AGL Upstream Investments Pty Ltd

Drilling Completion Report - Wards River Groundwater Monitoring Bores

Gloucester Gas Project

9 March 2016





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Contents

Page number

Glo	ssary		v
Abb	oreviati	ions	ix
Uni	ts		х
Exe	ecutive	summary	xi
1.		oduction	1
			'
	1.1	Background	1
	1.2	Objectives	1
	1.3	Scope of works	1
2.	Site	characterisation	5
	2.1	Site location	5
	2.2	Rainfall	5
	2.3	Surface hydrology	6
	2.4	Geological setting	6
	2.5	Hydrogeological setting	10
3.	Bore	e installation and field testing	12
	3.1	Health, safety and environment	12
	3.2	Drilling and installation	14
	3.3	Perforating program	16
	3.4	Field testing	17
4.	Resu	ults	20
	4.1	Permeability testing	20
	4.2	Groundwater levels	20
	4.3	Groundwater quality	22
	4.4	Isotopes	24
5.	Conclusions		28
6.	State	ement of limitations	29
	6.1	Scope of services	29
	6.2	Reliance on data	29

	6.3	Environmental conclusions	29
	6.4	Report for benefit of client	29
	6.5	Other limitations	30
7.	Refer	ences	31

List of tables

Page number

Table 2.1	Stratigraphy of the Gloucester Basin	8
Table 2.2	Four hydrogeological units – Gloucester Basin	10
Table 3.1	Monitoring bore licence	14
Table 3.2	Bore construction details	16
Table 3.4	Groundwater analytical suite	18
Table 4.1	Hydraulic conductivity results from slug tests	20
Table 4.2	Stable isotope results for the Wards River monitoring bores	25
Table 4.3	δ^{13} C-DIC, radiocarbon and tritium results for the Wards River monitoring bores	25
Table 4.4	Dissolved methane concentrations and isotope results	26

List of figures

Page number

Figure 1.1	Regional location	3
Figure 1.2	Wards River groundwater monitoring bores	3
Figure 2.1	Monthly rainfall and cumulative deviation from the monthly mean (CDFM) rainfall at	
	the AGL Gloucester station since installation in July 2011 (AGL 2015a)	6
Figure 2.2	Regional geology	9
Figure 4.1	Groundwater levels and rainfall at the Wards River monitoring bores	21
Figure 4.2	Piper diagram for the Wards River monitoring bores	22
Figure 4.3	Detected dissolved metal concentrations in groundwater for Wards River	
	monitoring bores	23
Figure 4.4	Deuterium versus oxygen – 18 for Wards River monitoring bores	24
Figure 4.5	Depth versus ¹³ C-CH ₄ for the Wards River monitoring bores	26
Figure 4.6	¹³ C-CH ₄ versus ² H-CH ₄ for the Wards River monitoring bores	27

List of appendices

- Appendix A Bore licence
- Appendix B Bore logs
- Appendix C Hydraulic conductivity reports
- Appendix D Hydrographs
- Appendix E Water quality summary table
- Appendix F Laboratory results

Glossary

Alluvium	Unconsolidated sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains, and alluvial fans.
Aquifer	Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water.
Aquifer, confined	An aquifer that is overlain by low permeability strata. The hydraulic conductivity of the confining bed is significantly lower than that of the aquifer.
Aquifer, semi- confined	An aquifer overlain by a low-permeability layer that permits water to slowly flow through it. During pumping, recharge to the aquifer can occur across the leaky confining layer – also known as a leaky artesian or leaky confined aquifer.
Aquifer, unconfined	Also known as a water table aquifer. An aquifer in which there are no confining beds between the zone of saturation and the surface. The water table is the upper boundary of an unconfined aquifer.
Aquitard	A low permeability unit that can store groundwater and also transmit it slowly from one formation to another. Aquitards retard but do not prevent the movement of water to or from adjacent aquifers.
Australian Height Datum (AHD)	The reference point (very close to mean sea level) for all elevation measurements, and used for correlating depths of aquifers and water levels in bores.
Bore	A structure drilled below the surface to obtain water from an aquifer or series of aquifers.
Coal	A sedimentary rock derived from the compaction and consolidation of vegetation or swamp deposits to form a fossilised carbonaceous rock.
Coal seam	A layer of coal within a sedimentary rock sequence.
Coal seam gas (CSG)	Coal seam gas is a form of natural gas (predominantly methane) that is extracted from coal seams.
Concentration	The amount or mass of a substance present in a given volume or mass of sample, usually expressed as microgram per litre (water sample) or micrograms per kilogram (sediment sample).
Datalogger	A digital recording instrument that is inserted in monitoring and pumping bores to record pressure measurements and water level variations.
Discharge	The volume of water flowing in a stream or through an aquifer past a specific point in a given period of time.
Electrical conductivity (EC)	A measure of a fluid's ability to conduct an electrical current and is an estimation of the total ions dissolved. It is often used as a measure of water salinity.
Fracture	Breakage in a rock or mineral along a direction or directions that are not cleavage or fissility directions.
Groundwater	The water contained in interconnected pores or fractures located below the water table in the saturated zone.

Groundwater	
age classification	Groundwater ages are commonly referred to as:
	 Recent – direct connection to surface water (measured in days by, for example, ²²²Rn)
	 Modern – permeable alluvium or fractured shallow aquifers (years - tritium; recharge since 1952);
	 Sub-modern - permeable alluvium or fractured shallow aquifers (<1,000 years; ³²Si, ¹⁴C);
	 Old – palaeoclimate (1,000 to 50,000 years; ¹⁴C);
	 Very old - >50,000 to 1 million years (multiple methods including ³⁶Cl, ⁴He, ²³⁴U/²³⁸U);and
	Fossil - > 1 million years (¹²⁹ I).
Groundwater flow	The movement of water through openings in sediment and rock within the zone of saturation.
Groundwater system	A system that is hydrogeologically more similar than different in regard to geological province, hydraulic characteristics and water quality, and may consist of one or more geological formations.
Hydraulic conductivity	The rate at which water of a specified density and kinematic viscosity can move through a permeable medium (notionally equivalent to the permeability of an aquifer to fresh water).
Hydraulic gradient	The change in total hydraulic head with a change in distance in a given direction.
Hydraulic head	Is a specific measurement of water pressure above a datum. It is usually measured as a water surface elevation, expressed in units of length. In an aquifer, it can be calculated from the depth to water in a monitoring bore. The hydraulic head can be used to determine a hydraulic gradient between two or more points.
Hydrogeology	The study of the interrelationships of geologic materials and processes with water, especially groundwater.
Hydrology	The study of the occurrence, distribution, and chemistry of all surface waters.
Lithology	The study of rocks and their depositional or formational environment on a large specimen or outcrop scale.
Micro Siemens per centimetre (µS/cm)	A measure of water salinity commonly referred to as EC (see also Electrical Conductivity). Most commonly measured in the field with calibrated field meters.
Monitoring bore	A non-pumping bore, is generally of small diameter that is used to measure the elevation of the water table and/or water quality. Bores generally have a short well screen against a single aquifer through which water can enter.
Oxidation reduction potential (ORP)	The oxidation redox potential is a measure (in volts) of the affinity of a substance for electrons – its electronegativity – compared with hydrogen (which is set at 0). Substances more strongly electronegative than (i.e. capable of oxidising) hydrogen have positive redox potentials. Substances less electronegative than (i.e. capable of reducing) hydrogen have negative redox potentials. Also known as redox potential.
Permeability	The property or capacity of a porous rock, sediment, clay or soil to transmit a fluid. It is a measure of the relative ease of fluid flow under unequal pressure. The hydraulic conductivity is the permeability of a material for water at the prevailing temperature.

Permian	The last period of the Palaeozoic era that finished approximately 230 million years before present.
Piezometer	See monitoring bore.
Quaternary	The most recent geological period extending from approximately 2.5 million years ago to the present day.
Recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and by river water reaching the water table or exposed aquifers. The addition of water to an aquifer.
Recovery	The difference between the observed water level during the recovery period after cessation of pumping and the water level measured immediately before pumping stopped.
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS).
Salinity classification	Fresh water quality – water with a salinity <800 μ S/cm.
	Marginal water quality – water that is more saline than freshwater and generally waters between 800 and 1,600 $\mu\text{S/cm}.$
	Brackish quality – water that is more saline than freshwater and generally waters between 1,600 and 4,800 $\mu\text{S/cm}.$
	Slightly saline quality – water that is more saline than brackish water and generally waters with a salinity between 4,800 and 10,000 μ S/cm.
	Moderately saline quality – water that is more saline than slightly saline water and generally waters between 10,000 and 20,000 μ S/cm.
	Saline quality – water that is almost as saline as seawater and generally waters with a salinity greater than 20,000 $\mu\text{S/cm}.$
	Seawater quality – water that is generally around 55,000 μ S/cm.
Screen	A type of bore lining or casing of special construction, with apertures designed to permit the flow of water into a bore while preventing the entry of aquifer or filter pack material.
Sandstone	Sandstone is a sedimentary rock composed mainly of sand-sized minerals or rock grains (predominantly quartz).
Sedimentary rock aquifer	These occur in consolidated sediments such as porous sandstones and conglomerates, in which water is stored in the intergranular pores, and limestone, in which water is stored in solution cavities and joints. These aquifers are generally located in sedimentary basins that are continuous over large areas and may be tens or hundreds of metres thick. In terms of quantity, they contain the largest volumes of groundwater.
Shale	A laminated sedimentary rock in which the constituent particles are predominantly of clay size.
Siltstone	A fine-grained rock of sedimentary origin composed mainly of silt-sized particles (0.004 to 0.06 mm).
Standing water level (SWL)	The height to which groundwater rises in a bore after it is drilled and completed, and after a period of pumping when levels return to natural atmospheric or confined pressure levels.
Stratigraphy	The depositional order of sedimentary rocks in layers.

Surface water- groundwater interaction	This occurs in two ways: (1) streams gain water from groundwater through the streambed when the elevation of the water table adjacent to the streambed is greater than the water level in the stream; and (2) streams lose water to groundwater through streambeds when the elevation of the water table is lower than the water level in the stream.
Total dissolved solids (TDS)	A measure of the salinity of water, usually expressed in milligrams per litre (mg/L). See also EC.
Water bearing zone	Geological strata that are saturated with groundwater but not of sufficient permeability to be called an aquifer.
Water quality	Term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water quality data	Chemical, biological, and physical measurements or observations of the characteristics of surface and ground waters, atmospheric deposition, potable water, treated effluents, and waste water and of the immediate environment in which the water exists.
Water table	The top of an unconfined aquifer. It is at atmospheric pressure and indicates the level below which soil and rock are saturated with water.
Well	Pertaining to a gas exploration well or gas production well.
Siltstone	A fine-grained rock of sedimentary origin composed mainly of silt-sized particles (0.004 to 0.06 mm).

Abbreviations

AGL	AGL Upstream Investments Pty Ltd
ALS	Australian Laboratory Service
BoM	Bureau of Meteorology
BoP	Blowout preventer
BP	Before present
BTEX	Benzene, toluene, ethyl benzene and xylenes
CBL	Cement bond log
CEMP	Construction and Environment Management Plan
CDFM	Cumulative deviation from mean
CSG	Coal seam gas
DO	Dissolved oxygen
DRE	Division of Resources and Energy
EC	Electrical conductivity
GGP	Gloucester Gas Project
GFDA	Gas Field Development Area
GMWL	Global Meteoric Water Line
HESP	Health, Environment and Safety Plan
JSA	Job Safety Analysis
LOQ	Limit of Quantification
LOR	Limit of Reporting
MDA	Minimum Detectable Activity
MGA	Map Grid Australia
NOW	NSW Office of Water
NUDLC	National Uniform Drillers Licencing Committee
ORP	Oxidation reduction potential
РАН	Polycyclic aromatic hydrocarbons

PEL	Petroleum Exploration Licence
рМС	Percent modern carbon
PPE	Personal protective equipment
QA/QC	Quality assurance/quality control
SMP	Safety Management Plan
SWL	Standing water level
SWMS	Safe Work Methods Statements
TDS	Total dissolved solids
ТОС	Total organic carbon
ТРН	Total recoverable hydrocarbons
VPDB	Vienna Pee Dee Belemnite
VSMOW	Vienna Standard Mean Ocean Water
VOC	Volatile organic compound

Units

°C	degrees Celsius
L/s	litres per second
m	metres
mAHD	metres Australian Height Datum
mbgl	metres below ground level
mbtoc	metres below top of casing
m/d	metres per day
mm	millimetres
µS/cm	microSiemens per centimetre
mg/L	milligrams per litre
µg/L	micrograms per litre

Executive summary

On 4 February 2016, AGL Upstream Investments Pty Ltd (AGL) announced that the Gloucester Gas Project (GGP) will not proceed to final investment stage. AGL will relinquish Petroleum Exploration Licence (PEL) 285 to the NSW Government and will commence a comprehensive decommissioning and rehabilitation program for well sites and other infrastructure in the Gloucester region.

A comprehensive surface water and groundwater monitoring network comprising nested monitoring bores and stream gauges was established during the Phase 2 Groundwater Investigations (Parsons Brinckerhoff 2012). Subsequent and ongoing site investigations have continued to expand this network since January 2011.

This report details the drilling, completion, hydraulic testing and water quality analysis of the Wards River nested groundwater monitoring site, which is located south of the GGP Stage 1 Gas Field Development Area (GFDA) in the Karuah River catchment. The drilling program which commenced in November 2013, involved the establishment of one monitoring bore in the Quaternary alluvium (WRMB01A), two monitoring bores in the shallow sandstone of the Jilleon Formation (shallow rock) (WRMB01B and C) and one monitoring bore in the deep sandstone of the Jilleon Formation of the Gloucester Coal Measures (interburden) (WRMB01D). Following the completion of all bores, in situ pressure transducers (dataloggers) were installed, permeability testing performed and baseline groundwater quality testing undertaken.

The initial findings for groundwater levels at this Wards River site are:

- Groundwater levels in the alluvium show a minor response to rainfall events and otherwise have been relatively stable since the start of monitoring in January 2014.
- Groundwater levels in the shallow rock do not show strong responses to individual rainfall events, with a
 minor response observed at monitoring bore WRMB01C. Groundwater levels in WRMB01B showed
 slow recovery following airlifting due to the low permeability of the target formation, as measured during
 permeability testing.

The initial findings for groundwater quality at this Wards River site are:

- Groundwater in the alluvium is of marginal water quality and slightly acidic. Groundwater salinity in the shallow rock is brackish and slightly alkaline.
- Elevated concentrations of aluminium, barium, bromine, iron, strontium and zinc were detected in groundwater in the alluvium and the shallow rock. Higher levels of iron and zinc were detected in groundwater in the alluvium compared to the shallow rock.
- No phenolic compounds or polycyclic aromatic hydrocarbons were detected, however low levels of toluene and total petroleum hydrocarbons were detected in the shallow rock groundwater (WRMB01C only).
- Dissolved methane was detected in the alluvium and the shallow rock groundwater.
- Stable isotope data indicates that groundwater in all hydrogeological units is of meteoric origin. Tritium
 and radiocarbon data confirms the presence of modern water in the alluvium, and indicates groundwater
 in shallow rock and interburden is much older ranging between 16,000 and 38,000 years BP.
- Methane isotopes indicate that dissolved methane present in all hydrogeological units is thermogenic.

1. Introduction

1.1 Background

On 4 February 2016 AGL Upstream Investments Pty Ltd (AGL) announced that the Gloucester Gas Project (GGP) will not proceed to final investment stage. AGL will relinquish Petroleum Exploration Licence (PEL) 285 to the NSW Government and will commence a comprehensive decommissioning and rehabilitation program for coal seam gas (CSG) well sites and other infrastructure in the Gloucester region.

The GGP was to involve several stages of gas field development. A comprehensive groundwater investigation (*Phase 2 Groundwater Investigations*) was completed in early 2012 to inform the hydrogeological conceptual model across the GGP Stage 1 Gas Field Development Area (GFDA) (Parsons Brinckerhoff 2012). The Stage 1 GFDA in relation to the PEL 285 boundary is shown in Figure 1.1.The dedicated water monitoring network has allowed the collection of baseline water level, water quality and hydraulic conductivity data for the different groundwater and surface water systems. Since 2013, the water monitoring network has been extended beyond the Stage 1 GFDA to allow baseline assessment of groundwater systems in the wider Gloucester Basin.

There are now more than 50 dedicated water monitoring locations across the Gloucester Basin area, including four monitoring bores installed as part of this investigation.

This report presents the drilling, installation and initial testing of four monitoring bores at Wards River, to the south of the Stage 1 GFDA (Figure 1.2) between November 2013 and October 2015. Following the completion of the three shallow monitoring bores (WRMB01A-C), in situ pressure transducers (dataloggers) were installed, and permeability testing and baseline groundwater quality testing completed. Deep monitoring bore WRMB01D was perforated in November 2014; and permeability testing and baseline groundwater quality testing and baseline groundwater quality sampling was completed in September 2015 and October 2015 respectively. Water level monitoring commenced in September 2015.

1.2 Objectives

The objectives of the drilling program were to:

- expand the groundwater monitoring network across the Gloucester Basin to collect additional baseline groundwater quality and level data;
- assess the natural characteristics and variability of the local groundwater systems;
- and enhance the conceptual understanding of the groundwater systems, including groundwater flow and aquifer connectivity, across the broader Gloucester Basin.

