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GROUNDWATER MONITORING PALMS OASIS CARAVAN PARK BLUEYS BEACH NSW

RAMBOLL

GROUNDWATER MONITORING
PALMS OASIS CARAVAN PARK BLUEYS BEACH NSW

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Made by	**Steve Cadman**
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Description	**Monitoring Report**

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1. INTRODUCTION

1.1 Background

Ramboll Australia Pty Ltd (Ramboll) was commissioned by Torque Projects, acting for Ingenia Communities (Ingenia) to undertake groundwater monitoring in and around a service station associated with the Palms Oasis caravan park at 321 Boomerang Drive, Blueys Beach, NSW, ("the site").

Ramboll understands that Torque Projects has been appointed in a project management role by Ingenia.

A section of the caravan park, fronting Boomerang Drive, comprises a service station area retailing fuel which we understand is stored in three underground storage tanks (USTs) installed approximately 20 years ago, (early 1990's).

The onsite USTs represent a potential liability in terms of possible soil and groundwater contamination. Ramboll understands that preliminary 2016 investigation works included the installation of three groundwater monitoring wells in the immediate vicinity of the site, with the subsequent installation of an additional six wells further down-gradient from the service station site.

Samples have been previously collected, analysed and reported (two reports) by Aurora Environmental Consulting in 2016 with visual and odour monitoring in 2017.

Ingenia required an updated round of sampling and laboratory analysis to assess ongoing impacts on groundwater beyond the visual/odour monitoring being completed.

Ingenia engaged Ramboll to undertake the scope of work outlined in the following section to provide an updated assessment of the status of groundwater conditions at the site.

1.2 Projective Objectives

The Project objectives were to undertake a monitoring program and evaluate the current condition of the site groundwater.

1.3 Scope of Work

Ramboll undertook the following scope of work for the project:

- Undertake a preliminary review of the existing site investigation reports for assessments conducted in 2016 by Aurora Environmental Consulting;
- Mobilization to the site and undertake groundwater monitoring activities for the nine site groundwater wells, which entailed:
  - Measurement of depth to groundwater in each well and recording of separate phase hydrocarbon layers, if present;
  - Collection of groundwater samples (using low flow sampling techniques) from each of the nine wells which also included in-situ, field measurement of physic-chemical parameters, pH, electrical conductivity (EC), dissolved oxygen (DO), temperature, and oxidation/reduction potential (redox);
  - Submission of samples to a NATA-accredited analytical laboratory (via chain of custody protocols) for analysis of selected samples for a range of contaminants of concern, including total recoverable hydrocarbons, volatile aromatic hydrocarbons, benzene, toluene, ethyl-benzene, xylene and naphthalene (BTEXN), poly-cyclic aromatic hydrocarbons, (PAHs) and lead.
  - Three samples from the wells within the service station area (MW1, MW2 and MW3) were initially analysed, with additional samples, down-hydraulic gradient of the service station (MW4, MW5 and MW6) subsequently analysed following receipt of initial results.
- Preparation of this report detailing the results of the monitoring round.

2. SITE SETTING

2.1 Site Identification and Details

The following table (**Table 2-1**) summarizes the site details and physical setting:

Table 2-1: Site Summary Details

Site Owner:	**Ingenia Communities**
Street Address:	"Palms Oasis Caravan Park" 321 Boomerang Drive, Blueys Beach NSW
Local Government Area	Mid-Coast Council
Distance from CBD	Approximately 17km south of Forster, 96 kms north-east of Newcastle.
Geographical Coordinates	Latitude 32°20'30.64"S, longitude 152°31'33.47"E.
Lot and DP Numbers	The site occupies Lot 1 in DP 862876
Site Area:	The site is a rectangular block aligned east-west, with a total area of approximately 4 ha (built area), with the service station area occupying the entrance from Boomerang Drive and an estimated area of 830m². The caravan park site is located on the northern side of Boomerang Drive, approximately 500m east of the turn off from Lakes Way and is 1.4 km west of Blueys Beach.
Current Zoning:	The site is currently zoned RE2 Private Recreation.
Current Landuse:	The site is currently used as a caravan park with a commercial area on the road frontage selling retail fuel product (service station).
Site History:	Based on previous reports, the site including the caravan park and service station, was established in the early 1990's. No information about previous uses was available.
Neighbouring Uses:	The site is located on Boomerang Drive, bordered to the south by the road, with bushland on all other sides (and across Boomerang Drive).

The site location is shown in **Figure 1, Appendix 1**.

2.2 Site Description

The site is located on a relatively flat area with a slight slope down towards the north-west. Ground levels rise to the rear of the caravan park site and north towards Lakes Way.

The large barrier estuary lake, Lake Wallis, is located less than a kilometre to the north-west on the north side of Lakes Way. The ocean at Blueys Beach is located approximately 1.4km to the east of the site.

2.3 Site Geology and Hydrogeology

The 1:250000 Newcastle Geology map indicates the site is underlain by lower Carboniferous-aged sandstones siltstones and claystones of the Wooten Beds.

The investigations conducted by Aurora indicated a clayey weathered siltstone/claystone profile under minor fill (associated with the service station). The weathered bedrock was encountered approximately 3 to 5m below surface, overlain by a silty clay profile.

Groundwater was encountered at approximately 2 mbgl (in the clay soils) and water level measurements indicated a north-west flow direction.

3. PREVIOUS REPORTS

In 2016, Aurora Environmental Consulting Pty Ltd was retained to undertake an environmental assessment of the service station and surrounding Caravan Park to assess the impacts of the storage of fuel products on the site soil and groundwater and the resulting risks to continued commercial use of the service station and residential use of the park.

An investigation was completed in March 2016 with a further investigation in October 2016.

Two reports were produced:

- "*Environmental Site Assessment Report Palms Oasis Caravan Park*", Aurora Environmental Consulting, April 2016
- "*Environmental Delineation Assessment Report Palms Oasis Caravan Park*", Aurora Environmental Consulting, October 2016

Briefly the scope of the investigations encompassed:

March 2016

- A review of site background information and available site history;
- Site investigation comprising drilling of six boreholes in the service station area and sampling/analysis of soil for a range of hydrocarbon contaminants (TPH/BTEXN and Pb);
- Installation of three groundwater monitoring wells into three of the boreholes and subsequent sampling and analysis of groundwater (TPH/BTEXN and Pb)

October 2016

- Following a review of the results from the March investigation, further boreholes were drilled in order to define the extent of observed impacted groundwater and a further six groundwater wells were installed to the west, north-west, north and east of the service station in the surrounding caravan park.
- Soil and groundwater (from both the initial wells and the new wells) was sampled and analysed for the contaminant suite.
- A visual /odour inspection was conducted in September 2017 which indicated only a mild hydrocarbon odour in MW3 with no indication of a sheen the wells.

The chief findings of the investigations comprised the following:

- The site geology comprised a weathered clayey soil profile overlying weathered siltstones/claystones.
- Groundwater was encountered at about 2 m depth and the groundwater flow direction was determined towards the north-west.
- Soil samples analysed as part of the investigations (on and off the service station site) were found to have concentrations of petroleum hydrocarbons at either below detectable limits or within guideline criteria.
- Petroleum hydrocarbon concentrations in the groundwater were found above guideline criteria for ecological receptors across the service station area but not in the wells installed down gradient (ie, in the caravan park).
- Petroleum hydrocarbon contaminant concentrations did not exceed human health guidelines (for vapour intrusion) for either commercial/industrial use (service station area) or residential use (caravan park), in any wells.
- Aurora indicated that the levels of contaminants in the groundwater may require notification to the NSW EPA reporting under section 60 of the Contaminated Land Management Act (1997).

In the direction of groundwater travel, the service station wells are located approximately 280m from the external property boundary.

4. METHODOLOGY

Groundwater sampling was undertaken on 14 December 2017. Sampling methodology is described in this section. All of the installed monitoring wells on the site were sampled comprising, MW1, MW2, MW3, MW4, MW5, MW6, MW7, MW8 and MW9,

The fieldwork methodology for groundwater sampling is outlined in **Table 4-1.**

Table 4-1: Groundwater Sampling Methodology

Activity	Details
Well gauging	Monitoring wells were gauged using a water level meter. The wells on site and on the neighbouring site were gauged within as short a time frame as possible to minimise tidal effects. The depth of groundwater sampling was documented as part of the sampling records. **(Appendix 2)**
Sampling method	Following stabilisation of groundwater parameters, sampling was completed using low-flow peristaltic techniques. Groundwater samples were collected into laboratory-supplied bottles that were preserved as required. Preservatives were: nitric acid for dissolved lead. Other sample bottles were unpreserved. All samples for dissolved lead analysis were field-filtered through a 0.45µm filter prior to addition of preservative. All samples were immediately placed into chilled eskies and promptly submitted to the laboratory (ALS) under chain-of-custody protocols.
Decontamination	Dedicated tubing was used per well. Decontamination of re-useable sampling equipment was completed using Decon90 and rinsing with potable water.
Disposal of water	Groundwater collected during sampling was disposed of to land on the site, down gradient of each well following sampling.

