627	----	----
Ionic Balance	----	0.01	%		7.62	5.95	7.40	----	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	1	µg/L		5460	7090	5500	----	----
Ethene	74-85-1	1	µg/L		<1	<1	<1	----	----
Ethane	74-84-0	1	µg/L		581	657	575	----	----
Propene	115-07-1	1	µg/L		<1	<1	<1	----	----
Propane	74-98-6	1	µg/L		16	17	13	----	----
Butene	25167-67-3	1	µg/L		<1	<1	<1	----	----
Butane	106-97-8	1	µg/L		<1	<1	<1	----	----
EP041A: Nonionic Surfactants									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	BET-PW001_Fe_11.5%	BET-PW001_Fe_12.15 %	BET-PW001_Fe_12.5%	----	----
			Client sampling date / time	15-Oct-2016 19:00	17-Oct-2016 09:00	19-Oct-2016 08:00	----	----
Compound	CAS Number	LOR	Unit	ES1623644-001	ES1623644-002	ES1623644-003	--------	--------
				Result	Result	Result	---	---
EP041A: Nonionic Surfactants - Continued								
Nonionic Surfactants as CTAS	----	5	mg/L	<5	<5	<5	----	----
EP050: Anionic Surfactants as MBAS								
Anionic Surfactants as MBAS	----	0.1	mg/L	<0.1	0.1	<0.1	----	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	2.3	2.2	2.2	----	----
2-Chlorophenol	95-57-8	1	µg/L	<1.0	<1.0	<1.0	----	----
2-Methylphenol	95-48-7	1	µg/L	<1.0	<1.0	<1.0	----	----
3- & 4-Methylphenol	1319-77-3	2	µg/L	2.6	2.1	2.9	----	----
2-Nitrophenol	88-75-5	1	µg/L	<1.0	<1.0	<1.0	----	----
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	<1.0	<1.0	----	----
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	<1.0	<1.0	----	----
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	<1.0	<1.0	----	----
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	<1.0	<1.0	----	----
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	<1.0	<1.0	----	----
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	<1.0	<1.0	----	----
Pentachlorophenol	87-86-5	2	µg/L	<2.0	<2.0	<2.0	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	<1.0	----	----
Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	<1.0	----	----
Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	<1.0	----	----
Fluorene	86-73-7	1	µg/L	<1.0	<1.0	<1.0	----	----
Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	<1.0	----	----
Anthracene	120-12-7	1	µg/L	<1.0	<1.0	<1.0	----	----
Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	<1.0	----	----
Pyrene	129-00-0	1	µg/L	<1.0	<1.0	<1.0	----	----
Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	<1.0	----	----
Chrysene	218-01-9	1	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	<1.0	----	----
Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	<1.0	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BET-PW001_Fe_11.5%	BET-PW001_Fe_12.15 %	BET-PW001_Fe_12.5%	----	----
				Client sampling date / time	15-Oct-2016 19:00	17-Oct-2016 09:00	19-Oct-2016 08:00	----	----
Compound	CAS Number	LOR	Unit		ES1623644-001	ES1623644-002	ES1623644-003	--------	--------
					Result	Result	Result	---	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		60	80	80	----	----
C10 - C14 Fraction	----	50	µg/L		110	160	240	----	----
C15 - C28 Fraction	----	100	µg/L		470	<100	100	----	----
C29 - C36 Fraction	----	50	µg/L		200	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		780	160	340	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		60	80	80	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		50	70	70	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	120	----	----
>C16 - C34 Fraction	----	100	µg/L		600	110	110	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		600	110	230	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	120	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		3	4	4	----	----
Toluene	108-88-3	2	µg/L		2	3	3	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ Total Xylenes	1330-20-7	2	µg/L		2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		7	7	7	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1	%		22.5	21.6	20.5	----	----
2-Chlorophenol-D4	93951-73-6	1	%		53.6	50.3	50.3	----	----
2.4.6-Tribromophenol	118-79-6	1	%		89.7	82.4	81.5	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1	%		63.1	58.3	53.7	----	----
Anthracene-d10	1719-06-8	1	%		81.1	74.5	72.6	----	----
4-Terphenyl-d14	1718-51-0	1	%		105	102	97.9	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BET-PW001_Fe_11.5%	BET-PW001_Fe_12.15 %	BET-PW001_Fe_12.5%	----	----
				Client sampling date / time	15-Oct-2016 19:00	17-Oct-2016 09:00	19-Oct-2016 08:00	----	----
Compound	CAS Number	LOR	Unit		ES1623644-001	ES1623644-002	ES1623644-003	--------	--------
					Result	Result	Result	---	---
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		125	124	122	----	----
Toluene-D8	2037-26-5	2	%		107	108	101	----	----
4-Bromofluorobenzene	460-00-4	2	%		114	112	109	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

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