1.3 Scope of works

The Wards River drilling program comprised of:

- establishment of one alluvial monitoring bore targeting the Wards River alluvium;
- establishment of two monitoring bores targeting the shallow sandstone of the Jilleon Formation;
- establishment of one monitoring bore targeting the deep sandstone of the Jilleon Formation;
- installation of in situ pressure transducers (dataloggers) at all monitoring bores;

- permeability testing (rising and falling head tests) at all monitoring bores;
- baseline groundwater quality testing including field parameters, major cations and anions, dissolved metals, nutrients, dissolved gases, hydrocarbons and isotopes;
- and a report outlining the drilling, installation and permeability testing of the monitoring bores and initial results of groundwater level and groundwater quality monitoring.



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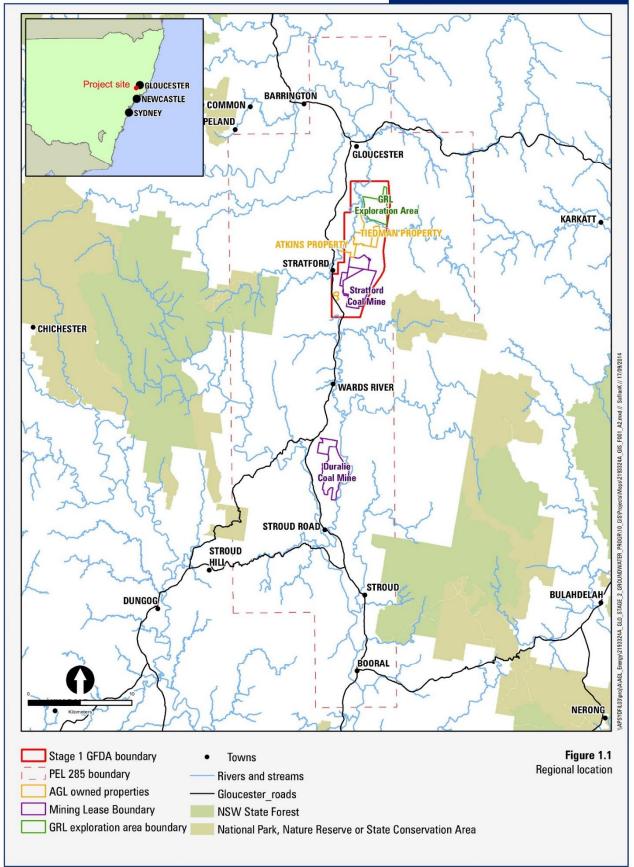


Figure 1.1 Regional location

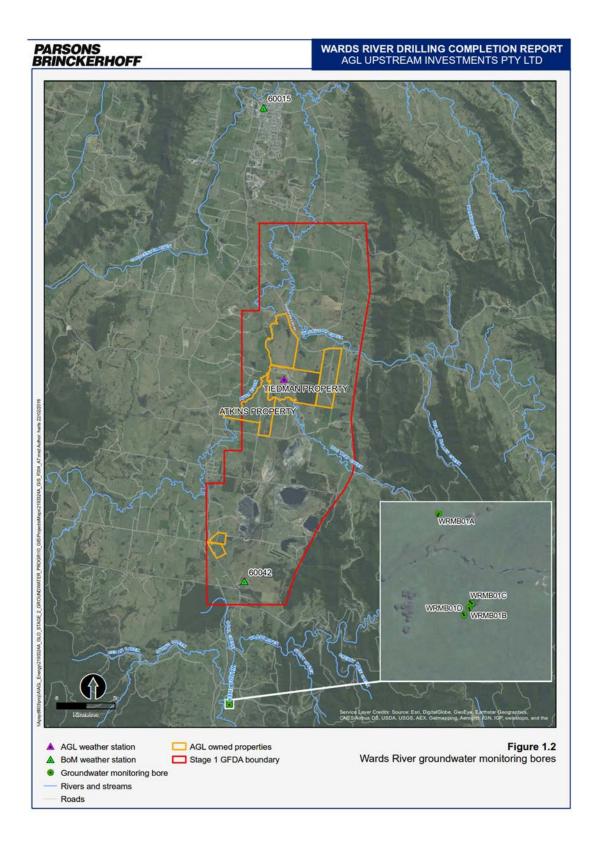


Figure 1.2 Wards River groundwater monitoring bores

2. Site characterisation

2.1 Site location

The Wards River site is located approximately 3 km north of the village of Wards River on privately owned land. The main monitoring site comprises the three deeper bores and is positioned off the floodplain to the east of Wards River while the alluvial site is approximately 200 m to the north-north-east on an alluvial terrace associated with the river. The main monitoring site is situated at an elevation of approximately 89.5 metres Australian Height Datum (mAHD), slopes gently to the west and is surrounded by gently undulating hills. The alluvial site has an elevation of 84.8 mAHD and is relatively flat.

The surrounding properties are primarily used for grazing. The Stratford Coal mine is located approximately 8 km to the north and the Duralie Coal Mine is located approximately 11 km to the south.

2.2 Rainfall

AGL has operated a weather station on the Tiedman property to the north of Wards River and within the Stage 1 GFDA since July 2011. The closest Bureau of Meteorology (BoM) weather station to the Wards River site is located at Craven (Longview – Stn 60042). However the BoM station with the longest period of record is at Gloucester Post Office (Stn 60015) (operational since 1888). The locations of the weather stations are shown in Figure 1.2.

Long-term average annual rainfall (1888 to 2015) at Gloucester Post Office is 980 mm. Rainfall is seasonal, with the highest mean monthly rainfall occurring in the summer months between January and March.

The long-term, annual cumulative deviation from mean (CDFM) rainfall for Gloucester Post Office is plotted in Figure 2.1. The long-term cumulative rainfall residual plots are formulated by subtracting the average annual rainfall for the recorded period from the actual annual rainfall and then accumulating these residuals over the assessment period. Periods of below average rainfall are represented as downward trending slopes while periods of above average rainfall are represented as upward trending slopes.

Rainfall data from the AGL weather station for the period July 2011 (installation) to December 2015 are presented in Figure 2.1. Since the Wards River monitoring bores have been installed there have been three significant rainfall events (September 2014, December 2014 and June 2015). Total annual rainfall in 2015 was 1,113 mm which is slightly above the long-term annual average for Gloucester (980 mm).

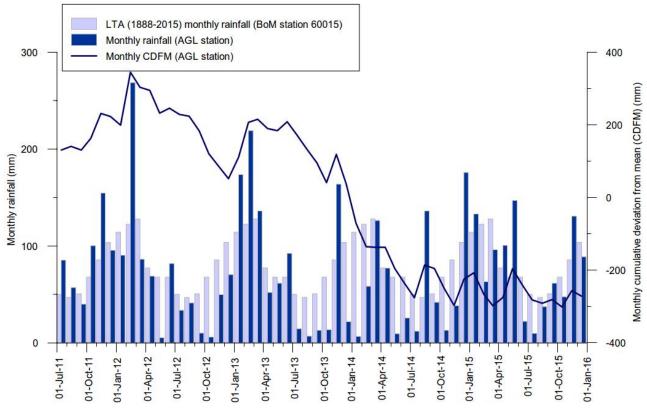


Figure 2.1 Monthly rainfall and cumulative deviation from the monthly mean (CDFM) rainfall at the AGL Gloucester station since installation in July 2011 (AGL 2015a)

2.3 Surface hydrology

The Gloucester Basin is a narrow, north-south trending, elongated basin approximately 40 km long and 10 km wide, extending from Gloucester in the north to Stroud in the south. The Gloucester Basin is located high in the Manning River and Karuah River coastal catchments. The area occupied by the Permian Coal Measures (about 217 km²) is small in comparison to the size of these catchments.

The Wards River investigation site is located in the Wards River catchment of the much larger Karuah River catchment.

There is a surface water divide between the Wards River catchment and the Avon River catchment (part of the Manning River catchment). In the northern Manning River catchment, surface water flow is generally to the north. In the southern Karuah River catchment, surface water flow is generally to the south.

The Avon River flows to the north, and includes the tributaries of Dog Trap Creek and Waukivory Creek within the Stage 1 GFDA. The Gloucester River joins the Avon River at the north of the Gloucester Basin. Wards River flows to the south, and is outside of the Stage 1 GFDA (Figure 1.2).

2.4 Geological setting

The Gloucester Basin represents a complex geological system formed by the interplay of extensional tectonic faulting and high rates of sedimentation. The Basin stratigraphy comprises a thick succession of Permian sedimentary rocks representing deposition in both terrestrial and marine environments during a complex period of subsidence, uplift and relative sea level change (marine transgression and regression).

The Basin is a synclinal intermontane structure formed in part of the New England Fold Belt between a major Permian plate margin and the Sydney-Gunnedah Basin (Lennox 2009). The north – south trending synclinal nature of the Gloucester Basin resulted from the collision between the East Australian and Pacific Plates.

Following a period of extension during the Early Permian the Gloucester Basin has undergone periods of normal and reverse faulting, with large scale tilting associated with late stage compressional movements towards the end of the Permian (Hughes 1984). Reverse faults dominate present day structure. A comparison with the contemporary horizontal stress field map (Hillis *et al* 1998) indicates the Basin is likely to be under compression in an east-west orientation.

The stratigraphy dips steeply (up to 90°) on the flanks of the Basin, dipping towards the north-south trending synclinal basin axis and flattening toward the centre of the Basin. Early Permian and Carboniferous hard resistive volcanics form the ridgelines of the Basin: the Mograni Range to the east; and the Gloucester and Barrington Tops to the west.

Overlying the Permian stratigraphy is a thin sequence of surficial Quaternary sedimentary deposits and regolith. The Quaternary sediments are non-uniform in thickness, and comprise unconsolidated alluvial sediments (sand, gravel, silt and clay) along the drainage channels and colluvial deposits across the rest of the plain sourced from the surrounding outcropping Permian deposits.

The Gloucester Basin is divided into three major Permian stratigraphic units each representing a distinct depositional setting: the Gloucester Coal Measures, the Dewrang Group, and the Alum Mountain Volcanics. The generalised stratigraphy of the basin is summarised in Table 2.1. A geological map of the basin is shown in Figure 2.2. AGL's previously proposed Stage 1 GFDA was to target the intermediate and deep coal seams in the Gloucester Coal Measures generally below depths of 250 m to around 1,000 m.

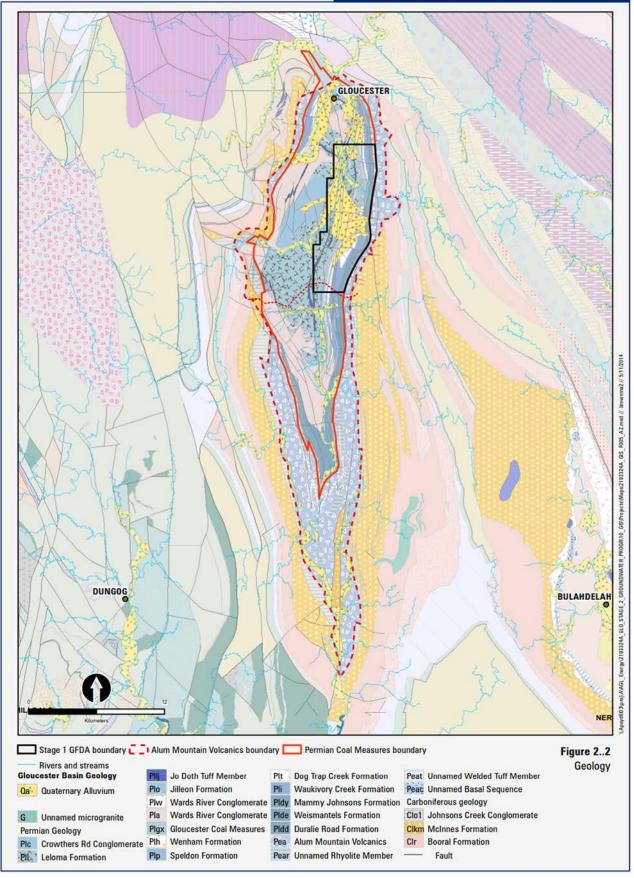
Table 2.1 Stratigraphy of the Gloucester Basin

Period	Group	Sub- group	Formation	Approx. thickness (m)	Coal seam	Depositional environment	Tectonic events
		Craven	Crowthers Road Conglomerate	350		Marine regression,	Uplift to west of
		Leloma	Leloma	585	Linden	pro-gradation of alluvial fans	Gloucester Basin
					JD	-	
				Bindaboo	-		
					Deards	-	
			Jilleon	175	Cloverdale		
	es			Roseville Tereel/Fairbairns	Roseville	-	
	asui				-		
	Me Me		Wards River Conglomerate	Variable			
an	Coal		Wenham	23.9	Bowens Road		
Upper Permian	Upper Permian Gloucester Coal Measures				Bowens Road Lower	_	
bbei	louc	Speldon For	mation				Extension (normal
	Ū	Avon Dog Tra	Dog Trap Creek	126	Glenview	but also some progradation of alluvial fans in the west related to uplift	fault development) and regional subsidence. Uplift to west of Basin
			Waukivory Creek	326	Avon		
					Triple		
					Rombo		
	Glen Road	Glen Road	-				
					Valley View	-	
					Parkers Road	-	
	bu	Mammy Joh	nsons	300	Mammy Johnsons	Marine transgression, regression and further marine transgression	Extension (normal
	Dewrang	Weismantel		20	Weismantel		fault development) and regional
	De	Duralie Roa	d	250			subsidence
au	G Alum Mountain Volcanics			Clareval	Arc-related rift	Rift?	
Lower Permian					Basal		

(1) Modified from AECOM (2009) and SRK (2005).

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2.5 Hydrogeological setting

Four broad hydrogeological units have been identified within the Gloucester Basin (Table 2.2). The permeability and groundwater flow characteristics of rocks within the Gloucester Basin are controlled by several factors including lithology, depth and the degree of fracturing and faulting. In this sense hydrogeological units and flow systems do not always correspond with defined geological boundaries.

Unit	Aquifer type	Formation name	General lithology	Hydraulic characteristics
Alluvium	Semi-confined, clay capped, porous, granular	Quaternary alluvium	Clay/mixed gravels	Heterogeneous, highly variable permeability associated with varying lithology
Shallow Rock (<150 m)	Semi-confined, fractured rock	Upper Permian Coal Measures, Alum Mountain Volcanics	Interbedded sandstone/siltstone with bedding plane fractures	Heterogeneous, high and low permeability domains associated with fault zones and fracturing
Interburden	Confined, fractured rock	Upper Permian Coal Measures	Interbedded indurated sandstone/siltstone and claystone	Low permeability associated with sparse fractures, permeability decreases with depth
Coal Seams	Confined, fractured rock	Upper Permian Coal Measures	Coal/shale	Low permeability associated with cleating and fractures in coal seams, permeability decreases with depth

Table 2.2	Four hydrogeological units – Gloucester Basin
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The four hydrogeological units are summarised as follows:

- 1. Alluvial deposits adjacent to major creeks and rivers comprising unconsolidated sand, gravel and clay. The deposits are typically 12–15 m thick. These systems are heterogeneous but generally permeable aquifers with rapid recharge, through-flow and discharge associated with interactions with streams, and to a lesser extent with the underlying less permeable shallow rock. Hydraulic conductivity measurements range from 0.3 m/d to 300 m/d, averaging around 10 m/d.
- 2. Shallow fractured rock comprising variably weathered and fractured Permian rocks extending to approximately 150 m below the surface, across all sub-cropping Permian units. The shallow rock zone is heterogeneous with relatively impermeable domains separated by more permeable domains, but on the whole it is more permeable than the deeper coal measures. The domains of higher permeability are due to a higher density of fracturing associated with an irregular weathering profile and the near-surface expression of faulting. Water bearing zones (minor aquifers) observed during drilling occur within 75 m of surface. Groundwater flow within this zone is more strongly controlled by weathering and fracturing than the attitude of geological strata. Hydraulic conductivity of the shallow rock ranges from 10 m/d to 1x10⁻⁶ m/d at a depth of 150 m, but is typically in the order of 10⁻³ m/d to 10⁻⁴ m/d.
- 3. **Deep Coal Measures interburden**. Sandstone and siltstone units that form the interburden to coal seams are indurated and typically of very low permeability, forming aquitards and confining layers. The permeability of the interburden decreases with depth such that, at the maximum depth of CSG production, it is likely to be in the order of 10⁻⁵ m/d to 10⁻⁷ m/d, or less.
- 4. Deep coal seams. Coal seams tend to be slightly more permeable than interburden and commonly form weak water bearing zones. Permeability and storage are provided by small fractures and cleats in the coal. As with interburden, drill-stem tests clearly show that the permeability of coal seams generally decreases with depth. At the maximum depth of CSG production, the permeability of coal seams is very low (10⁻⁴ m/d-10⁻⁶ m/d), but may be an order of magnitude higher than the interburden.

The Alum Mountain Volcanics underlie the Permian Coal Measures, and form the impermeable base of the Gloucester Basin. The Alum Mountain Volcanics outcrop in the eastern and western boundaries of the basin, forming the elevated topography of the Gloucester and Barrington Tops to the west, and the Mograni Range to the east.

3. Bore installation and field testing

Parsons Brinckerhoff was the Principal Contractor for the site investigation program for all phases bar the perforation program and provided all project management services, including the management of subcontractors. A drilling specification and program was developed for the site (Parsons Brinckerhoff 2013a).