4.1 Laboratory Analysis

All samples (including a field duplicate quality control sample and trip blank) were submitted to ALS which is NATA-accredited for the analyses conducted. The samples were sent to the laboratory under chain-of-custody protocols and analysed for:

- total recoverable hydrocarbons (TRH), C_6 to C_{40};
- volatile aromatic hydrocarbons, benzene, toluene, ethyl-benzene, xylene and naphthalene (BTEXN);
- poly-cyclic aromatic hydrocarbons, (PAHs); and
- dissolved lead.

5. DATA QUALITY INDICATORS

The project Data Quality Indicators (DQIs) have been established to set acceptance limits on field and laboratory data collected as part of this investigation. The DQIs are presented in **Table 5-1**. Non-compliance with the DQIs are documented and discussed in this section.

Table 5-1: Data Quality Indicators

Field	Laboratory	Acceptability Limits
Completeness - A measure of the amount of useable data (expressed as a %) from a data collection activity		
All critical locations sampled as per proposed sampling plan. All samples collected as per sampling plan. Experienced sampler Documentation correct	All critical samples analysed and all analytes analysed per sampling plan Appropriate Practical Quantitation Limits (PQLs) Sample documentation complete Sample holding times complied with laboratory specifications Matrix interference	As per NEPM (2013)
Comparability - The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event		
Experienced sampler In the event of multiple sampling events: Same types of samples collected Same sampling depths (groundwater) Same sampling methodologies used Climatic conditions	Same analytical methods used Same PQLs Same units	As per NEPM (2013)
Representativeness - The confidence (expressed qualitatively) that data are representative of each media present on the site		
Appropriate media sampled according to sampling plan. Relevant media sampled and preserved according to sampling plan.	All samples analysed according to sampling plan	As per NEPM (2013)
Precision - A quantitative measure of the variability (or reproducibility) of data		
Collection of duplicate samples at a rate of 1 in 10 samples for intra-laboratory and 1 in 20 samples for inter-laboratory.	Analysis of: Blind duplicate samples	RPD of <=50%
Sampling methodologies appropriate and complied with sampling plan	Trip blanks	RPD of <= 50%
All laboratories are NATA accredited.	Laboratory duplicate samples	RPD of <= 50%
Accuracy - A quantitative measure of the closeness of reported data to the true value		

Sampling methodologies appropriate and complied with the sampling plan	Laboratory quality control	Non-detect (minor metal concentrations)
Laboratory quality assurance testing completed in accordance with NEPM requirements	Method blanks	Non-detect
	Surrogate spikes	70 to 130%
	Laboratory control sample	70 to 130%
		70 to 130%

5.1 Field QA/QC

The following quality assurance/quality control (QA/QC) procedures were employed during the sampling program:

- All samples were collected by personnel trained and experienced in the collection of soil and groundwater samples for analysis, using standard industry techniques for sample collection;
- All down-hole equipment was decontaminated with DECON 90 prior to installation in the wells and dedicated sampling equipment was used to collect each sample to minimise the opportunity for cross contamination;
- All samples were promptly placed in clean, laboratory-supplied containers appropriate for the required analyses and containing the appropriate preservative;
- All samples were labelled with unique names, identifying location and date;
- All samples were immediately placed in chilled eskies;
- All samples were sent to the laboratory under chain-of-custody (COC) protocols;
- All samples were analysed within the recommended holding times;
- The water quality meter was hired from a rental company who calibrated the equipment prior to hire;
- The following quality control samples were also collected and submitted for analysis:
  - Field duplicates (intra-laboratory duplicates) at a ratio of one per 10 samples groundwater.
  - Trip blank for volatile components

A quality assurance assessment for this report is presented in **Table 5-2**. An assessment was made of data completeness, comparability, representativeness, precision and accuracy based on field and laboratory considerations, as outlined in the NEPM 2013.

Table 5-2 specifies the methodology in which the quality assurance and controls will be implemented in the field in order to comply with the stated Data Quality Indicators (DQIs).

Table 5-2: Field Quality Assurance and Quality Control

Field and Lab QA/QC	Ramboll Environ Comments
	Groundwater
Field quality control samples	Intra-laboratory duplicate groundwater samples were analysed at a rate of 11%. A trip blank was also employed. The water quality meter was calibrated prior to hire of the equipment. Standard practice is to rely on pre-hire calibration for short sampling periods. Intra-laboratory **groundwater** duplicate results are presented in **Appendix 3 Table 2.**
Field quality control results	No Relative Percent Differences (RPDs) were recorded outside the RPD criteria.
NATA registered laboratory and NATA endorsed methods	ALS was used as the primary laboratory. The laboratory certificates are NATA stamped.

Field and Lab QA/QC	Ramboll Environ Comments
Analytical methods	Summary analytical methods were included in the laboratory test certificates.
Holding times	Review of the CoCs and laboratory certificates indicate that holding times were met width the following exceptions: Volatile analyses for volatile TRH and BTEXN for MW4, MW5 and MW6 were **outside** recommended holding times.
Limit of Reporting (LOR)	LORs for all groundwater analytes were below the adopted screening criteria.
Laboratory quality control samples	Laboratory quality control samples including duplicates, laboratory control samples, matrix spikes, surrogate spikes and blanks were undertaken by the laboratories at appropriate frequencies.
Laboratory quality control results	**ES1721863 (Groundwater)** No method blank or laboratory duplicate outliers occur for the laboratory reports.

Overall, it is considered that the completed investigation works and the data obtained adequately complied with the requirements of NEPM (2013). In general, the Data Quality Indicators of completeness, comparability, representativeness, precision and accuracy outlined above have been met. There was a minor non-conformance with respect to holding times for MW4, 5 and 6 samples. It is not considered to significantly alter the analytical results.

It is considered that the data are of suitable quality to meet the project objectives.

6. ASSESSMENT CRITERIA

6.1 Groundwater

The site is located approximately 1 km to the east of Wallis Lake, a coastal barrier estuary lake which discharges into the ocean 20 km to the north at Forster. The lake and surrounding waterways are an important oyster production area.

For ecological communities, groundwater results will be compared against trigger values for *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000). Trigger values for the protection of 95% of freshwater aquatic species has been selected marine guidelines have also been included given the potential for interaction with a semi-marine environment (estuary).

For human health, the NEPM Groundwater Investigation Levels (GILs) have been adopted for HSL D for commercial/industrial properties and HSL A for low density residential use is also presented for comparison given the proximity of the residential caravan park.

Table 6.1 refers to the groundwater assessment criteria for established GILs and refers to the groundwater Health Screening levels for vapour intrusion.

Table 6.1: Groundwater Assessment Criteria

Contaminant (All units in µg/L)	ANZECC 2000 95% Protection for Fresh Waters	NEPM 2013 Table 1C GILs, Fresh Waters	NEPM 2013 Table 1C GILs, Marine Waters
Lead	3.4	3.4	4.4
Benzene	950	950	500
Toluene	180	-	-
Ethylbenzene	80	-	-
Total Xylene	-	-	-
o-xylene	350	350	-
m-xylene	75	-	-
p-xylene	200	200	-
Naphthalene	16	16	50

Schedule B1 of the NEPM provides generic health screening levels (HSL) for groundwater, for protection of human health from petroleum hydrocarbon vapours. The results will be compared to the dominant soil profile encountered onsite and depth to groundwater as well the type of land use scenario as shown in **Table 6.2**.

Table 6.2: Groundwater Assessment Criteria for Vapour Intrusion – HSL D/HSL A

Contaminant	HSL A	HSL D
All units in microgram per litre (µg/L)	Clay 2-4m	Clay 2-4m
Benzene	5000	30000
Toluene	NL[1]	NL
Ethylbenzene	NL	NL
Total Xylenes	NL	NL
Naphthalene	NL	NL

NL is no limit

7. RESULTS

7.1 Water Levels

Water levels were measured in the wells (MW1 to MW9) across the service station and caravan site.

Using the local datum set up by Aurora, water levels were compared to evaluate flow directions. **Table 7-1** shows measured and reduced levels.

Figure 3 presents groundwater contours based on the reduced water levels.

Table 7-1 Groundwater Levels

WELL ID	Water Level (mBToC)	Water Level (reduced level site datum*)
MW1	1.15	10.85
MW2	1.53	11.494
MW3	2.39	10.146
MW4	1.12	10.648
MW5	1.91	10.21
MW6	1	10.782
MW7	1.12	10.731
MW8	1.36	11.383
MW9	2.18	10.308

Mbtoc is metres below top of casing

* datum based on arbitrary datum adopted by Aurora.

Comparison of water levels shows groundwater movement generally towards the west and northwest.

7.2 Groundwater Aquifer Permeability

As part of the field work, a brief assessment was made of aquifer permeability (hydraulic conductivity) using a rising head test, monitoring water level recovery on a regular interval following removal of water from a selected well, (MW8).

Evaluation of recovery using the Hvorslev solution (as per Freeze and Cherry 1979), gave a hydraulic conductivity of 4 to 5 x 10^{-7} m/sec, and within the range of expected hydraulic conductivities in silt/clay soils.

At an assumed effective porosity of 30% and a hydraulic gradient of 0.05 m/m, a groundwater flow velocity of approximately 0.26 m/year.