Parsons Brinckerhoff supplied all the required technical services including geological, hydrogeological and surveying services, while AGL engaged Vause Wireline Australia Pty Ltd directly for the perforation phase. The subcontractors engaged to complete the site investigation program were:

- Highland Drilling Pty Ltd (drilling and bore completions)
- Groundsearch Australia Pty Ltd (geophysical logging)
- Vause Wireline Australia Pty Ltd (borehole perforation of deep monitoring bore)
- Water N Tipper Hire Pty Ltd (fresh water deliveries)
- Mid Coast Liquid Waste Pty Ltd (offsite water and mud disposal)
- CalCo Surveyors Pty Ltd (surveying services)

3.1 Health, safety and environment

Onsite health, safety and environment aspects were managed through a health, environment and safety plan (HESP) (Parsons Brinckerhoff 2013b), construction and environment management plan (CEMP) (Parsons Brinckerhoff 2013c) and safety management plan (SMP) (Parsons Brinckerhoff 2013e); these documents were prepared in advance of the drilling program and were reviewed and approved by AGL's safety team. Highland Drilling provided safe working methods statements (SWMS) (Highland Drilling 2013a) and job safety analyses (JSA) (Highland Drilling 2013b) covering works relating to the drilling and construction of the boreholes, these documents were also reviewed and approved by AGL.

Highland Drilling and Parsons Brinckerhoff staff as well as any site visitors were required to undergo a site induction during which they were given an overview of the commitments included in the HESP, SMP and CEMP and how these applied to their specific duties.

3.1.1.1 Health, environment and safety plan

Parsons Brinckerhoff developed a comprehensive site specific HESP for the supervision of drilling work and groundwater monitoring activities at the Gloucester sites. This plan detailed the field tasks and the associated risk, and introduced mitigation measures to manage and reduce the risks. Measures included task elimination, substitution and implementation of controls, training and use of personal protective equipment (PPE).

3.1.1.2 Safety management plan

The installation of the monitoring bores was conducted in accordance with the SMP which was developed by Parsons Brinckerhoff in collaboration with Highland Drilling and approved by AGL (Parsons Brinckerhoff 2012c). The SMP should be read in conjunction with the following AGL and Highland Drilling documents which together cover the health, safety and environmental working procedures for AGL's GGP:

- Gloucester Gas Project Health and Safety Management Plan (AGL 2013a)
- Gloucester Gas Project Emergency Response Procedure (AGL 2013b)
- Upstream Gas Golden Rules (AGL 2010)
- Standard Work Method Statement Gloucester drilling task (Highland Drilling 2013a)
- Job Safety Analysis Gloucester drilling (Highland Drilling 2013b)

All fieldwork undertaken at the Wards River site was covered under the aforementioned documents, including exploratory drilling and subsequent testing, and groundwater monitoring and sampling. These documents aim to maintain the health, safety and welfare of Parsons Brinckerhoff employees and subcontractors through systematically identifying and documenting hazards, and assessing and controlling the associated risks.

Prior to the commencement of the field program, a desktop risk assessment for the drilling and construction of each borehole was undertaken, as per the requirements of the SMP. Taking into consideration the borehole depth and the likely strata to be encountered (i.e. faults and/or producing coal seams), the bores were assessed to be high, medium or low risk. The risk rating determines the construction method and level of well control required i.e. the practices used to prevent and/or manage the influx of formation fluids/gas in the borehole (blowouts) and this is often via the use of a Blowout Preventer (BoP) and appropriately weighted drill muds.

3.1.1.3 Construction and environment management plan

All site operations were undertaken in accordance with the environmental management systems as detailed in the site specific construction and environment management plan (CEMP).

A detailed water management plan was a critical part of the CEMP detailing the stringent measures implemented to ensure compliance to zero discharge of produced (drilling) waters to adjacent land and surface water receivers. The water management plan stated that for:

- bores drilled with air rotary:
 - All water utilised during the drilling process was supplied by AGL through Water N Tipper Hire Pty Ltd.
 - All groundwater produced during the drilling operations was contained in above ground storage tanks. If the capacity of the tanks reached 80%, work on that bore ceased until excess water in the tanks could be emptied.
 - All cuttings produced during drilling were contained in above ground tanks and were dried and used for internal farm track maintenance.
 - All groundwater produced during the drilling was collected by Mid Coast Liquid Waste Pty Ltd and transported to AGL's Tiedman property for storage.
- bores drilled with mud rotary:
 - All drill muds were contained in a designated mud tank that was bunded using heavy duty PVC matting. The mud pump was also bunded using black plastic.
 - All drill cuttings were contained in a designated cuttings tank, which was collected at the end of the drilling program and transported to a treatment facility, no records of the contractors used were kept.

Runoff waters from rainfall events were diverted from the drilling pad areas by the construction of diversion bunds on the upgradient side of the site. Water from the drill pads and any constructed access tracks was diverted away by sand bag bunds, silt fencing and other control structures so as to direct water onto adjacent grassed areas and not erode the drill pads and track areas.

3.1.1.4 Wellsite Permit to Work System

The internationally recognised Wellsite Permit to Work System (www.wellsite.org.au) was utilised in the GGP groundwater drilling program. The system provides the means to manage field safety aspects in a systematic, formalised and auditable manner. As a standardised work planning mechanism, the Permit to Work System was used for all non-routine tasks where a health and safety plan did not exist (including hot works), thus forcing the individual to undertake a documented work plan and assessment of the risks.

3.2 Drilling and installation

The drilling and installation of the bores was undertaken by Highland Drilling, using a rotary drilling rig under the supervision of a Parsons Brinckerhoff hydrogeologist. The target depth of the boreholes was confirmed by the supervising Parsons Brinckerhoff hydrogeologist.

The alluvial (WRMB01A) and shallow rock (WRMB01B and WRMB01C) monitoring bores were drilled in November and December 2013. The deeper monitoring bore (WRMB01D), installed in the interburden unit, was completed in June 2014 (although the perforating was not completed until November 2014). AGL submitted a Category 1 notification together with the required Site Disturbance Notices to the Division of Resources and Energy (DRE) under the reconnaissance drilling program requirements of PEL 285. A test (monitoring bore) licence under the Water Act 1912 was obtained by AGL prior to the monitoring bore drilling program (Table 3.1). The bore licence and Form As are included in Appendix A and the geological bore logs are included in Appendix B.

NOW Licence no.	No. of bores	Local bore ID	Site location (property)	Lot	DP	Bore type
20BL173575	4	WRMB01A	Wards River	2	1128605	Monitoring
		WRMB01B				
		WRMB01C				
		WRMB01D				

Table 3.1 Monitoring bore licence

The drilling and completion of the groundwater monitoring bores was carried out in accordance with the NSW Office of Water (NOW) bore licence conditions and followed a detailed design and specification compliant with the National Uniform Drillers Licencing Committee (NUDLC) 2012, Minimum Construction Requirements for Water Bores in Australia, Edition 3.

The Wards River monitoring bores were drilled using two methods, air rotary and mud rotary. The predominant bit used in the bores drilled with air rotary was down hole hammer (WRMB01A, WRMB01B and WRMB01C). Due to the depth and possible intersection of a coal seam, WRMB01D was assessed as being high risk and was therefore drilled with a polycrystalline diamond PCD bit with muds and the use of BoP.

A detailed geological log of the lithology recorded at 1 m intervals was produced, and instantaneous water flow recorded at the end of each drill rod (every 6 m) where applicable. Water quality field parameters were measured (using a calibrated YSI water quality meter) including temperature, electrical conductivity (EC), pH, dissolved oxygen (DO), total dissolved solids (TDS) and oxidation reduction potential (ORP). These parameters are shown on the geological bore logs in Appendix B.

Airlift development was continuous during drilling and the air rotary boreholes were further developed at termination until the discharge water was free of sediment and the water quality field parameters stabilised.

The screened section of each monitoring bore targeted the most productive water bearing zone. A washed and graded (3 mm - 5 mm) gravel filter pack was installed in the annulus around the screen and extended 0.5 m - 5 m above the screened section in the three uppermost bores.

Coated bentonite pellets were installed 2 m - 4 m above the gravel pack. A cement grout mix was then tremmied in a controlled manner to the surface of the shallow monitoring bores. The bentonite seal and cement grout ensure hydraulic isolation of the screened section preventing any ingress of surface water or groundwater through the annulus of the bore column. Following the construction of each bore, the site was reinstated and a lockable steel monument welded over the bores and surrounded at its base by a concrete slab.

Monitoring bore WRMB01D was not able to be air lifted (nor was it required) due to the drilling method, pressure cementing and its final completion. The bore was constructed using threaded API certified steel casing and pressure cemented with 14 pounds per gallon cement grout slurry. The bore was subsequently perforated in November 2014. Further information on the perforating program is provided in Section 3.3.

All bores were surveyed by CalCo Surveyors to Map Grid Australia (MGA), a grid coordinate system based on the Universal Transverse Mercator projection and the Geocentric Datum of Australia 1994. The bores were also surveyed for surface elevation to mAHD.

Bore construction details and initial manual standing water levels (SWLs) following bore installation are presented in Table 3.2.

Table 3.2 Bore construction details

	WRMB01A	WRMB01B	WRMB01C	WRMB01D
Easting	400527	400580	400585	400571
Northing	6438013	6437851	6437859	6437838
Ground level elevation (mAHD)	84.83	89.49	89.41	89.48
Top of casing (mAHD)	85.38	90.04	89.99	90.10
Total depth (mbgl)	8.12	56.40	126.46	199.0
Bore diameter (mm)	140	140	140	127
Predominant drill bit	Down hole hammer	Down hole hammer	Down hole hammer	Polycrystalline diamond
Depth of 6" casing	2.0	11.5	11.5	30.0
Construction details	50 mm uPVC casing and screen	50 mm uPVC casing and screen	50 mm uPVC casing and screen	60 mm (ID)/ 75 mm (OD) flush threaded steel casing
Screened interval (mbgl)	4.5 - 7.0	48.4 - 54.4	111.5 – 123.5	178.0 – 184.0
Screened interval (mAHD)	80.83 - 77.83	41.01 – 35.09	-22.0434.04	-85.5294.52
Screened formation	Alluvium	Jilleon Formation	Jilleon Formation	Jilleon Formation
Hydrogeological unit	Alluvium	Shallow rock	Shallow rock	Interburden
Lithology	Alluvium	Sandstone	Sandstone	Sandstone
Inflow (L/s)	<0.1	<0.1	0.4	N/A
Peak inflow depth (mbgl)	4.5 - 8.12	33.0 - 56.4	108 – 120	N/A
Initial SWL (mbtoc)	3.98	7.2	5.77	6.28

Note: mAHD – metres Australian Height Datum (AHD); mbgl – metres below ground level; mbtoc – metres below top of casing; SWL – standing water level; Not applicable – data not available due to drilling method.

3.3 Perforating program

On completion of the drilling operations at WRMB01D, the pressure cemented steel casing was perforated to allow water to enter and establish connectivity with the target formation.

The first task of the perforating program was to run a cement bond log (CBL) to assess the effectiveness of the pressure cementing around the steel casing. The casing must be fully cemented in place with the annulus fully sealed to surface before any perforating can take place. The CBL for WRMB01D proved an effective cement seal and confirmed the depth of cased bore to 199 mbgl.

The perforating was undertaken by Vause Wireline Australia Pty Ltd in November 2014 using a scalloped gun system (43 mm diameter firing 6 shots per foot (over a length of 9 m) at a phase spacing of 60⁰) run from a gauged wireline to ensure the correct depth is targeted.

Geophysical logging was previously carried out by Groundsearch Australia Pty Ltd in June 2014 after the bore was drilled to total depth but prior to the installation and pressure cementing of casing. The 9239 suite of logs (gamma, resistivity, calliper and density) was used to define the exact location of the high permeability sandstone interburden horizon immediately above the Fairbairns coal seam.

3.4 Field testing

3.4.1 Permeability testing

Falling and rising head ('slug') tests were conducted at the monitoring bores (except WKMB01D) in October 2014 to estimate the horizontal hydraulic conductivity of the screened water bearing zones. Testing of WRMB01D was completed in September 2015 after a failed attempt at testing in February 2015.

Slug tests are simple field procedures designed to calculate the approximate hydraulic conductivity of water bearing formations adjacent to monitoring bore screens. A falling head test is achieved by introducing a 'slug' to displace the water column within the monitoring bore causing the water level to instantaneously rise and flow from the bore into the aquifer via the well screen (Waterra 2011). A rising head test is the opposite, where a volume of water is instantaneously removed from the monitoring bore, causing the water level to fall, drawing water into the bore from the aquifer. Forcing the water out of the monitoring bore and into the formation sometimes produces slightly different results and therefore by comparing the results for each test a degree of confidence in the accuracy of the test can be achieved. The slug consists of a solid 1.5 inch PVC bar (1.6 m long) used to displace 1 m of water in the groundwater monitoring bores.

At the commencement of the testing, the standing water level (SWL) was measured from a fixed reference point at the top of casing and the datalogger programmed between 0.125 to 5 second intervals to measure the groundwater level changes.

3.4.2 Groundwater level measurements

Following the completion of each monitoring bore, *in situ* pressure transducers (dataloggers) were suspended from a galvanised steel wire in the water column and programmed to record a SWL measurement every six hours. To verify the level recorded by the dataloggers, manual measurements are recorded quarterly using an electronic dip meter. There was an obstruction in WRMB01D after the initial (failed) permeability testing of this monitoring bore that prevented the immediate installation of a datalogger and water sampling. Highland Drilling returned to the site to push the obstruction to the base of the monitoring bore in August 2015 (AGL, 2015b). The installation of the datalogger was not completed until September 2015.

A barometric logger installed above the water table at monitoring bore S5MB01 on AGL's Tiedman property (part of the original Stage 1 groundwater monitoring network) records changes in atmospheric pressure. Data from this logger is used to correct for the effects of changing barometric pressure on groundwater levels.

3.4.3 Groundwater quality sampling

Groundwater quality sampling was undertaken between 4 and 17 September 2014 at WRMB01A, WRMB01B and WRMB01C, and on 9 October 2015 at WRMB01D.

3.4.3.1 Sampling techniques

A Grundfos submersible pump was used to purge and obtain groundwater quality samples from monitoring bores WRMB01A, WRMB01B and WRMB01C. A minimum of three well volumes was purged from the monitoring bores prior to sampling to allow collection of representative groundwater samples (unless purged dry). Monitoring bore WRMB01B was purged dry and the bore was allowed to recharge before it was sampled 14 days later with a double check valve stainless steel bailer.

WRMB01D was sampled using a micro-purge[™] low flow sampling pump. The micro-purge[™] system allows groundwater to be drawn into the pump intake directly from the screened portion of the aquifer, eliminating the need to purge relatively large volumes of groundwater from these bores.

3.4.3.2 Analytical suite

Field parameters (Table 3.3) were measured during and following purging using a calibrated hand held water quality meter to ensure a representative groundwater sample was collected.

Groundwater samples collected in the field were analysed for a broad chemical suite designed specifically to assess the chemical characteristics of the different water bearing zones at the monitoring sites. Table 3.3 details the groundwater analytical suite. Samples undergoing dissolved metal analysis were filtered through 0.45 μ m filters in the field prior to collection.

Category	Parameters	
Field parameters	EC Temperature DO	pH ORP TDS
General parameters (lab)	EC Total suspended solids	TDS (measured) pH
Major ions	Calcium Magnesium Sodium Potassium Silica	Chloride Bicarbonate Carbonate Sulphate Fluoride
Metals and minor/trace elements	Aluminium Antimony Arsenic Barium Beryllium Boron Bromine Cadmium Chromium Cobalt Copper Iron	Lead Manganese Mercury Molybdenum Nickel Selenium Strontium Tin Uranium Vanadium Zinc
Nutrients	Ammonia Phosphorus (total) Phosphorus (reactive) Total nitrogen	Nitrite Nitrate Total organic carbon (TOC) Total Kjeldahl Nitrogen
Hydrocarbons	Phenol compounds Polycyclic aromatic hydrocarbons (PAH) Oil and grease	Total petroleum hydrocarbons (TPH) Benzene, toluene, ethyl benzene and xylenes (BTEX) Volatile organic compounds (VOC's)
Dissolved gases	Methane Ethene Ethane Propene	Propane Butene Butane

 Table 3.3
 Groundwater analytical suite

Category	Parameters	
Isotopes	Oxygen-18 (¹⁸ O) Deuterium (² H) Radiocarbon (¹⁴ C) Tritium (³ H)	Carbon-13 dissolved organic carbon (¹³ C _{DIC}) Carbon-13 methane (¹³ C-CH ₄) and deuterium methane (² H-CH ₄)

The samples were sent to the following laboratories under appropriate chain-of-custody protocols:

- Australian Laboratory Service (ALS) Environmental Pty Ltd, Smithfield, Sydney chemistry analysis. NATA certified laboratory.
- GNS Stable Isotope Laboratory, Lower Hutt, New Zealand oxygen-18 and deuterium analysis.
- Rafter Radiocarbon Laboratory, Lower Hutt, New Zealand carbon-14 analysis.
- GNS Tritium and Water Dating Laboratory, Lower Hutt, New Zealand tritium.
- UC Davis Stable Isotope Facility, Davis, California, USA carbon-13 (¹³C_{DIC}) and methane isotope analysis (¹³C-CH₄ and ²H-CH₄).

3.4.3.3 Quality assurance and quality control

Data collection and data handling QA/QC

The quality assurance (QA) procedures during sampling and the quality control (QC) procedures during data handling are detailed in the Parsons Brinckerhoff sampling procedures (Parsons Brinckerhoff 2015). All sampling was undertaken in accordance with the Australia//New Zealand standards for water quality sampling (AS/NZS 5667).

Laboratory QA/QC

The laboratories conduct their own internal QA/QC program to assess the accuracy and precision of the analysis and reporting procedures. These programs include analysis of laboratory sample duplicates, spike samples, certified reference standards, surrogate standards/spikes and laboratory blanks.