7.3 Field Observations

Physico-chemical parameters including, pH, electrical conductivity (EC), oxidation/reduction potential (redox) and dissolved oxygen (DO) were measured as part of the sampling process.

Stable parameters recorded at the time of sample collection are presented in **Table 7-2**.

Table 7-2 Groundwater Physico-Chemical Parameters

WELL ID	Spec Cond (µS/cm)	pH	DO (ppm)	Redox (mV)
MW1	583	6.32	0.78	-81
MW2	659	5.79	1.37	-14
MW3	1379	5.10	0.73	-18
MW4	5920	5.43	0.63	70
MW5	9520	5.15	0.70	82
MW6	5010	5.62	0.73	74
MW7	1854	4.77	0.56	192
MW8	944	4.89	0.58	131
MW9	5110	5.11	0.54	89

DO is dissolved oxygen

TDS is total dissolved solids in ppm parts per million

Spec Cond is specific electrical conductivity in µS/cm

Redox is oxidation reduction potential in millivolts

The field measurements indicated:

- pH values range from 4.77 in MW7 (acidic) to 6.32 in MW1 (slightly acidic);
- the conductivity results indicate all wells to be slightly brackish to brackish water;
- mildly oxidising conditions were found in most wells except for MW1, MW2 and MW3, which had mildly reducing conditions.

7.4 Results

Groundwater samples collected from the site wells were analysed for the following compounds:

- TRH (C_6-C_{40}), BTEXN, PAHs and lead (MW1, MW2 and MW3).
- Volatile TRH (C_6-C_{10}) and BTEXN (MW4, MW5 and MW6).

The results of analyses of the sampled wells is summarized in **Table 1** in **Appendix 3**

Laboratory reports are presented in **Appendix 4.**

A brief discussion of the results is presented in the following section.

7.4.1 December 2017 Results

The results from the analytical program indicated:

- Elevated concentrations of TRH C_6-C_{10} and C_{10}-C_{16} fractions were detected in groundwater sampled from existing wells MW1, MW2 and MW3;
- Elevated concentrations of Benzene over the guideline criteria were detected in groundwater in wells MW1 and MW3 and at lower concentrations in MW2, MW4, MW5 and MW6.
- Elevated concentrations of Ethyl-benzene over the guideline criteria were detected in groundwater sampled from existing wells MW1 and MW3, and at lower concentrations in MW2, MW4, MW5 and MW6.
- Elevated concentrations of Xylenes over the guideline criteria were detected in groundwater sampled from existing wells MW1 and MW3, and at lower concentrations in MW5.
- Elevated concentrations of naphthalene over the guideline criteria were detected in groundwater sampled from existing wells MW1, MW2 and MW3.
- Naphthalene was not detected in wells MW4, MW5 and MW6.

- Lead was not detected in any site well.
- PAHs (excluding naphthalene) were not detected in any site well.

7.4.2 Comparison with Previous Results

Table 7-3 below presents a comparison of current selected results with previous monitoring rounds conducted in March and August 2016, (Aurora).

Table 7-3 Comparison with Previous Groundwater Monitoring – Selected Parameters

	Benzene			Ethyl-benzene			Xylenes			Naphthalene		
Well	**Dec-2017**	**Aug-2016**	**Mar-2016**	**Dec-2017**	**Aug-2016**	**Mar-2016**	**Dec-2017**	**Aug-2016**	**Mar-2016**	**Dec-2017**	**Aug-2016**	**Mar-2016**
MW1	166	**4610**	3480	104	1100	1060	<LOR	**2990**	**529**	**19**	144	258
MW2	25	18	26	23	<LOR	179	2	111	<LOR	22	35	92
MW3	**3540**	**2790**	258	1580	1370	39	**524**	**378**	**1370**	**288**	265	24
MW4	4	<LOR	NA	4	<LOR	NA	<LOR	<LOR	NA	<LOR	<LOR	NA
MW5	15	3	NA	10	<LOR	NA	3	23	NA	<LOR	<LOR	NA
MW6	2	<LOR	NA	3	<LOR	NA	<LOR	<LOR	NA	<LOR	<LOR	NA
Guideline												
GILs (Fresh Water)		950			-			200(*)			16	
HSL A (low density residential)		5000			NL			NL			NL	
HSL D (commercial Industrial)		30000			NL			NL			NL	

all concentrations in µg/L

LOR: limit of reporting (detection limit)

NA not analysed

GILs are Groundwater Investigation Levels (NEPM 2013) for Fresh Water Ecosystems

HSL are Health Screening Levels for inhalation/direct contact for Low Density Residential (A) and commercial /industrial (D)

Bold where criteria exceeded

(*) is for para-Xylene

Results indicate concentrations of petroleum hydrocarbons, including mono-aromatic hydrocarbons (benzene, ethyl-benzene, toluene, and xylene) and naphthalene to be present at concentrations consistent with previous investigations. Concentrations of benzene, xylene and naphthalene exceed the Groundwater Investigation Limits (GILs -NEPM 2013 -for impacts on fresh water ecosystems), although they are below health screening criteria (inhalation/direct contact). However, of note, contaminant concentrations appear to be decreasing in groundwater collected from on-site wells and increasing in groundwater collected from the down-hydraulic gradient well (MW3) and in the down-gradient wells, MW4, MW5 and MW6 which (although still very low) may be indicative of the migration of the contaminant plume to the northwest, towards the residential area of the park.

8. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the groundwater monitoring event conducted for the Palms Oasis Caravan Park at 321 Boomerang Drive, Blueys Beach, NSW, the following conclusions have been drawn:

- Results indicate concentrations of petroleum hydrocarbons, including mono-aromatic hydrocarbons (benzene, ethyl-benzene, toluene, and xylene) and naphthalene to be present at concentrations consistent with previous investigations.
- Fieldwork also confirmed similarly consistent depth to groundwater and groundwater flow directions.
- There were no separate phase hydrocarbons observed in any well.
- Concentrations of benzene, xylene and naphthalene exceed the Groundwater Investigation Limits (GILs -NEPM 2013 -for impacts on fresh water ecosystems), although are below health screening criteria (inhalation/direct contact).
- Contaminant concentrations appear to be decreasing over time in the groundwater collected from the service station wells MW1 and MW2, and increasing in MW3, on the down-hydraulic gradient side of the service station.
- Concentrations at the down-gradient wells, MW4, MW5 and MW6 in the residential park area, remain low and near detection levels however, are increasing which may be indicative of the migration of the contaminant plume to the northwest, towards the residential area of the park.
- At present there is no apparent pathway from the contaminant source (USTs and dissolved concentrations of petroleum hydrocarbons), to a human or ecological receptor, and no indication that contamination has migrated beyond the site, although there are still some data gaps.
- As such there is currently no risk to human or ecological receptors on or off the site.

Although distant from any external property boundary, in the direction of groundwater flow, Ramboll considers however, the presence of contaminants in the groundwater above relevant screening criteria at the service station area and potential off-site migration towards sensitive receptors (residential area of the park) will require action.

Initially, we consider that further monitoring could be conducted in, nominally, three months and including all wells, and an evaluation made whether notification to the NSW EPA under Section 60 of the NSW Contaminated Land Management Act 1997, (Duty to Report) is required. If notified, the EPA will conduct their assessment of the available data and may also require the site owner to undertake additional investigations in order to assess if the site needs to be regulated (i.e. managed or remediated).

The Owner also needs to follow the UPSS regulations (DECCW 2009) which have a similar requirement about duty to report, and also require regular (6 monthly) monitoring of the groundwater wells for visual indications of groundwater contamination by hydrocarbons.

A budget estimation of potential remediation costs, if tank removal was required, was made based on Ramboll experience of similar remediation conducted in suburban Sydney locations.

It is estimated that costs for; removal of USTs and associated infrastructure, (not including service station buildings), removal and appropriate disposal of affected soils, soil validation sampling and reporting and re instatement works would be in the range of $75,000 to $200,000 dependent on volumes of soils requiring disposal and premium costs for distance of transport due to the regional NSW location. These ballpark costs could be further refined, based on quotes from specialist contractors.

9. REFERENCES

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000).

CRC Care Technical Report no.10, *Health Screening Levels for petroleum hydrocarbons in soil and groundwater*, September 2011

DECCW (2009) *Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008,* NSW Department of Environment, Climate Change and Water, (now NSW EPA), August 2009.

National Environment Protection Council (NEPC)'s National Environmental Protection Council (Assessment of Site Contamination) Measure 1999, as amended 2013 (NEPM (2013)

Aurora (2016a) "*Environmental Site Assessment Report Palms Oasis Caravan Park*", Aurora Environmental Consulting, April 2016

Aurora (2016b) "*Environmental Delineation Assessment Report Palms Oasis Caravan Park*", Aurora Environmental Consulting, October 2016

Freeze and Cherry (1979), "*Groundwater*", Freeze and Cherry, Prentice hall Inc, 1979

10. LIMITATIONS

Ramboll Australia prepared this report in accordance with the scope of work as outlined in our proposal to Ingenia Communities and in accordance with our understanding and interpretation of current regulatory standards.