4. Results

4.1 Permeability testing

Test data were processed and analysed using the Bouwer and Rice (Bouwer 1989), or Hvorslev (1951) method with AQTESOLV Version 4.5. Results are presented as estimates of hydraulic conductivity (as m/day) in Table 4.1. The AQTESOLV reports are included in Appendix C.

The hydraulic conductivity values for WRMB01A (alluvium), WRMB01C (shallow rock) and WRMB01D (interburden) are consistent with previous hydraulic conductivity values within the Gloucester Basin (Parsons Brinckerhoff 2014a). The result for WRMB01B is an estimate only as the hydraulic response in the bore was too slow to be effectively analysed by AQTESOLV.

	WRMB01A	WRMB01B	WRMB01C	WRMB01D
Number of slug tests	2	1	1	2
Hydraulic conductivity range (m/d)	22 - 23 <0.0001		0.007	0.0003 - 0.0001
Mean hydraulic conductivity range (m/d)	22.5	<0.0001	0.007	0.0002
Screened formation	Alluvium	Jilleon Formation	Jilleon Formation	Jilleon Formation
Hydrogeological unit	Alluvium	Shallow rock	Shallow rock	Interburden
Lithology	Alluvial gravel	Sandstone	Sandstone	Sandstone

Table 4.1 Hydraulic conductivity results from slug tests

Note: m/d - metres per day.

Analysis conducted with the Hvorselv method except for WRMB01C where the Bouwer and Rice method was applied.

4.2 Groundwater levels

A hydrograph showing groundwater levels for the Wards River monitoring bores and rainfall from the start of monitoring until October 2015 is presented in Figure 4.1. The individual hydrographs for the Wards River monitoring bores are available in Appendix D. The data suggests there is an upward hydraulic gradient within the rock strata at this site.

The groundwater level in the alluvium (WRMB01A) shows an increase (~1.0 m) in response to large rainfall events (August 2014, December 2014, April 2015 and May 2015). The groundwater level returns to antecedent groundwater level over a period of one to two months.

Groundwater levels in the shallow rock (WRMB01B and WRMB01C) show a minimal response to rainfall recharge since monitoring commenced, with a stronger response visible at WRMB01C. Groundwater levels have been relatively stable since the start of monitoring, however monitoring bore WRMB01B showed slow recovery following airlift development during drilling, indicative of very low permeability. This is supported by the hydraulic conductivity results following permeability testing (Section 4.1).

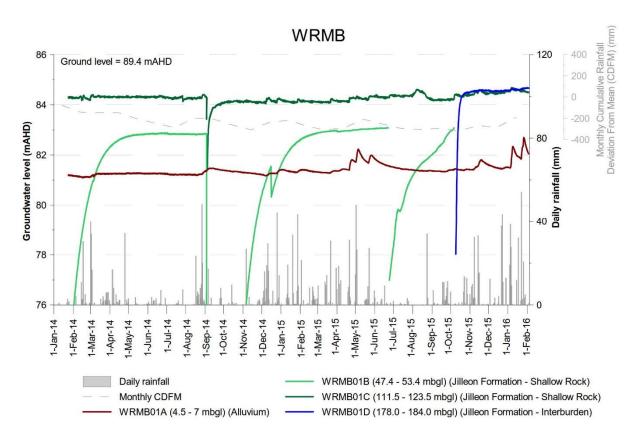


Figure 4.1 Groundwater levels and rainfall at the Wards River monitoring bores

4.3 Groundwater quality

Groundwater quality sampling was undertaken between 4 and 17 September 2014 at WRMB01A, WRMB01B and WRMB01C and on 9 October 2015 at WRMB01D. Full water quality results are presented in Appendix E and laboratory reports are presented in Appendix F.

4.3.1 Physico-chemical parameters

Groundwater in the alluvium (WRMB01A) is of marginal water quality (1,410 μ S/cm) and slightly acidic (pH 6.40).

Groundwater salinity (EC) in the shallow rock bores WRMB01B and WRMB01C is brackish (3,040 μ S/cm and 3,450 μ S/cm respectively) and slightly alkaline (pH 7.80 and 7.91 respectively).

Groundwater salinity in the interburden (WRMB01D) is brackish (2,900 µS/cm) and alkaline (pH 9.02).

Redox conditions are typically reducing in all hydrogeological units, with the exception of the shallow rock at WRMB01B.

4.3.2 Major ions

The major ion characteristics of groundwater samples are shown in the piper diagram in Figure 4.2. A piper diagram is a graphical representation of the relative concentrations of major ions (Ca²⁺, Mg²⁺, Na⁺, K⁺, Cl⁻, HCO₃⁻⁺CO₃²⁻ and SO₄²⁻). Groundwater in the alluvium is dominated by sodium, calcium, chloride and bicarbonate, and groundwater in the shallow rock and interburden is dominated by sodium, chloride and bicarbonate.

The change in water quality with depth is visible on the piper diagram as sodium and bicarbonate become increasingly more dominant with increasing depth. Chloride is more dominant in the alluvium.

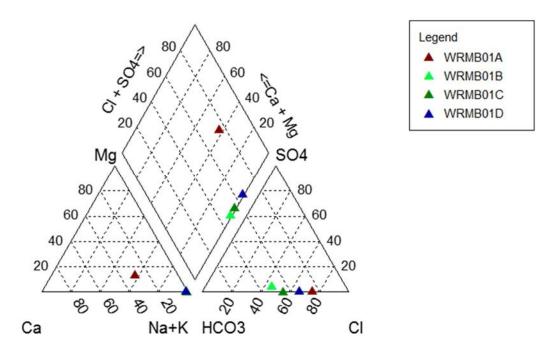


Figure 4.2 Piper diagram for the Wards River monitoring bores

4.3.3 Dissolved metals

Concentrations of detected dissolved metals in groundwater are presented in Figure 4.3. The major findings for dissolved metals are as follows:

- Concentrations of dissolved metals are generally similar in the alluvium, and shallow rock, with the
 exception of iron concentrations which are higher in the alluvium compared to the other
 hydrogeological units.
- Concentrations of dissolved metals are typically lower in the interburden than the alluvium and shallow bedrock with the exception of copper.
- Aluminium, barium, bromine, iron, strontium and zinc are detected at slightly elevated concentrations compared to other dissolved metals.
- Boron, cadmium and uranium were only detected at shallow rock monitoring bore WKMB01B.
 Molybdenum was only detected at monitoring bores WKMB01B and WKMB01D.

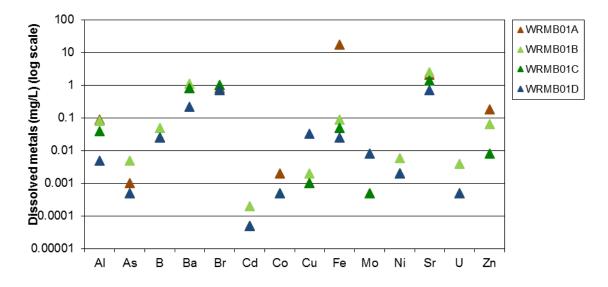


Figure 4.3 Detected dissolved metal concentrations in groundwater for Wards River monitoring bores

4.3.4 Nutrients

The major findings for nutrients are as follows:

- Ammonia concentrations ranged from 0.65 mg/L in the alluvium (WRMB01A) to 1.4 mg/L in the interburden at WRMB01D.
- Nitrate concentrations ranged from below the laboratory LOR (<0.01 mg/L) at WRMB01B and WRMB01D to 0.09 mg/L at WRMB01C.
- Nitrite concentrations were below the laboratory LOR (<0.01 mg/L) at all monitoring bores, with the exception of WRMB01B (0.07 mg/L).
- TOC concentrations ranged from 1 mg/L at WRMB01C to 10 mg/L at WRMB01D.
- Total phosphorus concentrations decreased with depth from 0.25 mg/L at WRMB01A to 0.01 mg/L at WRMB01D.

4.3.5 Dissolved gases

Dissolved methane was detected at all monitoring bores at concentrations increasing with depth (from 2,640 μ g/L at WRMB01A to 29,700 μ g/L at WRMB01D). No other dissolved gases were detected.

4.3.6 Hydrocarbons

No PAHs were detected in the monitoring bores. Phenolic compounds were not detected in the alluvium or shallow rock. Phenol was detected in the interburden at WRMB01D ($2.3 \mu g/L$).

Benzene was detected at WRMB01D (8 μ g/L) and toluene was detected at WRMB01C (11 μ g/L); no other BTEX compounds (*i.e.* ethylbenzene and xylenes) were detected. TPH C₆-C₉ fraction (20 μ g/L) and TRH C₆-C₁₀ fraction (30 μ g/L) were detected at shallow rock monitoring bore WRMB01C.

4.4 Isotopes

4.4.1 Stable isotopes of water

Stable isotopes of water, oxygen-18 (¹⁸O) and deuterium (²H) provide information about the origin of natural waters and the processes that have affected groundwater since it entered the groundwater system.

Stable isotope values (δ^{18} O and δ^{2} H) are plotted with the Global Meteoric Water Line (GMWL) (δ^{2} H = 8.13 δ^{18} O + 10.8) (Rozanski et al. 1993) and the Local Meteoric Water Line (LMWL) in Figure 4.4.

The meteoric water lines (as seen on Figure 4.4) provide an important key to the interpretation of oxygen-18 and deuterium data. They are lines that define the relationship between oxygen-18 and deuterium in fresh surface waters and precipitation. Water with an isotopic composition that lies on the meteoric water line is assumed to have originated from the atmosphere and to be unaffected by other isotopic processes. The isotopic values for the groundwater samples are also compared to the LMWL (δ^2 H = 8.3 δ^{18} O + 16.3) (Crosbie et al. 2012). This line defines the relationship between ¹⁸O and ²H for rainfall in the Sydney region.

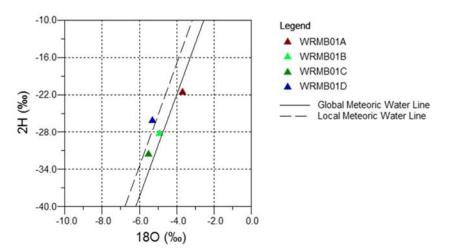


Figure 4.4 Deuterium versus oxygen-18 for Wards River monitoring bores

Stable isotope results for all the Wards River monitoring bores are presented in Table 4.2.

Bore	Oxygen-18 (‰)	Deuterium (‰)
WRMB01A	-3.68	-21.5
WRMB01B	-4.92	-28.2
WRMB01C	-5.50	-31.5
WRMB01D	-5.30	-26.1

Table 4.2	Stable isotope results for the Wards River monitoring bores
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Stable isotope results indicate that WRMB01D plots closest to the LMWL and departure from the LMWL increases as the depth of the bore decreases. This is most probably due to the shallower groundwater undergoing more evaporative processes relative to the deeper groundwater and becoming enriched in the heavier ¹⁸O isotope.

These isotope results are consistent with previous monitoring rounds in the Gloucester Gas Project area in 2012 (Parsons Brinckerhoff 2012) and 2013 (Parsons Brinckerhoff 2013e, 2014a and 2014b).

4.4.2 Radiogenic isotopes

Tritium, radiocarbon, Carbon-13 and dissolved inorganic carbon (δ^{13} C-DIC) results are presented in Table 4.3.

Bore	δ ¹³ C (‰)	a¹⁴C (pMC)	¹⁴ C age ^a (yrs BP)	¹⁴ C age ^b (yrs BP)	Tritium (TU)
WRMB01A	-14.09	87.37 ± 0.18	1,022 ± 17	Modern	0.845 ± 0.024
WRMB01B	-18.75	10.3 ± 0.19	18,194 ±151	16,350	0.052 ± 0.013
WRMB01C	-15.18	0.54 ± 0.21	41,825 ± 3,034	37,250	-0.010 ± 0.012
WRMB01D	-13.46	1.13 ± 0.22	35,958 ± 1,564	33,300	0.011 ± 0.015

Table 4.3 δ^{13} C-DIC, radiocarbon and tritium results for the Wards River monitoring bores

(a) Uncorrected radiocarbon age.

(b) Corrected radiocarbon age.

The carbon-14 activity for WRMB01A was 87.37±0.18 pMC, corresponding to an uncorrected age of 1,022±17 yrs BP. Four correction methods are applied (Fontes-Garnier (1979); revised Fontes-Garnier; Tamers (1975) and Ingerson and Pearson (1964)) to apparent radiocarbon data to account for potential dilution of ¹⁴C signature by incorporation of inactive carbon. The four models showed good agreement for corrected radiocarbon ages, and the average corrected radiocarbon age for WRMB01 was modern (<50 yrs BP). Radiocarbon age corresponded with tritium data that indicated the presence of modern water.

The carbon-14 activity for WRMB01B was 10.3 ± 0.19 pMC, corresponding to an uncorrected age of $18,194\pm151$ yrs BP. The carbon-14 activity for WRMB01C was 0.54 ± 0.21 pMC, corresponding to an uncorrected age of $41,825\pm3,034$ yrs BP. Radiocarbon ages have been corrected to account for potential dilution by processes such as carbonate dissolution, sulphate reduction and methanogenesis (as defined in Clark and Fritz (1997)) and are 16,350 and 37,250 years for WRMB01B and WRMB01C, respectively. Tritium values are negligible, and confirm that water in the shallow rock is old.

Groundwater in the deep interburden is also old; the carbon-14 activity for WRMB01D was 1.13 ± 0.22 pMC, corresponding to a corrected groundwater age of 33,300 years. The tritium concentration was also negligible, confirming that the age of the water in the interburden is old.

The slightly older age for the shallower groundwater at WRMB01C compared to the groundwater at WRMB01D may be indicative of upward flow.

4.4.3 Carbon and hydrogen isotopes of methane ($\delta^{13}C$ -CH₄ and $\delta^{2}H$ -CH₄)

Compound specific isotopes of dissolved methane (carbon-13 (δ^{13} C-CH₄) and deuterium (δ^{2} H-CH₄)) were analysed in all monitoring bores. Dissolved methane concentrations and isotope results are presented in Table 4.4, and isotope results are compared to data collected by AGL from coal seams during exploration in the GGP area.

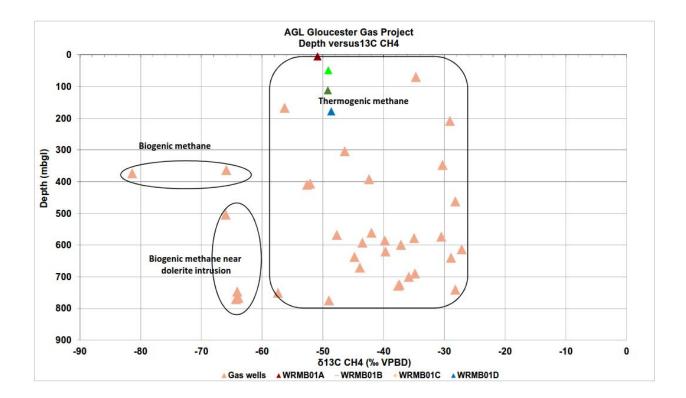
Bore	CH₄ (µg/L)	δ²H _{CH4} (‰)	δ ¹³ C _{CH4} (‰)
WRMB01A	2,640	606.0ª	-50.87ª
WRMB01B	6,840	2321.1ª	-49.10ª
WRMB01C	17,800	2103.2ª	-49.17ª
WRMB01D	29,700	-210.6	-48.63

Table 4.4 Dissolved methane concentrations and isotope results

(a) Below LOQ.

The limit of quantitation (LOQ) is the lowest concentration or quantity of a target variable that can be reported with a specified degree of confidence; therefore sample WRMB01A, WRMB01B and WRMB01C with δ^{13} C-CH₄ and δ^{2} H-CH₄ results below the LOQ cannot be interpreted with a degree of confidence; however, the δ^{13} C-CH₄ suggest a thermogenic origin of methane in alluvium and shallow rock (see Figure 4.5).

The results for WRMB01D indicate the methane is early mature thermogenic methane (Figure 4.6).



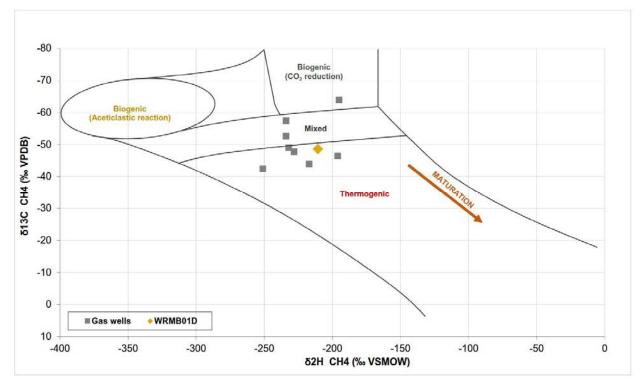


Figure 4.5 Depth versus ¹³C-CH₄ for the Wards River monitoring bores

Figure 4.6 ¹³C-CH₄ versus ²H-CH₄ for the Wards River monitoring bores

5. Conclusions

This drilling program involved the establishment of one nested groundwater monitoring site (a total of four monitoring bores) within the GGP between November 2013 and June 2014. The perforating of the deep monitoring bore was not completed until November 2014. Final site testing was completed in October 2015. One monitoring bore was installed in the Quaternary alluvium (WRMB01A), two monitoring bores in the shallow sandstone of the Jilleon Formation (shallow rock) (WRMB01B and WRMB01C) and one monitoring bore in the deep sandstone of the Jilleon Formation of the Gloucester Coal Measures (interburden) (WRMB01D).

The initial findings for groundwater levels at this Wards River site are:

- Groundwater levels in the alluvium show a minor response (~1.0 m) to rainfall events and otherwise have been relatively stable since the start of monitoring.
- Groundwater levels at WRMB01B slowly recovered following airlifting, which is indicative of very low permeability and corroborated by permeability testing results.
- Small groundwater level responses to rainfall events are observed at WRMB01C.