Site conditions may change over time. This report is based on conditions encountered at the site at the time of the report and Ramboll Australia disclaims responsibility for any changes that may have occurred after this time.

The conclusions presented in this report represent Ramboll Australia's professional judgment based on information made available during the course of this assignment and are true and correct to the best of Ramboll Australia's knowledge as at the date of the assessment.

Ramboll Australia did not independently verify all of the written or oral information provided to Ramboll Australia during the course of this investigation. While Ramboll Australia has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to Ramboll Australia was itself complete and accurate.

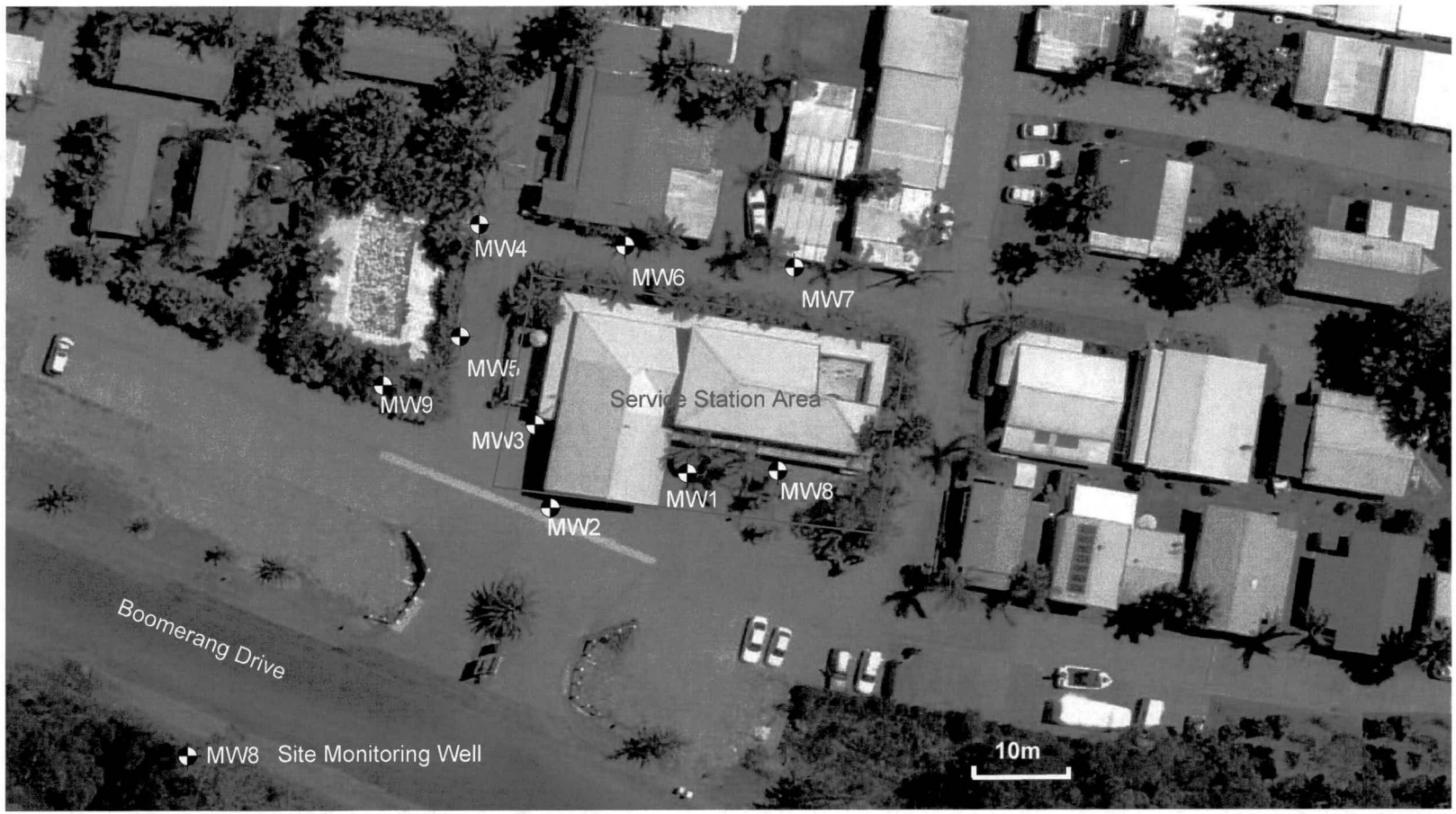
This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

10.1 User Reliance

This report has been prepared exclusively for Ingenia Communities and may not be relied upon by any other person or entity without Ramboll Australia's express written permission.

APPENDIX 1
FIGURES

Client: Ingenia Communities Pty Ltd	Palms Oasis Caravan Park - Site Location
RAMBOLL ENVIRON JOB NO: 318000371 Date: Jan 2018	FIGURE 2



Client: Ingenia Communities Pty Ltd	Palms Oasis Caravan Park - Site Layout
RAMBOLL ENVIRON JOB NO: 318000371 Date: Jan 2018	FIGURE 2

Client: Ingenia Communities Pty Ltd

Palms Oasis Caravan Park
Groundwater Contours

RAMBOLL ENVIRON

JOB NO: 318000371

Date: Jan 2018

FIGURE 3

APPENDIX 2
FIELD SAMPLING SHEETS

Time	DTW
MW7 2:38	1.12
MW6 2:40	1.00
MW4 2:40	1.12
MW 4 2:41	1.91
MW3 2:42	2.39
MW9 2:44	2.18
MW1 ~~2:45~~	~~1.53~~ 2.15? - 1.15
MW2 2:45	1.55
MW8 2:46	1.36

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14/12/17
Project:		**Well Number:**	MW8
Location:		**Sampler(s):**	NG

Field Measurements

Organic vapours in well:		ppm	Measurement device:
Depth to Groundwater:	1.35	m	Measurement Device:
Correction:	−0.11	m	
Groundwater Elevation :		m	
Depth to Immiscible Layer:		m	Measurement Device:
Thickness to Immiscible Layer:		m	
Well Depth:	4.49	m	
Thickness to Groundwater Column:		m	

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: End Sampling:

Sample Appearance: MS/ow

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
11:15	28.7	917	5.00	0.86	122mV	1.3 NTU	slightly turbid light brown ~~light brown~~ odour
11:16	28.1	944	4.98	0.79	124mV	1.4 NTU	"
11:17	27.7	946	4.95	0.65	127mV	1.4 NTU	"
11:18	27.4	944	4.93	0.59	130mV	1.5 NTU	"
11:19	27.3	942	4.89	0.58	131mV	1.5 NTU	"

TDS ppm
609
612
616
614
610

Miscellaneous Field Comments

Well Head Integrity:	1.58m after sampling
Samples Filtered	
Weather Condition:	
Other:	

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number: P1021	**Date:** 14/12/17.
Project:	**Well Number:** MW9
Location:	**Sampler(s):** NG.

Field Measurements			
Organic vapours in well:		ppm	Measurement device:
Depth to Groundwater:	2.18	m	Measurement Device:
Correction:	-0.13	m	
Groundwater Elevation :		m	
Depth to Immiscible Layer:		m	Measurement Device:
Thickness to Immiscible Layer:		m	
Well Depth:	4.44	m	
Thickness to Groundwater Column:		m	

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: 11.43 End Sampling:

Sample Appearance: M S/cm

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
11.46	31.3	5.2mS	5.53	0.78	101mV	2.7NTU	
11.47	31.0	5.18	5.40	0.80	97	2.7	
11.48	30.7	5.16	5.37	0.70	94	2.3	
11.49	30.8	5.14	5.39	0.65	90	1.9	
11.50	30.8	5.11	5.41	0.54	89	1.7	

TDS PPK
3.38
OVA 3.36
3.36
3.34
3.32

Miscellaneous Field Comments

Well Head Integrity: 2.35 after sampling.

Samples Filtered

Weather Condition:

Other:

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14/12/17.
Project:		**Well Number:**	MW7
Location:		**Sampler(s):**	NG

Field Measurements

Organic vapours in well:		ppm	Measurement device:
Depth to Groundwater:	0.76	m	Measurement Device:
Correction:	- 0.11	m	
Groundwater Elevation :		m	
Depth to Immiscible Layer:		m	Measurement Device:
Thickness to Immiscible Layer:		m	
Well Depth:	4.46	m	
Thickness to Groundwater Column:		m	

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: 12.25 End Sampling:

Sample Appearance:

TPS ppm	TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
1228	2.22	33.5	1888	4.66	0.99	139mV	1.5NTU	orange brown, turbid no odour.
1225	2.23	33.2	1885	4.57	0.97	144mV	1.6NTU	〃
1221	2.24	33.0	~~1223~~ 1878	4.52	0.83	150mV	1.8NTU	〃
1219	2.25	32.8	1879	4.46	0.77	158	2.0NTU	〃
12188	2.25	32.7	1870	4.39	0.79	167	2.2	〃
1213	2.26	32.6	1869	4.33	0.66	171	2.0	〃
1209	2.27	32.5	1855	4.28	0.51	187	7.6	〃
1205	2.28	32.5	1854	4.27	0.56	192	164	〃

Miscellaneous Field Comments

Well Head Integrity:	Head Q end 1.45.
Samples Filtered	
Weather Condition:	
Other:	

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14 / 12 / 17
Project:		**Well Number:**	MW6
Location:		**Sampler(s):**	NG.

Field Measurements			
Organic vapours in well:		ppm	Measurement device:
Depth to Groundwater:	0.99	m	Measurement Device:
Correction:	-0.11	m	
Groundwater Elevation :		m	
Depth to Immiscible Layer:		m	Measurement Device:
Thickness to Immiscible Layer:		m	
Well Depth:	4.56	m	
Thickness to Groundwater Column:		m	

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: 1.50 End Sampling:

Sample Appearance: mS/cm

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
2.00	31.3	4.98	5.66	1.07	73	2.3 NTU	turbid, orange/brown, no odour
2.01	30.8	5.00	5.63	0.94	74	1.7 NTU	"
2.02	30.6	5.02	5.62	0.80	75	1.5 NTU	"
2.03	30.6	5.01	5.62	0.73	74	1.8 NTU	"

TDS ppt: 3.25, 3.24, 3.25, 3.25

Miscellaneous Field Comments

Well Head Integrity:	Head @ end - 1.21m
Samples Filtered	
Weather Condition:	
Other:	

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14/12/17.
Project:		**Well Number:**	MW5
Location:		**Sampler(s):**	NG.

Field Measurements

Organic vapours in well:	ppm	Measurement device:	
Depth to Groundwater: 1·84 ~~2·84~~	m	Measurement Device:	
Correction: −0·11	m		
Groundwater Elevation :	m		
Depth to Immiscible Layer:	m	Measurement Device:	
Thickness to Immiscible Layer:	m		
Well Depth: 4·49.	m		
Thickness to Groundwater Column:	m		

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: 12·43 End Sampling:

Sample Appearance:

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
TDS 11K 6·16 12·47	31·7	9·51 mS	5·23	0·88	80mV	1·4 NTU	turbid, orange / brown, no odour
6·17 12·48	31·3	9·50	5·19	0·78	81mV	1·8 NTU	〃
6·17 12·49	31·1	9·50	5·17	0·76	82mV	2·1 NTU	〃
12·50	30·8	9·52	5·15	0·70	82mV	2·1 NTU	〃

Miscellaneous Field Comments

Well Head Integrity:	Thread @ end = 2·11m.
Samples Filtered	
Weather Condition:	
Other:	

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14/12/07
Project:		**Well Number:**	MW4
Location:		**Sampler(s):**	NG

Field Measurements

Organic vapours in well:		ppm	Measurement device:
Depth to Groundwater:	1.13	m	Measurement Device:
Correction:	-0.12	m	
Groundwater Elevation :		m	
Depth to Immiscible Layer:		m	Measurement Device:
Thickness to Immiscible Layer:		m	
Well Depth:	4.47	m	
Thickness to Groundwater Column:		m	

Well Sampling

Method: ☐ Micro-Purge ☐ Peristaltic ☐ Bailer

Start Sampling: 1.25. End Sampling:

Sample Appearance:

TIME	TEMP (°C)	SPEC. COND mS/cm	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
1.33	33.1	5.94	5.46	0.85	69mV	1.9 NTU	turbid, orange/brown no odour
1.34	32.7	5.92	5.44	0.70	70mV	1.6	"
1.35	32.3	5.92	5.43	0.63	70mV	18.1 NTU	"

TDS ppk
3.86
3.85
3.85

Miscellaneous Field Comments

Well Head Integrity:	Lead @ end = 1.25m
Samples Filtered	
Weather Condition:	
Other:	

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P102 1	**Date:**	14/12/17.
Project:		**Well Number:**	MW3
Location:	Palms oasis.	**Sampler(s):**	NC

Field Measurements

Organic vapours in well:	ppm	Measurement device:	
Depth to Groundwater:	2.04 m	Measurement Device:	
Correction:	-0.11 m		
Groundwater Elevation :	m		
Depth to Immiscible Layer:	m	Measurement Device:	
Thickness to Immiscible Layer:	m		
Well Depth:	4.35 m		
Thickness to Groundwater Column:	m		

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: 12.13 End Sampling:

Sample Appearance: as

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)
12.18	31.1	1481	5.03	1.06	-3mV	15.1NTU	strong hydrocarbon odour
12.19	30.9	1461	5.06	0.88	-8mV	45.6NTU	clear
12.20	30.9	1396	5.08	0.81	-13mV	136.7NTU	"
12.21	30.8	1379	5.10	0.73	-18mV	30.5NTU	"

TDS ppm: 956, 932, 903, 888

Miscellaneous Field Comments

Well Head Integrity:	water at top of well cap. Syringed out.
Samples Filtered	Strong hydrocarbon odour when
Weather Condition:	opened well.
Other:	

Head @ end = 2.41.

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14/12/17
Project:		**Well Number:**	MW02
Location:		**Sampler(s):**	

Field Measurements			
Organic vapours in well:		ppm	Measurement device:
Depth to Groundwater:	1.60	m	Measurement Device:
Correction:	0.11	m	
Groundwater Elevation :		m	
Depth to Immiscible Layer:		m	Measurement Device:
Thickness to Immiscible Layer:		m	
Well Depth:	4.39	m	
Thickness to Groundwater Column:		m	

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: End Sampling:

Sample Appearance: µS/cm TDS

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)	TDS ppm
10.08	31.1	689	5.88	1.92	-14mV	2.4 NTU	clear hydrocarbon algae ~~no odour~~	436.
10.09	30.9	664	5.80	1.54	-15mV	2.6 NTU	"	432
10.10	30.7	663	5.79	1.43	-14mV	2.6 NTU	"	430
10.11	30.7	659	5.79	1.37	-14mV	2.7 NTU	"	429

Miscellaneous Field Comments

Well Head Integrity:	1.78m after sampling
Samples Filtered	
Weather Condition:	
Other:	

Low Flow Groundwater Sampling Field Parameter Form

Ref. Number:	P1021	**Date:**	14/12/17
Project:		**Well Number:**	MW01
Location:		**Sampler(s):**	NG

Field Measurements

Organic vapours in well:	ppm	Measurement device:	
Depth to Groundwater:	1.10 m	Measurement Device:	
Correction:	-0.08 m		
Groundwater Elevation :	m		
Depth to Immiscible Layer:	m	Measurement Device:	
Thickness to Immiscible Layer:	m		
Well Depth:	4.41 m		
Thickness to Groundwater Column:	m		

Well Sampling

Method: ☐ Micro-Purge ☒ Peristaltic ☐ Bailer

Start Sampling: End Sampling:

Sample Appearance: M S

TIME	TEMP (°C)	SPEC. COND.	pH	DO	Redox	TDS	Comments (appearance, odour, etc)	TDS ppm
10:35	26.1	595	6.38	0.92	-85mV	1.6 NTU	clear hydrocarbon odour	~~0.86~~
10:36	26.1	584	6.35	0.81	-85mV	1.6 NTU	"	380
10:37	25.9	584	6.33	0.80	-82mV	1.5 NTU	"	380
10:38	25.8	583	6.32	0.78	-81	1.5	"	380

Miscellaneous Field Comments

Well Head Integrity:	Head kept dropping on lowest pumping rate dropped to 1.73m
Samples Filtered	
Weather Condition:	
Other:	QA1.

Groundwater Recovery Log Sheet

Project Name:	Project Number: P1021
Bore Hole No.: MW8	Date: 14/12/17.
Location:	Elevation (mAHD):

0.136
101.
1.22

Height of casing above ground (m)	-0.11	Depth to bottom of well (from top of casing) (m)	4.49
Depth to water (from top of casing) (m)	1.36	Volume removed/added (L) 20L	bentonite buckets

Actual Time (hh:mm:ss)	Elapsed Time (hh:mm:ss)	Water Level (m)	Actual Time (hh:mm:ss)	Elapsed Time (hh:mm:ss)	Water Level (m)
3:09	0:00	3.73	3:43	3:30	1.98
3:10	0:05	3.68	3:44	3:40	1.97
3:11	0:10	3.52	3:45	3:50	1.96
3:12	0:15	3.38	3:46	4:00	1.95
3:13	0:20	3.23	3:47	4:30	1.94
3:14	0:25	3.09	3:48	5:00	1.93
3:15	0:30	2.95	3:49	5:30	1.92
3:16	0:35	2.85	3:50	6:00	1.92
3:17	0:40	2.78		7:00	
3:18	0:45	2.69		8:00	
3:19	0:50	2.62		9:00	
3:20	0:55	2.56		10:00	
3:21	1:00	2.50		12:00	
3:22	1:05	2.45		14:00	
3:23	1:10	2.40		16:00	
3:24	1:15	2.37		18:00	
3:25	1:20	2.31		20:00	
3:26	1:25	2.29		25:00	
3:27	1:30	2.26		30:00	
3:28	1:35	2.23		35:00	
3:29	1:40	2.20		40:00	
3:30	1:45	2.18		50:00	
3:31	1:50	2.16		1:00:00	
3:32	1:55	2.14		1:15:00	
3:33	2:00	2.12		1:30:00	
3:34	2:10	2.11		1:45:00	
3:35	2:20	2.09		2:00:00	
3:36	2:30	2.07		2:30:00	
3:37	2:40	2.06		3:00:00	
3:38	2:50	2.03		3:30:00	
3:39	3:00	2.03		4:00:00	
3:40	3:10	2.02		5:00:00	
3:41	3:20	2.00		6:00:00	
3:41		1.99			