The initial findings for groundwater quality at this Wards River site are:

- Groundwater in the alluvium is of marginal water quality and slightly acidic. Groundwater salinity (EC) in the shallow rock is brackish and slightly alkaline; and groundwater in the interburden is brackish and alkaline.
- Groundwater in the alluvium is chemically classified as Na-Ca-CI-HCO₃ type water, and in the shallow rock and interburden groundwater is Na-CI-HCO₃ type.
- Aluminium, barium, bromine, iron, strontium and zinc were detected in groundwater at higher concentrations in the alluvium and the shallow rock compared to the interburden (WRMB01D).
 Higher levels of iron and zinc were detected in groundwater in the alluvium compared to the shallow rock.
- Concentrations of dissolved metals are generally similar in the alluvium, and shallow rock, and are higher than the interburden. Aluminium, barium, bromine, iron, strontium and zinc are detected at slightly elevated concentrations in all hydrogeological units.
- No phenolic compounds or PAHs were detected in alluvium or shallow bedrock, however low levels
 of toluene and TPH were detected at shallow rock monitoring bore WRMB01C. Benzene and phenol
 were detected at low concentrations in the interburden monitoring bore WRMB01D.
- Dissolved methane was detected in all hydrogeological units, with concentrations increasing with depth.
- Stable isotope data indicates that groundwater in all hydrogeological units is of meteoric origin. Tritium and radiocarbon data confirms the presence of modern water in the alluvium, and indicates that the age of groundwater in the shallow rock and interburden is much older ranging between 16,000 and 38,000 years BP.
- Methane isotopes indicate that dissolved methane present in all hydrogeological units is thermogenic.

6. Statement of limitations

6.1 Scope of services

This report has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client (AGL) and Parsons Brinckerhoff (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

6.2 Reliance on data

In preparing the report, Parsons Brinckerhoff has relied upon data, surveys, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

6.3 Environmental conclusions

In accordance with the scope of services, Parsons Brinckerhoff has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

6.4 Report for benefit of client

The report has been prepared for the benefit of the client (and no other party). Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report. Parties other than the client should not rely upon the report or the accuracy or

completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

6.5 Other limitations

Parsons Brinckerhoff will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

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Appendix A Bore licence and Form A's



NSW Office of Water

Hunter Region Po Box 2213 3/26 Honeysuckle Drive Dangar NSW 2309 Phone: (02) 49042500

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

20BL173575



A G L Upstream Investments Pty Ltd Locked Bag 1837 St Leonards NSW 2065

	LICENSE NUMBER
	20BL173575
	DATE LICENSE VALID FROM
	25-Oct-2013
	DATE LICENSE VALID TO
	PERPETUITY
	FEE
	\$0.00
ABN	47661556763 GST NIL

Portion(s) or Lot/Section/DP 2//1128605 LOCATION OF WORKS PARISH Grant

COUNTY Gloucester

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

CONDITIONS APPLYING TO THIS LICENSE ARE

As shown on the attached Condition Statement

COPY

NSW Office of Water

CONDITIONS STATEMENT REFERRED TO ON 20BL173575 ISSUED UNDER PART V OF THE WATER ACT, 1912 ON 25-Oct-2013

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

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

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

(4) THE WORK SHOULD BE CONSTRUCTED TO SEAL OFF WATER FROM ANY AQUIFER OTHER THAN THE TARGET AQUIFER BY:

(A) INSERTING THE APPROPRIATE LENGTH OF CASING TO A DEPTH IMMEDIATELY ABOVE THE TARGET AQUIFER

(B) CEMENTING BETWEEN THE CASING(S) AND THE WALLS OF THE BORE HOLE FROM THE BOTTOM OF THE CASING TO GROUND LEVEL.

(5) THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER IF A FLOWING SUPPLY OF WATER IS OBTAINED. THE BORE SHALL THEN BE LINED WITH CASING AND CEMENTED AND A SUITABLE CLOSING GEAR SHALL BE ATTACHED TO THE BOREHEAD AS SPECIFIED BY NSW OFFICE OF WATER.

(6) IF A WORK IS ABANDONED AT ANY TIME THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER THAT THE WORK HAS BEEN ABANDONED AND SEAL OFF THE AQUIFER IN ACCORDANCE WITH THE MINIMUM CONSTRUCTION REQUIREMENTS FOR WATER BORES IN AUSTRALIA.

(7) THE LICENCE HOLDER MUST, WITHIN 2 MONTHS OF COMPLETION OF THE CONSTRUCTION OF THE WORK, OR WITHIN 2 MONTHS AFTER THE ISSUE OF THE APPROVAL IF THE WORK IS EXISTING, SUBMIT TO THE DEPARTMENT THE FOLLOWING:

(I) THE COMPLETED APPROVED FORM (FORM A),

(II) DETAILS OF THE LOCATION OF THE WORK ON A COPY OF THE LOT AND DEPOSITED PLAN, THE WORKS GPS REFERENCE, AND THE RESPECTIVE DISTANCE(S) OF THE WORK FROM THE PROPERTY BOUNDARIES,

(III) IF THE MINISTER HAS REQUESTED ANY WATER ANALYSIS AND/OR PUMPING TESTS TO BE CARRIED OUT, DETAILS OF THE WATER ANALYSIS AND/OR PUMPING TESTS AS REQUIRED BY THE MINISTER,

(8) IF, DURING THE CONSTRUCTION OF THE WORK, SALINE OR CONTAMINATED WATER IS ENCOUNTERED ABOVE THE PRODUCTION AQUIFER, THE LICENCE HOLDER MUST: (I) NOTIFY THE DEPARTMENT,

(II) ENSURE THAT SUCH WATER IS SEALED OFF BY:

(1) INSERTING CASING TO A DEPTH SUFFICIENT TO EXCLUDE THE SALINE OR CONTAMINATED WATER FROM THE WORK,

(2) IF SPECIFIED BY THE MINISTER, PLACING AN IMPERMEABLE SEAL BETWEEN THE CASING(S) AND

20BL173575 THE WALLS OF THE WORK FROM THE BOTTOM OF THE CASING TO GROUND LEVEL AS SPECIFIED BY THE MINISTER,

(III) IF THE MINISTER HAS SPECIFIED ANY OTHER REQUIREMENTS, COMPLY WITH THE REQUIREMENTS (IF ANY) SPECIFIED BY THE MINISTER,

(9) THE HOLDER OF THE LICENCE SHALL NOT ALLOW ANY WATER EXTRACTED FROM THE BORE TO DISCHARGE INTO OR ONTO: - ANY LAND

- ANY RIVER, CREEK OR WATERCOURSE;

(10) THE LICENCE HOLDER IS NOT AUTHORISED BY THIS LICENCE TO REMOVE OR CLEAR ANY NATIVE VEGETATION OR TREES AS DESCRIBED WITHIN THE NATIVE VEGETATION ACT 2003. ANY VEGETATION REMOVAL WILL REQUIRE SEPARATE WRITTEN APPROVAL FROM NSW OFFICE OF WATER.

(11) BORE DRILLING/CONSTRUCTION MUST OCCUR IN ACCORDANCE WITH THE MINIMUM CONSTRUCTION REQUIREMENTS FOR WATER BORES IN AUSTRALIA.

(12) THE LICENCE HOLDER SHALL NOT DISTURB THE HABITAT OF ANY NATIVE FLORA AND/OR FAUNA.

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Page 3

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Scientific and Technical Operating Procedures Form: A Issue: 3 Date issued: 28Aug2009



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GOVERNMENT	of Water

Page 2

Work Licence No:

WRMB01A

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Site chosen b	y: Hydrogeolo		Geolog	gist	Driller	Diviner	Client		ther	12
GPS: Please m	ion Co ordina (Yes/No) Y ark the work si ilso the distanc	>> te with "X	Easting	AMG	AGD		G 4 380 MGA/GDA ttach the ma		Zone (See explan orm A packa	
					Signatu	res:				
Driller:	IAN F	PALK			Licens	ee:				
Date:	10-12	- 20	513		Date:					
Scientific and T	echnical Operatin			-						Page 2 of 4

Form: A Issue: 3 Date issued: 28Aug2009

GOVE	RNMENT	of	Wat	er				MR	RMB	01	B			Pa
	's Licer	1	Work	Licen	ce No:	105	3-1-	735	575	-				
Contraction of	of Lice		CLAS				Nam	e of Lic	ensee:	A	GL			
	's Nam		TAN				Inten	Intended Use: MONITO					G	
Assist	tant Dri	ller:	ASHL	Err	Juis	1	Completion Date: 2.12.20					20	13	
Contra	actor:	н	GHL	AND	Dein	LING	DRI	LING	DETAIL	and the second second				
New b	ore	$\overline{\Lambda}$		cemen			Fro		To		le Diam	otor D	rilling Me	th
Deepe	ened	Ĥ	Enlarg		Dore	H	(m	2.000 U	(m)	The second	(mm)	100.00	See Cod	
	nditione		second Sta	(specif	iv)	H		·/				545.03	9	ie 5
				(opeon	37		0		11.4		200		9	1
Final [Depth	56.4 n	n ——				<u> </u>	-	56.1	+	140	201	. 9	
W/AT	ERBE	ARING 2	ZONES		1.1.1.1.1.1.1.	I								
Rundos alladad	ierstaffendige	ar fine for singly diversition		E	stimate	d Yield	Te	st	DDL	Dur	ation		Salinity	
From	То	Thicknes	s S W L		(L/s	;)	meth	nod at	end of test			(Cond	luctivity o	or T
(m)	(m)	(m)	(m)	Indivi	92833	Cumulative	See Co	de 4	(m)	Hrs	min	Cond		DS
20				Aqui	fer	1858						(µS/cm		1
30	31	<u>\</u>		• 1		• 1		1			15	947	.6	16
		_									-			
CASI	NG//E	NERIDEI	AILS							1	I Maria			
Material	OD	Wall	From	То	Method	Cas	sing sup	oport r	nethod		See Co	do 5		
		Thicknes			Fixing	04.	ang sup	spon i	neurou		See co	le 5	2	244
Code 5	(mm)	(mm)	(m)	(m)	Code 5	Тур	be of ca	asing I	oottom		See Co	de 5	2	
9	168	4.2	4.5	11.4	کا ا	Centralise	ers insta	lled {Y	es/No)) (indi	cate on ske	etch)	the triange attain	EH: Q
8	60.2	5	+.5	48.4		Sump ins	talled	(Y)	es/No)	F	rom 54	m	To 56	. 4
8	60.2	5	54.4	56.4	11-22-32-22-22-22	Pressure	-	ed m	es/No)		rom C			_
0						Casing P			2 I			<u>, [iii</u>	10	45
WAT		IRY DES	GN							5 A -	in termini			
HANNIN CARADO	eredestrellersolertaf	Columbility Conducts	Gene	ral			S	Creen			Slot D)etails		推測
Material	OD	Wall	From	То	Openi	ng Fixi		perture		ngth	Widt		Alignme	ent
		Thickness	S		type								J	
Code 5	(mm)	(mm)	(m)	(m)	See Coo	Lot the Skin of the Vi	de 5	(mm)	(m	m)	(mm	ı)	See Code	e 6
8	60.2	·5	48.4	54.4	<u> </u>	5		.4	20	>	10		H	
1			-									125		
andra and sa Taga daga da	-		-		and seat of the							14-14 14-14 14-14	anna an	1.1
GRAN	VEL P/	ACK											500 (e k	
e Derth Carffeld	erine in the line	uncture State (SAU)		NACH DE LE CALENDARIE		Grain size	2012/07/2010/07/2010 C		Dept	h		Q	uantity	政治
						(mm)			(m)					
	Type		Grade	-	Fron		То	Fro		То		itres	m	3
	unded	/		ded √	3		5	45.0	+ 5	6.4	2	60		
<u> </u>	rushed		Ungrad	bed							_			
		CONTRACTOR CONTRACTOR	A	V										
Benton	ite/Gro	ut seal ement of G	(Yes/No)	•1		<u></u>					_			

Page 1 of 4



Page 3

WRMB01B

Work Licence No:

	RILLER	S ROCK	STRATA DE	SCRIPTION (LI	THOLOGY)					15
De	epth		and the state	Description		ALCONTRACTOR OF	WORK CON	ISTRU	CTIO	N
From	То				ETCH	CHOI				
(m)	(m)					a start and				
0	6	CL	AY					TTT	TT	
6	12	SIL	TSTONE							
12	15		IDS TONE							
15	16	SIL	TSTONE						11	
16	18		NDSTONE							
18	19	SIL	TSTONE							
19	20		DSTONE							
20	21		TSTONE							
21	27		JOSTON							
27	30	SIL	TSTONE							
30	33		NDSTON	يَّ ل						1
33	42		TSTONE							
42	45	SAN	DSTONE	1						
45	46		TSTONE							
46	56.4		DSTONE							
			1111							
										1
										1
									-	-
									++	
									-	+
										+
			WORK NOT	CONSTRUCTED	BY DRILLING	RIG		SWARE STR		16
Method of e	xcavation:	Hand dug	Back ho	CONTRACTOR OF A DESCRIPTION OF A DESCRIP	Dozer	Pananga-Sections	Other			
Donth	Longth	Width	Diameter					-	Dent	
Depth (m)	Length (m)	(m)	(m)	Lining material	Dimentions of liner (m)	or	From Depth (m)		Depti (m)	n
(iii)	(11)		(11)	material			(11)		(11)	
										-
			Please attac	h copies of the fo	ollowing if avail	lable				17
Geologist log	(Yes/No)		Laboratory analys	is of water Sample	(Yes/No)	Pumping	test(s) (Yes/	/No)		
Geophysical I	0g (Yes/No)		Sieve analysis of	aquifer material	(Yes/No)	Installed I	Pump details (Yes/	/No)	- T	
			, ,	ħ.						

Scientific and Technical Operating Procedures Form: A Issue: 3 Date issued: 28Aug2009



WRMB01B

Page 2

Work Licence No:

	1.18.200	074M		BO	RE DEVE	OPMENT	S. Jones E	S		8
Chemical u	used for breaking	ng down di	rilling muc	(Yes/No)	N	Name:				
Method	Bailing/Surgin	g J	etting	Airlif	ting Y	Backwashing	P	umping	Other:	
Duration		hrs	hrs		30 hrs		hrs	hr	s	hrs
			C	ISINFE	CTION ON	COMPLETIO	N			9
	Chemical(s) used		C	uantity app	lied (Litres)	1	Method o	f application	
			-				/			
			PU Pump	Initial	TESTS O	N COMPLET	ON	Page State State		10
AND THE REPORT OF THE PARTY	Fest ype	Date	intake depth (m)	Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Water level (m)	Recovery Time (hrs)	taken (mins)
	Stage 1			()	NA	(0.0)	(110)	(11)	(113)	(mins)
Multi stage	Stage 2			,						
(stepped	Stage 3				-					
drawdown) Single stag	Stage 4	_								
(constant ra		-								
Height of m	easuring point	above grou	und level		m	Test Method			See Code 4	
			WORK P		BACKELL	ED OR ABAI	NDONED			11
ls work aba Has any ca	sing been left i	-] Me (Yes/	No)	abandonme	From	dm	(Yes/No) Plugged To] Capp m	
Sealing See Co		From dep (m)	th	To de (m)	100.00	Sealing / fill typ See Code 11	pe F	rom depth (m)		depth (m)
Site chosen t	oy: Hydrogeol	ogist 🗸	Geolog	gist	Driller	Diviner	Client	t 🗌 Ot	ther	12
Lot No	2		10 112	860	5					13
	tion Co ordina		Easting		00581	Northing	64378	53	Zone	
GPS:	(Yes/No) Y	>>		AMG		2	MGA/GDA		(See explana	ation)
	nark the work s also the distan					ndaries, and at	tach the ma	ap to this F	orm A packa	ige.
					Signatu	res:				
Driller:	IAN	PALK			Licens	ee:				
Date:	10-12		513		Date:					
scientific and	Technical Operativ	g Procedure	6	_	Contraction of the local division of the loc	Million Contraction of Contraction		and the second second		Page 2 of 4