Comments/environmental conditions:

no of bailers = . 23 bailers.
start bailing @ 2:58.
finish @ 3:08

APPENDIX 3
LABORATORY RESULTS

Table 1: Summary of Results

Sample Identification	POL	Aquatic Ecosystem Guideline [A]	Ecosystem Guidelines [E]	Ecosystem Guidelines [D]	Human Health (Vapour Inhalation) Guideline HSL A [B]	Human Health (Vapour Inhalation) Guideline HSL D [C]	MW1	MW2	MW3	MW4	MW5	MW6
Sample Description												
Sample Purpose							Monitoring	Monitoring	Monitoring	Monitoring	Monitoring	Monitoring
Sample collected by							NG	NG	NG	NG	NG	NG
Date							14/12/17	14/12/17	14/12/17	14/12/17	14/12/17	14/12/17
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)												
Benzene	1	950	950	500	5000	30000	**166**	25	**3540**	4	15	2
Toluene	2	*180*	180	180	NL	NL	<2	<2	<10	<2	<2	<2
Ethylbenzene	2	*80*	80	80	NL	NL	**104**	23	**1580**	4	10	3
meta- and para-Xylene	2				NL	NL	<2	2	524	<2	3	<2
ortho-Xylene	2				NL	NL	<2	<2	<10	<2	<2	<2
Total Xylenes	2	200	200	200	NL	NL	<2	2	**624**	<2	3	<2
Sum of BTEX	1				NL	NL	270	50	5640	8	28	5
Naphthalene	5		16	50	NL	NL	**19**	**22**	**288**	<5	<5	<5
Total Petroleum Hydrocarbons (TPH)												
C6 - C9 Fraction	20						520	560	8630	<20	30	<20
C10 - C14 Fraction	50						70	590	1930	—	—	—
C15 - C28 Fraction	100						<100	<100	140	—	—	—
C29 - C36 Fraction	50						<50	<50	<50	—	—	—
TPH C6-C36	50						70	590	2070	—	—	—
Total Recoverable Hydrocarbons (TRH) - NEPM 2013 Fractions												
C6 - C10 Fraction	20						500	500	9270	<20	30	<20
C6 - C10 Fraction minus BTEX (F1)	20						230	450	3630	<20	<20	<20
>C10 - C16 Fraction	100						<100	560	1370	—	—	—
>C10 - C16 Fraction minus Naphthalene (F2)	100						<100	540	1080	—	—	—
>C16 - C34 Fraction	100						<100	<100	<100	—	—	—
>C34 - C40 Fraction	100						<100	<100	<100	—	—	—
>C10 - C40 Fraction (sum)	100						<100	560	1370	—	—	—
Dissolved Metals												
Lead	1	3,4	3,4	3,4			<1	<1	<1	—	—	—
Polycyclic Aromatic Hydrocarbons (PAH)												
Naphthalene	1	16	16	16			3,4	6,7	**110**	—	—	—
Acenaphthylene	1						<1,0	<1,0	<1,0	—	—	—
Acenaphthene	1						<1,0	<1,0	<1,0	—	—	—
Fluorene	1						<1,0	<1,0	<1,0	—	—	—
Phenanthrene	1						<1,0	<1,0	<1,0	—	—	—
Anthracene	1						<1,0	<1,0	<1,0	—	—	—
Fluoranthene	1						<1,0	<1,0	<1,0	—	—	—
Pyrene	1						<1,0	<1,0	<1,0	—	—	—
Benz(a)anthracene	1						<1,0	<1,0	<1,0	—	—	—
Chrysene	1						<1,0	<1,0	<1,0	—	—	—
Benzo(b+j)fluoranthene	1						<1,0	<1,0	<1,0	—	—	—
Benzo(k)fluoranthene	1						<1,0	<1,0	<1,0	—	—	—
Benzo(a)pyrene	0,5						<0,5	<0,5	<0,5	—	—	—
Indeno(1,2,3,cd)pyrene	1						<1,0	<1,0	<1,0	—	—	—
Dibenz(a,h)anthracene	1						<1,0	<1,0	<1,0	—	—	—
Benzo(g,h,i)perylene	1						<1,0	<1,0	<1,0	—	—	—
Sum of polycyclic aromatic hydrocarbons	0,5						3,4	6,7	110	—	—	—
Benzo(a)pyrene TEQ (zero)	0,5						<0,5	<0,5	<0,5	—	—	—

All results are in units of µg/L, unless specified
Blank Cell indicates no criterion available
POL = Practical Quantitation Limit.
Results Bold and shaded grey are in excess of the primary acceptance criteria: ANZECC 95%, NHMRC (2011)
A. ANZECC (2000) Freshwater 95% trigger values. Guidelines in italics are low reliability guidelines
B. CRC CARE (2011) Health Screening Levels for Groundwater, residential values for clay 2 to <4m' adopted
C. CRC CARE (2011) Health Screening Levels for Groundwater, commercial values for clay 2 to <4m' adopted
D. ANZECC (2000) Marine 95% trigger values. Guidelines in italics are low reliability guidelines
E. ANZECC (2000) Freshwater 95% trigger values. Guidelines in italics are low reliability guidelines

Table 2: Quality Assurance/Quality Control

Sample Identification	PQL	MW1	QA1	RPD %	Trip Blank
Date		14/07/2017			
Duplicate Type		Intralaboratory			
Sample Purpose		Monitoring			
Sample Appearance		clear			
Sample collected by		NG			
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)					
Benzene	1	166	163	*1.8*	<1
Toluene	2	1	1	*0.0*	<2
Ethylbenzene	2	104	100	*3.9*	<2
meta- and para-Xylene	2	1	1	*0.0*	<2
ortho-Xylene	2	1	1	*0.0*	<2
Total Xylenes	2	1	1	*0.0*	<2
Naphthalene	5	19	20	*5.1*	<5
Total Petroleum Hydrocarbons (TPH)					
C6 - C9 Fraction	20	520	510	*1.9*	<20
C10 - C14 Fraction	50	70	90	*25.0*	-
C15 - C28 Fraction	100	50	50	*0.0*	-
C29 - C36 Fraction	50	25	25	*0.0*	-
TPH C6-C36	50	70	90	*25.0*	-
Total Recoverable Hydrocarbons (TRH) - NEPM 2013 Fractions					
C6 - C10 Fraction	20	500	480	*4.1*	<20
C6 - C10 Fraction minus BTEX (F1)	20	230	220	*4.4*	<20
>C10 - C16 Fraction	100	50	50	*0.0*	-
>C16 - C34 Fraction	100	50	50	*0.0*	-
>C34 - C40 Fraction	100	50	50	*0.0*	-
>C10 - C40 Fraction (sum)	100	50	50	*0.0*	-
>C10 - C16 Fraction minus Naphthalene (F2)	100	50	50	*0.0*	-
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	1	0.5	0.5	*0.0*	-
Acenaphthylene	1	0.5	0.5	*0.0*	-
Anthracene	1	0.5	0.5	*0.0*	-
Benz(a)anthracene	1	0.5	0.5	*0.0*	-
Benzo(a) pyrene	1	0.5	0.5	*0.0*	-
Benzo(b)&(j)fluoranthene	1	0.5	0.5	*0.0*	-
Benzo(g,h,i)perylene	1	0.5	0.5	*0.0*	-
Benzo(k)fluoranthene	1	0.5	0.5	*0.0*	-
Chrysene	1	0.5	0.5	*0.0*	-
Dibenz(a,h)anthracene	1	0.5	0.5	*0.0*	-
Fluoranthene	1	0.5	0.5	*0.0*	-
Fluorene	1	0.5	0.5	*0.0*	-
Indeno(1,2,3-c,d)pyrene	0.5	0.25	0.25	*0.0*	-
Naphthalene	1	3.4	3.8	*11.1*	-
Phenanthrene	1	0.5	0.5	*0.0*	-
Pyrene	1	0.5	0.5	*0.0*	-
Benzo(a)pyrene TEQ (zero)	0.5	0.25	0.25	*0.0*	-
Sum of reported PAH	0.5	3.4	3.8	*11.1*	-
Dissolved Metals					
Lead	1	0.5	0.5	*0.0*	–

All results are in units of µg/L, unless specified

PQL = Practical Quantitation Limit. Where PQL is for a summation, PQL of all components is summed and may be different from that presented by laboratory

Results underlined were not detected and are reported as half the detection limit for statistical purpose.

BOLD Identifies where RPD results

intralaboratory	*interlaboratory*	
>50	*>60*	*where sam*
>75	*>85*	*where sample results are > 5 to ≤10 x PQL*
>100	*>100*	*where sample results are >2 to ≤5 x PQL*
*AD>2.5 * PQL*		*where sample results are ≤2 x PQL*

BOLD Identified where blanks >0

BOLD Identified where spikes outside of 70-130% recovery range

Where results are within two of the above ranges the most conservative criteria have been used to assess duplicate performance

APPENDIX 4
LABORATORY REPORTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1731862**	Page	: 1 of 7
Amendment	: **1**		
Client	: **RAMBOLL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: NATALIE GILBERT	Contact	: Sepan Mahamad
Address	: PO BOX 564 MAITLAND NSW, AUSTRALIA 2320	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 99548114	Telephone	: +61-2-8784 8555
Project	: P1021 PALMS OASIS GW SAMPLING	Date Samples Received	: 15-Dec-2017 09:17
Order number	: ----	Date Analysis Commenced	: 18-Dec-2017
C-O-C number	: ----	Issue Date	: 08-Jan-2018 10:37
Sampler	: NATALIE GILBERT		
Site	: ----		
Quote number	: EN/222/17		
No. of samples received	: 11		
No. of samples analysed	: 8		

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*
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Raymond Commodore	Instrument Chemist	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.

- EP080: Particular sample required dilution due to the presence of high level contaminants. LOR values have been adjusted accordingly.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW1	MW2	MW3	MW4	MW5
			Client sampling date / time	14-Dec-2017 00:00	14-Dec-2017 00:00	14-Dec-2017 00:00	14-Dec-2017 00:00	14-Dec-2017 00:00
Compound	CAS Number	LOR	Unit	ES1731862-001	ES1731862-002	ES1731862-003	ES1731862-004	ES1731862-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS								
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	---	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	3.4	6.7	110	---	---
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Benzo(k)fluoranthene	207-08-9	1.0	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	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	---	---
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	---	---
^ Sum of polycyclic aromatic hydrocarbons	---	0.5	µg/L	3.4	6.7	110	---	---
^ 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	520	560	8630	<20	30
C10 - C14 Fraction	---	50	µg/L	70	590	1930	---	---
C15 - C28 Fraction	---	100	µg/L	<100	<100	140	---	---
C29 - C36 Fraction	---	50	µg/L	<50	<50	<50	---	---
^ C10 - C36 Fraction (sum)	---	50	µg/L	70	590	2070	---	---
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	500	500	9270	<20	30
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	230	450	3630	<20	<20
>C10 - C16 Fraction	---	100	µg/L	<100	560	1370	---	---
>C16 - C34 Fraction	---	100	µg/L	<100	<100	<100	---	---
>C34 - C40 Fraction	---	100	µg/L	<100	<100	<100	---	---
^ >C10 - C40 Fraction (sum)	---	100	µg/L	<100	560	1370	---	---

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW1	MW2	MW3	MW4	MW5
				Client sampling date / time	14-Dec-2017 00:00	14-Dec-2017 00:00	14-Dec-2017 00:00	14-Dec-2017 00:00	14-Dec-2017 00:00
Compound	CAS Number	LOR	Unit		ES1731862-001	ES1731862-002	ES1731862-003	ES1731862-004	ES1731862-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	540	1080	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		166	25	3540	4	15
Toluene	108-88-3	2	µg/L		<2	<2	<10	<2	<2
Ethylbenzene	100-41-4	2	µg/L		104	23	1580	4	10
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	2	524	<2	3
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<10	<2	<2
^ Total Xylenes	----	2	µg/L		<2	2	524	<2	3
^ Sum of BTEX	----	1	µg/L		270	50	5640	8	28
Naphthalene	91-20-3	5	µg/L		19	22	288	<5	<5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		24.2	29.6	30.6	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		46.6	58.9	44.4	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		50.4	77.3	70.3	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		52.5	55.8	52.3	----	----
Anthracene-d10	1719-06-8	1.0	%		64.2	82.2	71.8	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		66.0	86.8	76.5	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		119	112	114	106	132
Toluene-D8	2037-26-5	2	%		109	113	102	125	122
4-Bromofluorobenzene	460-00-4	2	%		109	111	102	113	116

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**MW6**	**QA1**	**TRIP BLANK**	----	----
			Client sampling date / time	14-Dec-2017 00:00	14-Dec-2017 00:00	13-Dec-2017 00:00	—	—
Compound	*CAS Number*	*LOR*	*Unit*	**ES1731862-006**	**ES1731862-010**	**ES1731862-011**	-------	-------
				Result	Result	Result	—	—
EG020F: Dissolved Metals by ICP-MS								
Lead	7439-92-1	0.001	mg/L	---	<0.001	---	---	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	---	**3.8**	---	---	---
Acenaphthylene	208-96-8	1.0	µg/L	---	<1.0	---	---	---
Acenaphthene	83-32-9	1.0	µg/L	---	<1.0	---	---	---
Fluorene	86-73-7	1.0	µg/L	---	<1.0	---	---	---
Phenanthrene	85-01-8	1.0	µg/L	---	<1.0	---	---	---
Anthracene	120-12-7	1.0	µg/L	---	<1.0	---	---	---
Fluoranthene	206-44-0	1.0	µg/L	---	<1.0	---	---	---
Pyrene	129-00-0	1.0	µg/L	---	<1.0	---	---	---
Benz(a)anthracene	56-55-3	1.0	µg/L	---	<1.0	---	---	---
Chrysene	218-01-9	1.0	µg/L	---	<1.0	---	---	---
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	---	<1.0	---	---	---
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	---	<1.0	---	---	---
Benzo(a)pyrene	50-32-8	0.5	µg/L	---	<0.5	---	---	---
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	---	<1.0	---	---	---
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	---	<1.0	---	---	---
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	---	<1.0	---	---	---
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	---	**3.8**	---	---	---
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L	---	<0.5	---	---	---
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	**510**	<20	---	---
C10 - C14 Fraction	----	50	µg/L	---	**90**	---	---	---
C15 - C28 Fraction	----	100	µg/L	---	<100	---	---	---
C29 - C36 Fraction	----	50	µg/L	---	<50	---	---	---
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	---	**90**	---	---	---
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	**480**	<20	---	---
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<20	**220**	<20	---	---
>C10 - C16 Fraction	----	100	µg/L	---	<100	---	---	---
>C16 - C34 Fraction	----	100	µg/L	---	<100	---	---	---
>C34 - C40 Fraction	----	100	µg/L	---	<100	---	---	---
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	---	<100	---	---	---

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW6	QA1	TRIP BLANK	---	---
				Client sampling date / time	14-Dec-2017 00:00	14-Dec-2017 00:00	13-Dec-2017 00:00	---	---
Compound	CAS Number	LOR	Unit		ES1731862-006	ES1731862-010	ES1731862-011	-------	-------
					Result	Result	Result	---	---
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
^ >C10 - C16 Fraction minus Naphthalene (F2)	---	100	µg/L		---	<100	---	---	---
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		2	163	<1	---	---
Toluene	108-88-3	2	µg/L		<2	<2	<2	---	---
Ethylbenzene	100-41-4	2	µg/L		3	100	<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	---	2	µg/L		<2	<2	<2	---	---
^ Sum of BTEX	---	1	µg/L		5	263	<1	---	---
Naphthalene	91-20-3	5	µg/L		<5	20	<5	---	---
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		---	27.6	---	---	---
2-Chlorophenol-D4	93951-73-6	1.0	%		---	54.8	---	---	---
2.4.6-Tribromophenol	118-79-6	1.0	%		---	60.8	---	---	---
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		---	51.3	---	---	---
Anthracene-d10	1719-06-8	1.0	%		---	73.6	---	---	---
4-Terphenyl-d14	1718-51-0	1.0	%		---	76.7	---	---	---
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		103	115	107	---	---
Toluene-D8	2037-26-5	2	%		118	110	110	---	---
4-Bromofluorobenzene	460-00-4	2	%		113	106	108	---	---

Surrogate Control Limits

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

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1731862**	Page	: 1 of 6
Amendment	: **1**		
Client	: **RAMBOLL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: NATALIE GILBERT	Contact	: Sepan Mahamad
Address	: PO BOX 564 MAITLAND NSW, AUSTRALIA 2320	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 99548114	Telephone	: +61-2-8784 8555
Project	: P1021 PALMS OASIS GW SAMPLING	Date Samples Received	: 15-Dec-2017
Order number	: ---	Date Analysis Commenced	: 18-Dec-2017
C-O-C number	: ---	Issue Date	: 08-Jan-2018
Sampler	: NATALIE GILBERT		
Site	: ---		
Quote number	: EN/222/17		
No. of samples received	: 11		
No. of samples analysed	: 8		