Form: A Issue: 3 Date issued: 28Aug2009

N			fice			For			ticula 1BO			mp	lete		Ca
GOVER	NMENT	and the second se	Wat					K I	100	LC	-			sim.	
		nce No:	191		-	1	Work	Licen	nce No:	10	341	73	57	5	
	of Lice	\sim	<u>CLA</u>		4		Name	e of Li	censee:	A	GL				
	's Nam	<u>11</u>	m	PA			Inten	ded U	se:	Mo	DNIT	TOR	Linte	6	
Assist	ant Dril	ler:	ASH	EY	Wir	s	Comp	oletion	Date:	2.	12	2	013)	
Contra	actor:	H	GHL	AND	DRin	UNG	DRIL	LING	DETAIL	S	S.C.S.				のない
New b	ore	\checkmark	Repla	cement	bore		Fro	m	То	Н	ole Dia	meter	Drilli	ng Met	h
Deepe	ened		Enlarg		000000000		(m)	(m)		(mr		100.000.000es	ee Code	100
Recon	ditione	d 🗖	- AND A PROVIDE	(specif	y)		C		11.5		200			9	49 X
Final F	N 44			202			11.5		126.6	0	140			3	
Final D	Jepin	126.60	,			·			12074		1 - 1				1000
W/AT	ER BE	ARING Z	ONES					an a				1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -			
an ann an Star Barbach	American		AND THE REAL PROPERTY	E	stimated	l Yield	Tes	st	DDL	Du	ration		S	alinity	No.
From	То	Thickness	SWL		(L/s))	meth	iod a	at end of test			(Co		tivity or	Т
(m)	(m)	(m)	(m)	Individ	gordania - uvido	umulative	See Co	de 4	(m)	Hrs	mi		ond	TDS	_
				Aquit	fer				53 1.52			(µS4	/cm)	(mg/	L
30	31	1		•1		• 1		1			15	31-		2.06	Į
	55	<u> </u>		• 1		•2		1			15	314		1.04	
		ich feo derither and remain		•2	Increased and the second	• 4		1			15	22	81	1.48	-
ALL PROPERTY.	AND AN ACCORDING	NERIDET													611120
Material	OD	Wall	From	То	Method	Cas	ing sup	port i	method		See 0	Code 5	2		学会社
		Thickness	1 22 34		Fixing				17						
Code 5	(mm)	(mm)	(m)	(m)	Code 5		e of ca				See (Code 5	2		100
9	168	4.2	+.5		2.4.4.56.656	Centralise		lled (Y		-	dicate on	5			
	60.2	5	+.5			Sump inst	alled	{Y	(es/No)	1 1	From	23.4	im T	0126.	4
8	b0.2	5	123.45	126.45	5	Pressure	cement	ed (Y	(es/No)	r I	From	0	m T	034	
						Casing Pr	otector	cemer	nted in pla	ace		-0.			
WATE	REN	IRY DESI	GN.								a				E State
			Gene	-			S	creen			Slot	Detai	ls		~
Material	OD	Wall	From	То	Openir	ng Fixin	g Ap	perture	e Ler	ngth	W	idth	AI	ignmer	1
Coder	(m	Thickness		1000	type	1	1111 m	27 12	1.00	2	(32		- en el la compañía de la	NAP TO A	
Code 5	(mm)	(mm)	(m)	(m)	See Code	12 10 MB 12 10 10 10 10 10 10 10	Cardon N	(mm)		m)		ım)	1.1.2 yr (1.3.96	ee Code	5
8	60.2	5	111.45	123.45	5	5		04	20	_	10			<u>H</u>	家で
antes dati.							1485. 2014				-		a Maria Gan Gan		103 103
5 St.							to years				-		12.00		
GRAN	/EL P/	юк.						1997 (P)						(C) (2) (4)	時の
C. AND	and the second		In the second	AND	erseren en tertiskelet	Grain size			Dept	h			Quar	ntitv	2
						(mm)			(m)					393	
Т	уре		Grade		From	Т	ō	Fro	om	Тс)	Litres	S	m³	
	unded	\checkmark	Grad	led 🗸	3	5		106.	45 12	6.45	5 4	180			
			Ungrad	bed											
Ro	ushed		the second se							_			_		-
Ro Cr	ushed ite/Grou	ut seal	(Yes/No)	4				l							
Roi Cr Bentoni	ite/Gro	ut seal ement of G	12.10.10.00		See Co	ide 7 1	Girlind							u - s - all	_

Page 1 of 4



WRMB01C

Page 3

Work Licence No:

Den D	RILLER	S ROCK/STRATA DESCRIPTION (LITHOLOGY)		15
De	pth	Description	WORK CONSTRUC	
From	То	See Code 15	SKETCH	TION
(m)	(m)			
0	6	CLAY		
6	16	SILTSTONE		
16	17	SANDSTONE		
17	18	SILTSTONE		
18	19	SHALE		
19	21	SILTSTONE		
21	27	SANDSTONÉ		
27	42	SILTSTONE		
42	49	SANDSTONE		
49	61	SILTSTONE		
61	70	SANDSTONE		
70	80	SILTSTONE		
80	126.45	SANDSTONE		
		WORK NOT CONSTRUCTED BY DRILLING	RIG	16
Method of ex	cavation:	Hand dug Back hoe Dragline Dozer	Other	
Depth	Length	Width Diameter Lining Dimentions of		
(m)	(m)	(m) (m) Nnaterial liner (m)	(m) (n	n)
				-
		Please attach copies of the following if avail	able	17
Geologist log	(Yes/No)		Pumping test(s) (Yes/No)	
Geophysical lo	ng (Yes/No)	Sieve analysis of aquifer material (Yes/No)	nstalled Pump details (Yes/No)	

Scientific and Technical Operating Procedures Form: A Issue: 3 Date issued: 28Aug2009

	1
	Office
NSW GOVERNMENT	of Water

WRMBO1 C

Page 2

Work Licence No:

				BO	RE DEVEL	ODMENT	licence				8
Chemical u	sed for breaking	g down d	Irilling mud	NACIONALI IN MUMB	CONTRACTOR OF A	Name:					
Method	Bailing/Surging		Jetting	Airlift	ing Y	Backwashing	g.	Pumping	ALC: NO.	Other:	
Duration	b	hrs	hrs		5 hrs		hrs *		hrs		hrs
			D	ISINFE	CTION ON	COMPLETIC	ON				9
	Chemical(s) used		Q	uantity app	lied (Litres)		Metho	d of app	olication	
		_					/				
			A DESCRIPTION OF THE PARTY OF	al weat a sub-state of the second	TESTS O	N COMPLET	A Constant of Alberta Market				10
Т	est	Date	Pump intake	Initial Water	Pumping	Water Level	Durat	tion	R	ecovery	
t. t	уре		depth	Level	rate	pumping	of Te	Lead of the second s	and the second	Time	taken
1000 C			(m)	(SWL) (m)	(L/s)	(DDL) (m)	(hrs	s) (m	CONTRACTOR SPECTOR	(hrs)	(mins)
	Stage 1			A							
Multi stage	Stage 2			-7	4		A) 114			_	
(stepped drawdown)	Stage 3 Stage 4	-		/				-	-	1	
Single stag			1/1				1				
(constant ra	2				343						
Height of m	Height of measuring point above ground level m Test Method See Code 4										
ls work aba Has any ca	ising been left i	Yes/No)	rk (Yes	/No)	abandonme	work partly b ent: Backfil & From	led	Plugge		Cappo m	
Sealing See Co	/ fill type ode 11	From de (m)	epth	To de	COLOR	Sealing / fill See Code 1	A VALUE AND A VALUE AND A VALUE AND A	From de (m)	pth	1 10	depth (m)
Site chosen	by: Hydrogeol	logist 🗸	Geolo	gist	Driller	Divine	r 🕅	Client	Other		12
Lot No	2		No 1	128	605	1					13
Work Loca	ation Co ordina	_	Easting	_	00587	Northing	64	37860	Zo	one	
GPS:	(Yes/No)	8	>>	AMG	AGD] or	MGA/	GDA	(Se	ee explan	ation)
	mark the work s also the distan			120			attach t	he map to th	nis Form	n A packa	age.
					Signatu	ires:				1	A.
Driller:	IAN	PAL	K		Licen	see:					
Date:	10-1	2-2	013		Date:						
Scionti	fic and Technical C	Decreting D)ro ooduroo	- Andrews		Contraction of the second				Baa	e 2 of 4

Form: A Issue: 3 Date issued: 28Aug2009

GOVERNMENT Of Water Driller's Licence No: 1913 1 Class of Licence: CLASS 4 Driller's Name: JAN PALK Assistant Driller: ASHLEY MILLS Contractor: HIGHLAND DEILLING DETAIL New bore Replacement bore Deepened Enlarged	10BL173575 AGL. MONITORING 231612014					
Class of Licence: CLASS 4 Driller's Name: JAN PALK Assistant Driller: ASHLEY WILLS Contractor: HIGHLAND DEILLING DETAIL New bore Replacement bore From To	AGL. MONITORING 23/6/2014					
Driller's Name: Image: Tan Palk Intended Use: Assistant Driller: Ashley Willis Completion Date: Contractor: Highland Deillig Drillig New bore Replacement bore From To	MONITORING 23/6/2014					
Assistant Driller: ASHLEY WILLS Contractor: HIGHLAND DRILLING DETAIL New bore Replacement bore From To	23/6/2014					
Contractor: HIGHLAND DEILLING DETAIL New bore Replacement bore From To	A CONTRACTOR OF A CONTRACTOR O					
New bore Replacement bore From To						
Replacement bore	DRILLING DETAILS 3					
Deepened Enlarged (m) (m)	Hole Diameter Drilling Metho					
	(mm) See Code 3					
Reconditioned Other (specify) 0 5-5	254 9					
5.5 20	200 9					
Final Depth 200 m 32 200	130 9					
WATER BEARING ZONES						
Estimated Yield Test DDL	Duration Salinity					
From To Thickness SWL (L/s) method at end of tes	The second se					
(m) (m) (m) (m) Individual Cumulative (m)	Hrs min Cond TDS					
Aquifer See Code 4	(µS/cm) (mg/L)					
54 55 1 01 01 1	15 2.00					
102 103 1 .1 .2 1	15 7.00					
150 151 1 •1 •3 1	15 2.00					
CASING / LINER DETAILS						
Material OD Wall From To Method Casing support method	See Code 5 1 1 2					
Thickness						
Code 5 (mm) (m) (m) Code 5 Type of casing bottom	See Code 5 1/1 2					
9 219.1 4.8 +.5 5.5 Centralisers installed (Yes/No)	ers installed (Yes/No) Y (indicate on sketch)					
9 168 00 4.8 4.5 29 5 Sump installed (Yes/No)	From 184 m To 193					
International Action of the Ac	From O m To 200					
Casing Protector cemented in pla						
WATER ENTRY DESIGN						
General Screen Material OD Wall From To Opening Fixing Aperture Lei	Slot Details					
Thickness type	ngth Width Alignment					
The second	nm) (mm) See Code 6					
8						
STEEL TO BE PERFORATED 175 - 184 M	I Butter					
GRAVEL PACK						
Grain size Dep	th Quantity					
(mm) (m)						
Type Grade From To From	To Litres m ³					
Rounded Graded						
Crushed Ungraded						
Bentonite/Grout seal (Yes/No)						
Method of placement of Gravel Pack See Code 7						
For Departmental use only: GW						

Form: A Issue: 3 Date issued: 28Aug2009

Page 1 of 4

	Office
GOVERNMENT	of Water

WRMB01D

Page 3

Work Licence No:

1	DRILLER		
De	epth	Description	WORK CONSTRUCTION
From	То	See Code 15	SKETCH
(m)	(m)		
0	8	CLAY	
8	14	SHALE	
14	15	SANDSTONE	
15	22	SILTSTONE	
22	23	SANDSTONE	
23	32	SILTSTONE	
32	46_	SANDSTONE	
46	55	SILTS TONE	
55	60	SANDSTONE	
60	61	SILTSTONE	
61	66	SANDSTONE	
66	15	SILTSTONE	
75	174	SANDSTONE	
174	178	SILTSTONE	
178	180	SANOSTONE	
180	183	SILTSTONE	
183	200	SANDSTONE	
		WORK NOT CONSTRUCTED BY DRILLING	
ethod of ex	cavation:	Hand dug Back hoe Dragline Dozer	RIG 1 Other
Depth (m)	Length (m)	WidthDiameterLiningDimentions of(m)(m)materialliner (m)	
(11)	(11)	(m) (m) material liner (m)	(m) (m)
		Please attach copies of the following if available	able 1
ologist log	(Yes/No)	Laboratory analysis of water Sample (Yes/No)	Pumping test(s) (Yes/No)
ophysical lo	g (Yes/No)	Sieve analysis of aquifer material (Yes/No)	nstalled Pump details (Yes/No)
	L	rating Procedures	

Form: A Issue: 3 Date issued: 28Aug2009



Page 2

WRMBOLD Work Licence No:

				BC	RE DEVE	OPMENT				0
Chemical u	sed for break	king down d	rilling mu	050	1 1	Name:				8
Method	Bailing/Surgi	ing J	letting	Airlif	ting	Backwashing	P	umping	Other:	
Duration		hrs	hrs	1 [hrs		hrs	h		hrs
			[DISINFE	CTION ON	COMPLETIO	N			
	Chemica	I(s) used		Participation of the local division of the l	Quantity app			Method o	fapplication	9
									- oppnoutor	
			PL	MPING	TESTS O	N COMPLETI	ON			10
т	ost	Date	Pump intake	Initial	Dumping	Water Level		/	Recovery	In the Party of Street
Test type		Date	depth	and a second sec		at end of pumping	Duration of Test	Water Time taken		15 m 20 20 31
			(m)	(SWL)	(1.10)	(DDL)		level		
	Stage 1		(m)	(m)	(L/s)	(m)	(hrs)	(m)	(hrs)	(mins)
Multi stage	Stage 2				X					
(stepped	Stage 3			/						
drawdown)	Stage 4									
Single stage (constant rat										
	asuring point	t above grou	und level		m	Test Method		10.000 L	See Code 4	1
						ED OR ABAI				
Original dept Is work aban Has any cas Sealing / f See Cod	idoned: ing been left fill type	From dep] Me (Yes/	No) To de	abandonme	work partly bac nt: Backfille From Sealing / fill typ See Code 11	dm	(Yes/No) Plugged To To		depth
- See Cou	en	(m)		(m)		See Code II		(m)	2	(m)
Site chosen by	: Hydroged		Geolog	niet 🗌	Driller	Diviner	Client		her	12
Site chosen by	. Hydroged				L	Divinei			ner	12
GPS: Please ma	2, on Co ordin (Yes/No)	>> site with "X	Easting	AMG/	9570.97 AGD		6437 838 MGA/GDA tach the ma		Zone (See explana	
					Signatur	es:				
Driller:	10	M			License	ee:				
Date:	7/7/2	014			Date:			a san ana dha alla alla an an an an an an		
	chnical Operati 3 Date issued:	•						and the second		Page 2 of 4

Appendix B

Bore logs



BORE COM	PLE	TI	ON	REPOR	T- WRMB	01A			Page1/1	
Project: AGL Gloucester Gas P Location: Wards River	roject				Drilling contrac Driller: I. Palk		Highland Drilling Rig: Rig 2	20		
Easting: 400527.34 Northing	j: 64	3801	2.51		Drilling, n. thou	d: Ro	tary air	Total drilled depth: 8.12 m		
Top of casing elevation: 85.38	-				Bc.ehole dia	eter:	205.0 mm	0 - 7.5 m	Bit: Blade	
Grid system: MGA 94 Zone 56	tick-	up h	eight: 0.55 m	B⊾ eh⊄ie diam	eter:	139.0 mm	7.5 - 8.12 m	Bit: DHH		
Purpose of bore:Monitoring staScreened Formation:AlluviumLogged by:K. MaherStart date:28/11/13Completion date:28/11/13Static WL:81.39 mAHD3Water level date:2/12/13	8	Plain chsing: Srachn: Sump: Cement grout: Gravel backfill: Bentonite seal: Gravel pack: Bentonite plug	4.5-7 7.0-8 0-2.0 : NA : 2.0-4 4-7.5		C Class 18 (0 C Class 18					
BORE CONSTRUCTION BORE CONSTRUCTION BORE CONSTRUCTION			LITHOLOGY	Ý		WATE	R QUALITY			
Steel headworks and monument (not to scale)	-1									
Cement grout	-1			SOIL medium brow	n, extremely weathered					
50 mm blank PN18 U- PVC casing (threaded) Bentonite seal	—2 —3			CLAY medium brow	wn, SAND 15%					
5 1/2 inch diameter borehole	-4			GRAVEL medium I	prown, up to 2 cm					
50mm slotted PN18 U- PVC casing (0.5 mm	-5			GRAVEL medium,	brown blue					
	-6			GRAVEL blue, up t	to 3 cm					
Gravel pack (5mm wash) -7 50 mm blank PN18 U- PVC sump (threaded) Bentonite plug -9								Water cut: <0.1 L/s, Temp: 28.39 °C, EC: 1611 μS/cm, TDS: 1.048 g/L, DO: 50 %, DO: 3.82 ppm, pH: 6.8, ORP: 19.2 mV		
	10									

DIDOONO	Drawing No.: WRMB	01A - Bore Constructio	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01A
BRINCKERHOFF	Drawn by: K. Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			· · · · · · · · · · · · · · · · · · ·

BORE COM	PLE	TIC	ON	REPOR	Г- WRMBC)1B			Page1/4
Project: AGL Gloucester Gas Pl	roject				Drilling contrac	tor:	Highland D	-	L
Location: Wards River					Driller: I. Palk	_	Rig: F		
Easting: 400579.58 Northing	: 643	3785	60.83	}	Drilling, m. thod				ed depth: 5 m
Top of casing elevation: 90.04 r					Bc.ehole dia			0 - 6.0 m	Bit: Blade
Grid system: MGA 94 Zone 56	St	ick-	up h	eight: 0.55 m	Burghrie diame	eter:	139.0	6.0 56.4 m	Bit: DHH
Screened Formation: Jilleon Formation Logged by: K Maher Start date: 27/11/13 Completion date: 27/11/13					Srien:	48.4- 54.4- 0-42. NA	54.4 m: 50 n 56.4 m: 50 n 4 m	18 50 mm PVC Im PVC Class 18 Im PVC Class 18	
Static WL: 83.81 mAHD 6.	0 - 56	.4 m			Gravel pack:			n washed gravel	
Water level date: 90.04 mAH	D				Bentonite plug:				
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	<u></u>	LITHOLOGY	,		WATE	ER QUALITY
Steel headworks and	-1								
monument (not to scale)	-0		\sum	CLAY light Tan, or	ange, mottles				
	-1		\sum	-					
			\geq	CLAY light grey, or	ange red mottles				
	-2		\geq						
	-3		\searrow	CLAY light grey, m	ottles less abundant				
	-4		\geq						
	5		$\langle \rangle$						
	-6		$\backslash\rangle$						
				SILTSTONE mediu oxidised	um greenish brown, CLAY 10% white, moderately				
	-7			SILTSTONE light b	rown, highly oxidised, CLA	AY 5%			
	8								
	-9								
	- 10				luish grey, CLAY 5%				
	- 11								
	- 12			SANDSTONE fine	grained, medium grey				
	- 13								
	- 14								
	45								
	- 15			SILTSTONE dark g	rey, COAL 10% black, CL	AY 5%			
	- 16			SANDSTONE fine	grained, medium grey, SIL	TSTON	E 20% dark grey		
	- 17			SANDSTONE fine	grained, medium grey				
	Drawing	No :		01B - Bore Construction	NIACI			oom Invootmo	nto Divilital

DIDOONO	Drawing No.: WRMB	01B - Bore Construction	SAGL	AGL Upstream Investments Pty Lto			
PARSONS	Revision: A	Date drawn: 10/7/14	/14	WRMB01B			
BRINCKERHOFF	Drawn by: K. Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation			
	Project No. 2193324A						

BOR	E COM	PLE	TIC	ON	REPORT	- WRMB)1B		Page2/4
Project: AGL Gloud		roject				Drilling contrac Driller: LPalk	0	d Drilling g: Rig 20	
Location: Wards Ri						Drilling in thod		-	d depth: 5 m
Easting: 400579.58 Top of casing eleva	-	-	3785	50.83	-	Bc.ehole dia		0 - 6.0 m	Bit: Blade
Grid system: MGA			ick-	up h		B⊾ 'eh∕ ie diame			Bit: DHH
Purpose of bore: M Screened Formation Logged by: K Mahe Start date: 27/11/13 Completion date: 27	n: Jilleon Fo er 3					Sric n:	48.4-54.4 m: 5 54.4-56.4 m: 5 0-42.4 m	ASS 18 50 mm PVC 50 mm PVC Class 18 50 mm PVC Class 18	(0.5 mm slot)
Static WL: 83.81 Water level date:	mAHD 6. 90.04 mAH	.0 - 56 ID	.4 m			Bentonite seal: Gravel pack: Bentonite plug:	45.4-56.4 m: 8	5 mm washed gravel	
BORE CONSTRUCTION BORE CONSTRUCTION BORE CONSTRUCTION					LITHOLOGY	,	WATE	R QUALITY	
		- 18		••••					
		19			SILISIONE dark gr	ey, SANDSTONE 10% fi	ne grained, medium g	jrey	
					SANDSTONE fine g	ained, medium grey, SIL	TSTONE 10% dark g	jrey	
		- 20			SILTSTONE dark gr	ey, carbonate, CLAY 109	%		
Ceme	nt grout	- 21			SANDSTONE mediu	m grained , medium gre	у		
		- 22							
		-23		· ·	SANDSTONE mediu	m grained , medium gre	y, SILTSTONE 10% c	lark grey	
50 mm	n blank PN18 U-	- 24							
PVC c	asing (threaded)	- 25			SANDSTONE fine g	ained, medium grey			
		- 26			SANDSTONE fine g	ained, medium grey, SIL	TSTONE 10% dark g	jrey	
] [- 26							
		- 27			SILTSTONE dark gr	ey			
5 1/2 i	nch diameter	- 28							
		- 29				ey, SANDSTONE 10% v	erv fine to fine arained	d.	
		- 30			medium grey	• ·			
22		31			SANDS I ONE fine g	ained, medium grey, SIL	LISTONE 10% dark g	jrey	
22		- 32							
22		- 33				ey, SANDSTONE 10% fi	ne to medium grained		, Temp: 26.62 °C, EC: 6 g/L, DO: 22.3 %, DO:
		34			medium grey, CLAY	5%		1.77 ppm, pH: 8.46	
		35							
22		- 36							
		Drawing	No :		01B - Bore Construction			ostream Investmer	

DADCONC	Drawing No.: WRMB	01B - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01B
BRINCKERHOFF	Drawn by: K. Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE COM	BORE COMPLETION REPORT - WRMB01B Page3/4											
Project: AGL Gloucester Gas P	roject				Drilling contrac	tor:	3	0				
Location: Wards River					Driller: I. Palk Drilling, n. thod	. Poi	Rig: R		ed depth: 5 m			
Easting: 400579.58 Northing		3785	50.83	3	Bc.ehole dia			0 - 6.0 m				
Top of casing elevation: 90.04 r Grid system: MGA 94 Zone 56		lak		aight 0 55 m	Builde dian			6.0 56.4 m	Bit: Blade			
-			up r	leight: 0.55 m					Bit: DHH			
Purpose of bore: Monitoring sta Screened Formation: Jilleon Fo Logged by: K Maher Start date: 27/11/13 Completion date: 27/11/13	8	Srachn: Sump: Cement grout: Gravel backfill:	48.4- 54.4- 0-42 NA	54.4 m: 50 m 56.4 m: 50 m 4 m	18 50 mm PVC m PVC Class 18 m PVC Class 18							
Static WL: 83.81 mAHD 6. Water level date: 90.04 mAH	0 - 56 D	5.4 m	1		Bentonite seal: Gravel pack: Bentonite plug	45.4	-	washed gravel				
BORE CONSTRUCTION BORE CONSTRUCTION GRAPHIC LOG					LITHOLOGY			WATE	ER QUALITY			
2.2.	36			SILTSTONE dark g grey	rey, SANDSTONE 10% f	ine grain	ed, medium to dark		/s, Temp: 25.6 °C, EC: 947 6 g/L, DO: 9.9 %, DO: 0.79 RP: 35.8 mV			
	- 38											
	- 39											
	40											
	- 41											
	- 42							Water cut: <0.1 L	/s, Temp: 25.9 °C, EC: 771			
	- 43			SANDSTONE fine	µS/cm, TDS: 0.50 ppm, pH: 8.67, O	02 g/L, DO: 12 %, DO: 1.02						
Bentonite seal	- 44											
	- 45			SILTSTONE dark o	rev							
	- 46		=									
	- 47			grey	grained, medium to dark ç	grey, SIL	ISIONE 20% dark					
	- 48		• •	SANDSTONE fine	to medium grained, mediu	um grey,	SILTSTONE 5% da	Water cut: <0.1 L	/s, Temp: 28.2 °C, EC: 1630			
	- 49			grey				ppm, pH: 8.75, O	8 g/L, DÓ: 30 %, DO: 2.33 RP: 24.3 mV			
	50		• • •	SANDS I ONE fine	grained, medium grey, SII	LISION	E 5% dark grey					
Gravel pack (5mm wash)	- 51											
50 mm slotted PN18 U-												
aperture)												
	- 53											
Gravel pack (5mm wash) Gravel pack (5mm wash) 	- 54								/s, Temp: 26.91 °C, EC: 3: 1.789 g/L, DO: 56 %, DO:			

BABOONO	Drawing No.: WRMB	01B - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01B
BRINCKERHOFF	Drawn by: K. Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE COMPLETION REPO	RT - WRMB01B	Page4/4
Project: AGL Gloucester Gas Project Location: Wards River	Drilling contractor: Highland Drilling Driller: I. Palk Rig: Rig 20 Drilling n. thod: Rotary air	Total drilled depth: 5 m
Easting:400579.58Northing:6437850.83Top of casing elevation:90.04 mAHGrid system:MGA 94 Zone 56Stick-up height:0.5	Br ehole dial eter: 205.0	D - 6.0 m Bit: Blade 6.0 56.4 m Bit: DHH
Purpose of bore: Monitoring stand pipe Screened Formation: Jilleon Formation Logged by: K Maher Start date: 27/11/13 Completion date: 27/11/13 Static WL: 83.81 mAHD 6.0 - 56.4 m Water level date: 90.04 mAHD	Plain uising: 0-48.4 m: CLASS 18 50 Srien: 48.4-54.4 m: 50 mm PV Sump: 54.4-56.4 m: 50 mm PV Genent grout: 0-42.4 m Gravel backfill: NA Bentonite seal: 42.4-45.4 m: 5 mm was Bentonite plug: NA	/C Class 18 (0.5 mm slot) /C Class 18
BORE CONSTRUCTION BORE CONSTRUCTION BORE CONSTRUCTION	LITHOLOGY	WATER QUALITY
50 mm blank PN18 U- PVC sump (threaded) 56 57	W 22	.01 ppm, pH: 8.77, ORP: 22 mV /ater cut: <0.1 L/s, Temp: 33.11 °C, EC: 655 μS/cm, TDS: 1.726 g/L, DO: 56.3 %, Ο: 4 ppm, pH: 8.16, ORP: 33.8 mV

DIDOONO	Drawing No.: WRMB	01B - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01B
BRINCKERHOFF	Drawn by: K. Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE COMI	PLE	TI	ON	REPORT - WRMB01C		Page1/7
Project: AGL Gloucester Gas P Location: Wards River	roject			Drilling contractor: Highland Drilling Driller: I. Palk Rig: Rig 2	0	
Easting: 400584.81 Northing	j: 643	3785	58.50	Drillin, n. thod: Rotary air	Total drille	ed depth: 126.46 m
Top of casing elevation: 89.99 r	nAHD)		Br.ehole dia, eter: 205.0	0 - 5.5 m	Bit: Blade
Grid system: MGA 94 Zone 56	St	ick-	up h	eight: 0.58 m B. eh ie diameter: 139.0	5.5 - 126.45	5 m Bit: DHH
Purpose of bore:Monitoring staScreened Formation:Jilleon ForLogged by:K. MaherStart date:21/11/13Completion date:22/11/13Static WL:40.51 mAHDWater level date:2/12/13		on		Plain c sing: 0-1114.45 m: CLASS Sr.c.m: 111.45-123.45: 50 mm Sump: 123.45-126.45 m: 50 m Cement grout: 0-23.45 m; 60.45-102. Gravel backfill: NA Bentonite seal: 102.45-106.45 m Gravel pack: 106.45-126.45 m: 5 m Bentonite plug: NA	n PVC Class mm PVC Cla .45 m: 0.78 n	18 (0.5 mm slot) iss 18 n3
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATE	ER QUALITY
Steel headworks and monument (not to scale)	-1			CLAY medium orange brown, SOIL 10% brown		
	-1		$\langle \rangle$	CLAY light greyish brown		
	-2		\rightarrow	CLAY light yellowish green		
	-3					
	-4		$\langle \rangle$			
	5					
	6			SILTSTONE dark grey, SANDSTONE 20% medium grained , medium grey		
	-7					
	-8					
	-9					
	- 10					
	- 11					
	- 12					
	13					
	- 14					
	- 15					
	- 16			SANDSTONE medium grained , medium grey, SILTSTONE 5% dark grey		
	- 17			SILTSTONE dark grey, CARBONACEOUS SHALE 10% dark grey black		
	Drawing	No.:	WRME	01C - Bore Construction AGL Upstream	n Investme	nts Ptv Ltd
PARSONS	Revision			Date drawn: 10/7/14		WRMB01C
BRINCKERHOFF	Drawn b	y: K. M	aher	Checked by: E. Kwantes		
	Project N	No. 21	93324A			

BORE COM	PLE	τιο	N REPORT	- WRMB01C			Page2/7
Project: AGL Gloucester Gas P	roject			Drilling contractor:	Highland Drillin	-	
Location: Wards River				Driller: I. Palk Drilling, n. thod: Ro	Rig: Rig tarv air	ZU Total drilled d	epth: 126.46
Easting: 400584.81 Northing Top of casing elevation: 89.99			50	Bolehole dial eter:		0 - 5.5 m	Bit: Blade
Grid system: MGA 94 Zone 56			height: 0.58 m	Burght lie diameter:		5.5 - 126.45 m	Bit: DHH
Purpose of bore: Monitoring sta Screened Formation: Jilleon Fo Logged by: K. Maher Start date: 21/11/13 Completion date: 22/11/13			2	Sr. n: 111.	45-123.45: 50 m 45-126.45 m: 50	S 18 50 mm PVC nm PVC Class 18) mm PVC Class 1 2.45 m: 0.78 m3	,
Static WL: 40.51 mAHD 4	9.85 m			Bentonite seal: 102.			
Water level date: 2/12/13				Gravel pack: 106. Bentonite plug: NA	45-126.45 m: 5	mm washed grave	1
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY CBABUIC LOC		LITHOLOGY		WATER	QUALITY
2 2 2	- 18	E	CARBONACEOUS	SHALE dark greyish black, MUD	STONE 10% black	-	
	- 19	-	SILTSTONE 5%			_	
	- 20		SILTSTONE dark g	rey, CARBONACEOUS SHALE	10% dark grey black		
	- 21					_	
			SANDSTONE fine	grained, medium grey, SILTSTO	NE 5% dark grey		
	- 22						
	- 23						
	- 24						
	- 25						
	- 26						
	- 27					_	
	- 28		SILTSTONE dark g	rey, SANDSTONE 20% fine grain	ned, medium grey		
	- 29						
	- 30					Water Cut: 0.1 L/s, Tem µS/cm, TDS: 2.066 g/L,	DO: 83.9 %, DO:
	- 31					6.65 ppm, pH: 7.49, OR	P: 59.3 mV
	- 32						
	- 33						
	- 34						
	- 35						
	35						
DADCONC	Drawing I	No.: WI	RMB01C - Bore Construction	MAGL	AGL Upstrea	m Investments	•
PARSONS BRINCKERHOFF	Revision:		Date drawn: 10/7/1	4		WR	MB01C
	Drawn by	: K. Mahei	Checked by: E. Kwant				

BORE COM	PLET	ION	REPORT - WRM	B01C		Page3/7
Project: AGL Gloucester Gas P Location: Wards River	-		Drilling cont Driller: LP Drilling a th	0	20	ed depth: 126.46
Easting: 400584.81 Northing Top of casing elevation: 89.99 Grid system: MGA 94 Zone 56	mAHD		Br.ehole dia Br.ehole dia	a eter: 205.0	0 - 5.5 m 5.5 - 126.4	Bit: Blade
Purpose of bore: Monitoring sta Screened Formation: Jilleon Fo Logged by: K. Maher Start date: 21/11/13 Completion date: 22/11/13 Static WL: 40.51 mAHD 4 Water level date: 2/12/13			Gravel back Bentonite se	111.45-123.45: 50 m 123.45-126.45 m: 50 ut: 0-23.45 m; 60.45-10 fill: NA eal: 102.45-106.45 m : 106.45-126.45 m: 5	nm PVC Class) mm PVC Cla 12.45 m: 0.78 i	18 (0.5 mm slot) ass 18 m3
BORE CONSTRUCTION	DEPTH (m)	GRAPHIC LOG	LITHOLO	GY	WATE	ER QUALITY
	36 				µS/cm, TDS: 2.03	s, Temp: 24.61 °C, EC: 3172 36 g/L, DO: 89.2 %, DO: 39, ORP: 152.4 mV
	- 42 - 43 - 44 - 45		SANDSTONE medium grained , mediur SANDSTONE medium grained , mediur SANDSTONE medium grained , mediur	n grey, SILTSTONE 20% dark grey		s, Temp: 24.52 °C, EC: 303' r g/L, DO: 91.7 %, DO: 7.55 RP: 116.2 mV
	— 46 — 47 — 48		SANDSTONE medium grained , medium SANDSTONE medium grained , medium		µS/cm, TDS: 2.00	s, Temp: 25.82 °C, EC: 308: 15 g/L, DO: 92.1 %, DO:
Cement grout	- 49 - 50 - 51 - 52 - 53		SILTSTONE dark grey, SANDSTONE 2	0% fine grained, medium grey		93, ORP: 103.2 mV
	54				µS/cm, TDS: 2.02	s, Temp: 25.4 °C, EC: 3117 26 g/L, DO: 74 %, DO: 6.02
PARSONS BRINCKERHOFF	Drawing No. Revision: Drawn by: K	A	IC - Bore Construction Date drawn: 10/7/14 Checked by: E. Kwantes	GL AGL Upstrea		nts Pty Ltd WRMB01C

Project No. 2193324A

BORE COM	PLET	ION	REPORT - WRMB01C	Page4/7
Project: AGL Gloucester Gas P	roject		Drilling contractor: Highland Drilling	g
Location: Wards River			Driller: L Palk Rig: Rig 2	
Easting: 400584.81 Northing	j: 64378	358.50		Total drilled depth: 126.46 m
Top of casing elevation: 89.99 r			Br ehole dia, eter: 205.0	0 - 5.5 m Bit: Blade
Grid system: MGA 94 Zone 56	Stic	k-up h	eight: 0.58 m Burehrie diameter: 139.0	5.5 - 126.45 m Bit: DHH
Purpose of bore: Monitoring sta Screened Formation: Jilleon Fo Logged by: K. Maher Start date: 21/11/13 Completion date: 22/11/13	ormation		Plain cosing: 0-1114.45 m: CLASS Sricen: 111.45-123.45: 50 m Sump: 123.45-126.45 m: 50 Cement grout: 0-23.45 m; 60.45-102 Gravel backfill: NA Bentonite seal: 102.45-106.45 m	m PVC Class 18 (0.5 mm slot) mm PVC Class 18
Static WL: 40.51 mAHD 43 Water level date: 2/12/13	9.85 mbi	oc	Gravel pack: 106.45-126.45 m: 5 m Bentonite plug: NA	nm washed gravel
BORE CONSTRUCTION	DEPTH (m) STRATICRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	- 55	臺		ppm, pH: 7.69, ORP: 100.6 mV
50 mm blank PN18 U- PVC casing (threaded)	- 56			
	- 57			
	50			
	58			
	- 59			
	- 60			Water Cut: 0.2 L/s, Temp: 24.68 °C, EC: 3149
	- 61			μS/cm, TDS: 7.047 g/L, DO: 85.2 %, DO: 7.02 ppm, pH: 7.82, ORP: 103.2 mV
	- 62		SANDSTONE medium grained , medium grey, SILTSTONE 10% dark grey	
	- 63			
5 1/2 inch diameter borehole			SANDSTONE very fine grained , medium to dark grey, SILTSTONE 10% dark grey	
	- 64			
	- 65			
	- 66			Water Cut: 0.2 L/s, Temp: 25.28 °C, EC: 3015
	- 67		SANDSTONE medium grained , medium grey	µS/cm, TDS: 1.96 g/L, DO: 91.6 %, DO: 7.48 ppm, pH: 7.79, ORP: 83.7 mV
			SANDSTONE medium grained , medium grey, SILTSTONE 10% dark grey	
	- 68		SANDSTONE medium grained , medium grey	
	- 69			
	- 70	· · ·		-
	71		SILTSTONE dark grey, SANDSTONE 10% fine grained, medium grey	
	— 72 — 73		SILTSTONE dark grey, SANDSTONE 10% medium grained , medium grey	Water Cut: 0.2 L/s, Temp: 25.6 °C, EC: 2912 µS/cm, TDS: 1.893 g/L, DO: 91.3 %, DO: 7.39 ppm, pH: 7.87, ORP: 89.8 mV
	Drawing No.:	WRMB	IC - Bore Construction AGL Upstream	m Investments Pty Ltd
PARSONS	Revision: A	4	Date drawn: 10/7/14	WRMB01C
BRINCKERHOFF	Drawn by: K	Maher	Checked by: E. Kwantes	