ilac-MRA NATA

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 Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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*
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Raymond Commodore	Instrument Chemist	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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1327339)									
ES1731862-001	MW1	EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
ES1731969-001	Anonymous	EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 1325767)									
ES1731856-001	Anonymous	EP080: C6 - C9 Fraction	---	20	µg/L	<20	<20	0.00	No Limit
ES1731869-001	Anonymous	EP080: C6 - C9 Fraction	---	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 1351141)									
ES1731862-004	MW4	EP080: C6 - C9 Fraction	---	20	µg/L	<20	<20	0.00	No Limit
ES1801015-003	Anonymous	EP080: C6 - C9 Fraction	---	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 1325767)									
ES1731856-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
ES1731869-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 1351141)									
ES1731862-004	MW4	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
ES1801015-003	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 1325767)									
ES1731856-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
ES1731869-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP080: BTEXN (QC Lot: 1325767) - continued									
ES1731869-001	Anonymous	EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP080: BTEXN (QC Lot: 1351141)									
ES1731862-004	MW4	EP080: Benzene	71-43-2	1	µg/L	4	4	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	4	4	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
ES1801015-003	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1327339)								
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.0	83	111
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 1323048)								
EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	5 µg/L	71.5	50	94
EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	5 µg/L	70.6	64	114
EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	5 µg/L	64.8	62	113
EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	5 µg/L	66.5	64	115
EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	5 µg/L	74.0	63	116
EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	5 µg/L	67.0	64	116
EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	5 µg/L	64.4	64	118
EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	5 µg/L	73.7	63	118
EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	5 µg/L	68.2	64	117
EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	5 µg/L	74.7	63	116
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	5 µg/L	71.8	62	119
EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	5 µg/L	89.1	63	115
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	5 µg/L	70.7	63	117
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	5 µg/L	65.5	60	118
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	5 µg/L	66.5	61	117
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	5 µg/L	66.3	59	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1323049)								
EP071: C10 - C14 Fraction	---	50	µg/L	<50	2000 µg/L	92.7	76	116
EP071: C15 - C28 Fraction	---	100	µg/L	<100	3000 µg/L	104	83	109
EP071: C29 - C36 Fraction	---	50	µg/L	<50	2000 µg/L	84.5	75	113
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1325767)								
EP080: C6 - C9 Fraction	---	20	µg/L	<20	260 µg/L	104	75	127
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1351141)								
EP080: C6 - C9 Fraction	---	20	µg/L	<20	260 µg/L	99.1	75	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1323049)								
EP071: >C10 - C16 Fraction	---	100	µg/L	<100	2500 µg/L	101	76	114
EP071: >C16 - C34 Fraction	---	100	µg/L	<100	3500 µg/L	102	81	111
EP071: >C34 - C40 Fraction	---	100	µg/L	<100	1500 µg/L	104	77	119
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1325767)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	108	75	127

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	LCS: Spike Recovery (%)	Recovery Limits (%): Low	Recovery Limits (%): High
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1351141)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	101	75	127
EP080: BTEXN (QCLot: 1325767)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	100	70	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	101	69	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	104	70	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	106	69	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	109	72	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	119	70	120
EP080: BTEXN (QCLot: 1351141)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	109	70	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	105	69	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	104	70	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	99.1	69	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	102	72	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	103	70	120

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1327339)							
ES1731862-002	MW2	EG020A-F: Lead	7439-92-1	1 mg/L	87.1	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1325767)							
ES1731856-001	Anonymous	EP080: C6 - C9 Fraction	---	325 µg/L	116	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1351141)							
ES1731862-004	MW4	EP080: C6 - C9 Fraction	---	325 µg/L	98.4	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1325767)							
ES1731856-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	115	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 1351141)							
ES1731862-004	MW4	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	99.9	70	130
EP080: BTEXN (QCLot: 1325767)							
ES1731856-001	Anonymous	EP080: Benzene	71-43-2	25 µg/L	102	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP080: BTEXN (QCLot: 1325767) - continued							
ES1731856-001	Anonymous	EP080: Toluene	108-88-3	25 µg/L	98.4	70	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	105	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	106	70	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	111	70	130
		EP080: Naphthalene	91-20-3	25 µg/L	108	70	130
EP080: BTEXN (QCLot: 1351141)							
ES1731862-004	MW4	EP080: Benzene	71-43-2	25 µg/L	108	70	130
		EP080: Toluene	108-88-3	25 µg/L	96.5	70	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	101	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	98.6	70	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	100	70	130
		EP080: Naphthalene	91-20-3	25 µg/L	101	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1731862**	Page	: 1 of 5
Amendment	: **1**		
Client	: **RAMBOLL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: NATALIE GILBERT	Telephone	: +61-2-8784 8555
Project	: P1021 PALMS OASIS GW SAMPLING	Date Samples Received	: 15-Dec-2017
Site	: ----	Issue Date	: 08-Jan-2018
Sampler	: NATALIE GILBERT	No. of samples received	: 11
Order number	: ----	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EP080/071: Total Petroleum Hydrocarbons						
Amber VOC Vial - Sulfuric Acid						
MW4, MW5, MW6	04-Jan-2018	28-Dec-2017	7	04-Jan-2018	28-Dec-2017	7
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions						
Amber VOC Vial - Sulfuric Acid						
MW4, MW5, MW6	04-Jan-2018	28-Dec-2017	7	04-Jan-2018	28-Dec-2017	7
EP080: BTEXN						
Amber VOC Vial - Sulfuric Acid						
MW4, MW5, MW6	04-Jan-2018	28-Dec-2017	7	04-Jan-2018	28-Dec-2017	7

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	0	18	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	19	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
PAH/Phenols (GC/MS - SIM)	0	18	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	19	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
MW1, MW2, MW3, QA1	**14-Dec-2017**	**----**	**----**	**----**	**19-Dec-2017**	12-Jun-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM)) MW1, MW2, MW3, QA1	**14-Dec-2017**	**18-Dec-2017**	21-Dec-2017	✓	**21-Dec-2017**	27-Jan-2018	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071) MW1, MW2, MW3, QA1	**14-Dec-2017**	**18-Dec-2017**	21-Dec-2017	✓	**21-Dec-2017**	27-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) TRIP BLANK	**13-Dec-2017**	**19-Dec-2017**	27-Dec-2017	✓	**19-Dec-2017**	27-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) MW4, MW5, MW6	**14-Dec-2017**	**04-Jan-2018**	28-Dec-2017	×	**04-Jan-2018**	28-Dec-2017	×
Amber VOC Vial - Sulfuric Acid (EP080) MW1, MW2, MW3, QA1	**14-Dec-2017**	**19-Dec-2017**	28-Dec-2017	✓	**19-Dec-2017**	28-Dec-2017	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071) MW1, MW2, MW3, QA1	**14-Dec-2017**	**18-Dec-2017**	21-Dec-2017	✓	**21-Dec-2017**	27-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) TRIP BLANK	**13-Dec-2017**	**19-Dec-2017**	27-Dec-2017	✓	**19-Dec-2017**	27-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) MW4, MW5, MW6	**14-Dec-2017**	**04-Jan-2018**	28-Dec-2017	×	**04-Jan-2018**	28-Dec-2017	×
Amber VOC Vial - Sulfuric Acid (EP080) MW1, MW2, MW3, QA1	**14-Dec-2017**	**19-Dec-2017**	28-Dec-2017	✓	**19-Dec-2017**	28-Dec-2017	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080) TRIP BLANK	**13-Dec-2017**	**19-Dec-2017**	27-Dec-2017	✓	**19-Dec-2017**	27-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) MW4, MW5, MW6	**14-Dec-2017**	**04-Jan-2018**	28-Dec-2017	×	**04-Jan-2018**	28-Dec-2017	×
Amber VOC Vial - Sulfuric Acid (EP080) MW1, MW2, MW3, QA1	**14-Dec-2017**	**19-Dec-2017**	28-Dec-2017	✓	**19-Dec-2017**	28-Dec-2017	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	18	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	19	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	18	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	19	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

Palms Oasis GW Sampling

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

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WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT:	RAMBOLL ENVIRON	TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☒ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE:	HUNTER		
PROJECT:	P1021 PROJECT NO.:	ALS QUOTE NO.:	
ORDER NUMBER:	PURCHASE ORDER NO.:	COUNTRY OF ORIGIN:	
PROJECT MANAGER:	S. Cadman CONTACT PH:	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 CF: 1 2 3 4 5 6 7	FOR LABORATORY USE ONLY (Circle) Custody Seal Intact? Yes No N/A; Free ice / frozen ice bricks present upon receipt? Yes No N/A; Random Sample Temperature on Receipt: °C; Other comment:
SAMPLER:	N. Gilbert SAMPLER MOBILE: 0432184301		
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed):	ngilbert@ramboll.com &	RELINQUISHED BY: N Gilbert DATE/TIME: 15/12/17 9:15	RECEIVED BY: DB 9:15a DATE/TIME: 15/12/17
Email Invoice to (will default to PM if no other addresses are listed):	scadman@ramboll.com	RELINQUISHED BY: KH DATE/TIME: 15/12/17 5pm	RECEIVED BY: AJ DATE/TIME: 15/12/17 7.30pm

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	W-21 (TRH/BTEX PAH/Pb)	W-18 (TRH/BTEX)						Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	MW1	14/12/17	W	Glass / preserved	4	X							E-MAILED
2	MW2				4	X							
3	MW3				4	X							
4	MW4				4	X							
5	MW5				4	X							
6	MW6				4	X							
7	MW7				4	X							
8	MW8				4	X							
9	MW9				4	X							
10	QA1				4	X							
11	Trip Blank	13/12/17			1		X						
				TOTAL	41								

LAB OF ORIGIN: NEWCASTLE

Environmental Division Sydney
Work Order Reference
ES1731862

Telephone : +61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.