Project No. 2193324A

BORE COM	PLE	тіс	ON REPOR	T - WRMB01	IC		Page5/7
Project: AGL Gloucester Gas P Location: Wards River Easting: 400584.81 Northing	-	2705	8.50	Drilling contracto Driller: L Palk Drilling m. thod:	Rig: Rig	20	l depth: 126.46 r
Top of casing elevation: 89.99 Grid system: MGA 94 Zone 56	mAHD			Br.ehole dia. etc n B. ehr ie diamete		0 - 5.5 m 5.5 - 126.45 r	Bit: Blade
Purpose of bore: Monitoring sta Screened Formation: Jilleon For Logged by: K. Maher Start date: 21/11/13 Completion date: 22/11/13 Static WL: 40.51 mAHD 4 Water level date: 2/12/13		on	3	Srichn: 1 Sump: 1 Cement grout: 0 Gravel backfill: N Bentonite seal: 1	02.45-106.45 m 06.45-126.45 m: 5 ı	m PVC Class 1 mm PVC Class 2.45 m: 0.78 m3	8 (0.5 mm slot) s 18 3
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY		WATER	2 QUALITY
	74 75 76 77						
	- 78 - 79 - 80		SANDSTONE fir	ne grained, medium grey, SILTS	STONE 5% dark grey	-	
	- 81 - 82 - 83 - 84						emp: 23.46 °C, EC: 2881
	- 85 - 86 - 87	_	SANDSTONE m	edium grained , medium grey, {	SILTSTONE 15% dark grey	μS/cm, IDS: 1.872 ξ 7.31 ppm, pH: 7.79,	µL, DO: 86.7 %, DO: ORP: 75.3 mV
2222222	- 88 - 89 - 90			ne grained, medium grey, COAI	5% black, SILTSTONE		iemp: 24.04 °C, EC: 2712
	-91 92		5% dark grey	e grained, medium grey, SILTS		µS/cm, TDS: 1.762 g 6.49 ppm, pH: 7.86,	µL, DO: 76.5 %, DO: ORP: 71.5 mV
PARSONS BRINCKERHOFF	Drawing Revision Drawn b Project N	: A y: K. Mał	her Checked by: E. Kw	7/14	AGL Upstrea		ts Pty Ltd RMB01C

BORE COM	PLE	TIC	ΟN	REPORT - WRMB01	С		Page6/7
Project: AGL Gloucester Gas P Location: Wards River	roject			Drilling contracto Driller: I. Palk	Rig: Rig	20	d dopthy 126.46 m
Easting: 400584.81 Northing	•		8.50	Drilling n. thod: Bc.ehole dia. etc		0 - 5.5 m	ed depth: 126.46 m
Top of casing elevation: 89.99 r Grid system: MGA 94 Zone 56			un h	eight: 0.58 m B. teh ie diamete		5.5 - 126.45	Bit: Blade
Purpose of bore: Monitoring sta			upi		1114.45 m: CLASS		
Screened Formation: Jilleon For Logged by: K. Maher Start date: 21/11/13 Completion date: 22/11/13 Static WL: 40.51 mAHD 44 Water level date: 2/12/13		Sricen: 1 Sump: 1 Cement grout: 0 Gravel backfill: N Bentonite seal: 1	11.45-123.45: 50 m 23.45-126.45 m: 50 23.45 m; 60.45-102 A 02.45-106.45 m 06.45-126.45 m: 5 r	m PVC Class mm PVC Cla 2.45 m: 0.78 r	18 (0.5 mm slot) ss 18 n3		
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY		WATE	R QUALITY
Bentonite seal	- 92 - 93 - 94 - 95 - 96 - 97 - 98 - 99 - 100 - 101 - 102 - 103 - 104 - 105 - 106 - 107 - 108 - 109 - 110			SANDSTONE fine grained, medium grey, SILTS SANDSTONE fine grained, medium grey, SILTS SANDSTONE fine to medium grained, medium	TONE 20% dark grey	ppm, pH: 7.85, Of Water Cut: 0.35 L 2352 µS/cm, TDS DO: 6.07 ppm, pH	/s, Temp: 29.09 °C, EC: : 1.528 g/L, DO: 79.9 %, I: 7.9, ORP: 93.8 mV s, Temp: 20.53 °C, EC: 2828 8 g/L, DO: 85 %, DO: 7.58
PARSONS	Drawing I		WRMB	IIC - Bore Construction	AGL Upstrea		•
BRINCKERHOFF	Revision: Drawn by		aher	Date drawn: 10/7/14 Checked by: E. Kwantes			WRMB01C

Project No. 2193324A

BORE COM	PLE	TIC	ΟN	REPORT - WRMB01C		Page7/7
Project: AGL Gloucester Gas Pr	roject			Drilling contractor: Highland Drillir		
Location: Wards River				Driller: I. Palk Rig: Rig		
Easting: 400584.81 Northing	j: 643	3785	8.50			lepth: 126.46 n
Top of casing elevation: 89.99 r				Be ehole dia, eter: 205.0	0 - 5.5 m	Bit: Blade
Grid system: MGA 94 Zone 56	St	ick-	up h	eight: 0.58 m B. eh ie diameter: 139.0	5.5 - 126.45 m	Bit: DHH
Purpose of bore: Monitoring sta Screened Formation: Jilleon Fo Logged by: K. Maher Start date: 21/11/13 Completion date: 22/11/13				Plain chsing: 0-1114.45 m: CLAS3 Srichn: 111.45-123.45: 50 m Sump: 123.45-126.45 m: 50 Cement grout: 0-23.45 m; 60.45-10 Gravel backfill: NA Bentonite seal: 102.45-106.45 m	nm PVC Class 18) mm PVC Class 1	,
Static WL: 40.51 mAHD 49	9.85 m	nbto	5	Gravel pack: 106.45-126.45 m: 5	mm washed grave	
Water level date: 2/12/13				Bentonite plug: NA	min washed grave	
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
Gravel pack (5 mm wash) 50mm slotted PN18 U- PVC casing (0.5 mm aperture) 50 mm blank PN18 U- PVC sump (threaded)	- 111 - 112 - 113 - 114 - 115 - 116 - 117 - 118 - 119 - 120 - 121 - 122 - 123 - 124			SANDSTONE fine to medium grained, medium grey, SILTSTONE 20% dark grey SANDSTONE fine to medium grained, medium grey, SILTSTONE 5% dark grey	Water Cut: 0.4 L/s, Tem μS/cm, TDS: 1.668 g/L, 6.58 ppm, pH: 7.95, OR Water Cut: 0.4 L/s, Tem μS/cm, TDS: 1.482 g/L, 6.72 ppm, pH: 7.98, OR	DO: 76.5 %, DO: P: 103.2 mV p: 23.58 °C, EC: 2281 DO: 79.8 %, DO:

DARCONO	Drawing No.: WRMB	01C - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS BRINCKERHOFF	Revision: A	Date drawn: 10/7/14		WRMB01C
DRINGRERHUFF	Drawn by: K. Maher	Checked by: E. Kwantes		
	Project No. 2193324A			

Project: AGL Gloucester Gas Project: Location: Wards River Easting: 4007507 Northing: 6437838.17 Top of casing elevation: 90.1 mAHD Grid system: MGA 94 Zone 56 Stick-up height: 0.62 m Borehole diameter: 205 0-32 m Bit: DHH Borehole diameter: 205 0-32 m Bit: DHH Borehole diameter: 205 0-32 m Bit: DHH Borehole diameter: 205 0-32 m Bit: DHH Bit: PCD Palin casing: 0-178 m: 73 mm threaded steel Screene formation: Logged by: K.Maher Start dite: 11/6/14 Completion date: 13/6/14 Completion date: 11/6/14 Bore ConSTRUCTION BORE CONSTRUCTION Curving tradewise and Curving tradewi	BORE COM	PLE	TIC	ON	REPORT	Г- WRMB0	1D		Page1/8
Location: Values Note: Top of casing elevation: 90.1 mAHD Grid system: MGA 94 Zone 56 Stick-up height: 0.62 m Borehold diameter: 205 0-32 m Bit: DHH Borehold diameter: 205 0-32 m Bit: DHH Borehold diameter: 127 32-199 m Bit: PCD Purpose of bore; Groundwater monitoring bore Screened Formation: 11/0/14 Completion date: 18/0/14 Statt date: 11/0/13 Statt date: 11/0/13 Statt date: 11/0/14 Completion date: 18/0/14 Statt date: 11/0/13 Bore CONSTRUCTION Borehold diameter: 205 0-32 m Bit: PCD Borehold diameter: 205 0-32 m Bit: DHH Borehold diameter: 127 32-199 m Bit: PCD Borehold diameter: 127 33 m: 178 m Bit: PCD Screene: 178-184 m: Pedrotadd Steel Screene: 178-184 m: Pedrotadd Steel Screene: 178-184 m: Pedrotadd Steel Screene: 178-184 m: Nearded steel Screene: 178-184 m: Pedrotadd Steel Sump: 184-193 m: 73 mm threaded steel Screene: NA Gravel pack: NA Bentonite plug: NA Bentonite plug: NA Bore CONSTRUCTION BORE CONSTRUCTION Cut get: block, with cating engl Cut get: block, with ca	_	roject				-	0	-	
Lasting - NUCL 02, WITHING - State of the second of the							-		d denth: 199 m
Top of classing elevation, our involution of child system. WAG 49 42 one 55 Stick-up height: 0.62 m Borehole diameter: 127 32 - 199 m Bit: PCD Purpose of bore: Groundwater monitoring bore Screene: 178 - 194 m: Perforated Steel Screene: 178 - 194 m: Perforated Steel Screened Formation: Jielico Mitter: Jielico Mitter: Jielico Mitter: 178 - 194 m: Perforated Steel Screene: 178 - 194 m: Perforated Steel Screene: 178 - 194 m: Perforated Steel Completion date: 186/014 Stere Steel Screene: 178 - 194 m: Perforated Steel Static WL: NA NA Gravel pack:: NA BORE CONSTRUCTION Wag Market Berninite set: NA Gravel pack:: NA BORE construction -1 CLAY fight boomth grey, with orange motion CLAY fight growth browt, with orange motion Gravel pack:: NA State data: -1 CLAY fight growth browt, with orange and red motion Gravel pack in set on the se	Easing. 400370.97 Northing. 0437636.17								
Purpose of bore: Groundwater monitoring bore Screened Formation: Jilleon Formation Logged by: K. Mahar Start date: 11/8/14 Completion date: 12/8/14 Static WL: NA NA Water level date: 17/10/13 BORE CONSTRUCTION H G 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1									
Sorie and Formation: Screen: 172-134 m: Perforated Steel Logged by: K. Maher Sump: 184-193 m: 73 mm threaded steel Start date: 11/6/14 Camend grout: Camend grou	-			-	-	Borehole diame	ter: 127	32 - 199 m	Bit: PCD
Gravel pack: NA Bentonite plug: NA BORE CONSTRUCTION Image: state of the state of	Screened Formation: Jilleon Fo Logged by: K. Maher Start date: 11/6/14 Completion date: 18/6/14	ormatic		g bor	e	Screen: Sump: Cement grout: Gravel backfill:	178-184 m: Perforate 184-193 m: 73 mm th D-199m: 2.5m3 NA	d Steel	
BORE CONSTRUCTION Image: Participation of the state o		A				-			
Steel headworks and monument (not to scale) -1 CLAY light brownish grey, with orange motiles -1 CLAY light greyish brown, with orange and red motiles -2 -3 -3 CLAY light greyish brown, with orange and red motiles -3 CLAY light reddish grey -5 CLAY light greyish grey -6 CLAY light grey -7 SHALE light grey -8 SHALE light grey -1 -1 -1 -1 -2 SHALE light grey -7 SHALE light grey -7 SHALE light grey -1 -1 -1 -1 -2 SHALE light grey -7 SHALE light grey -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -11 -1 -12 SHALE medium grey -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -16 -17 -18 -10	Water level date: 17/10/13				1	Bentonite plug:	NA	1	
Steel headworks and monument (not to scale) -0 CLAY light brownish grey, with orange mottles -1 CLAY light greyish brown, with orange and red mottles -2 -3 -3 -4 CLAY light greyish brown, with orange and red mottles -3 -4 CLAY light greyish brown, with orange and red mottles -3 -6 CLAY light grey -6 CLAY light grey -7 -6 CLAY light grey -7 -8 SHALE light grey -11 -1 -2 -1 -3 -1 -4 CLAY light grey -6 CLAY light grey -7 -7 -8 SHALE light grey -10 -1 -11 -1 -12 SHALE medium grey -13 -1 -14 SANDSTONE fine grained (0: 125-0.25 mm), medium grey, CLAY 10% SLTSTONE dark grey -16 -17 -18	BORE CONSTRUCTION		STRATIGRAPHY	GRAPHIC LOG		LITHOLOGY		WATE	R QUALITY
CLAY light greyish brown, with orange motites -1 CLAY light greyish brown, with orange and red motites -2 -4 -4 CLAY light reddish grey -5 CLAY light reddish grey -6 CLAY light grey -7 CLAY light grey -8 SHALE light grey -7 SHALE light grey 10 SHALE dark grey 11 -11 12 SHALE light grey 13 SHALE medium grey 14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% 15 SILTSTONE dark grey 16 -17 18 -17		1							
1 CLAY light greyish brown, with orange and red mottles 2 3 4 CLAY light greyish brown, with orange and red mottles 5 CLAY light grey 6 CLAY light grey 7 CLAY light grey 8 SHALE light grey 9 SHALE light grey 10 SHALE light grey 11 SHALE light grey 12 SHALE medium grey 13 SHALE medium grey 14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% 15 SLITSTONE dark grey 16 SLITSTONE dark grey	monument (not to scale)	-0		\square	CLAY light brownis	h grev, with orange mottles			
-2 -3 -4 CLAY light reddish grey -5 CLAY light grey -6 CLAY light grey -7 -8 SHALE light grey -9 SHALE light grey -10 -11 -12 SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17		-1		\longrightarrow	_				
-3 -3 -4 CLAY light reddish grey -5 CLAY light yellowish grey -6 CLAY light grey -7 CLAY light grey -7 SHALE light grey 9 SHALE light grey 10 SHALE dark grey 11 SHALE medium grey 12 SHALE medium grey 13 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% 15 SILTSTONE dark grey 16 SILTSTONE dark grey		_2		$\langle \rangle \rangle$	CLAY light greyish	brown, with orange and rec	Imottles		
-4 CLAY light reddish grey -5 CLAY light yellowish grey -6 CLAY light grey -7 CLAY light grey -8 SHALE light grey -9 SHALE dark grey -10 SHALE dark grey -11 SHALE medium grey -12 SHALE medium grey -13 SHALE medium grey -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 SILTSTONE dark grey		2		$\langle \rangle$					
CLAY light reddish grey -5 CLAY light reddish grey -6 CLAY light grey -7 CLAY light grey -8 SHALE light grey -9 SHALE light grey -10 SHALE dark grey -11 SHALE medium grey -12 SHALE medium grey -13 SHALE medium grey -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 SILTSTONE dark grey		-3		$\langle \rangle \rangle$					
-5 CLAY light yellowish grey -6 CLAY light grey -7 CLAY light grey -8 SHALE light grey -9 SHALE dark grey -10 -11 -11 -12 SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% SILTSTONE dark grey -16 -17 -18		-4		\mathcal{H}	CLAY light reddish	arev			
-6 CLAY light grey -7 SHALE light grey -9 SHALE light grey -10 SHALE dark grey -11 SHALE medium grey -12 SHALE medium grey -13 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 SILTSTONE dark grey		-5		$\not\leftarrow$	_				
CLAY light grey -7 -8 SHALE light grey -9 SHALE dark grey -10 -11 -12 SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18		-6		\sum	CLAY light yellowis	n grey			
-8 SHALE light grey -9 SHALE dark grey -10 -11 -11 -12 -12 SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18 -18				$\langle \rangle \rangle$	CLAY light grey				
SHALE light grey 9 10 11 12 12 SHALE dark grey 13 14 14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% 15 SILTSTONE dark grey 16 17 18		_′		$\langle \rangle \rangle$					
9 SHALE dark grey 10 -11 -12 SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18		-8			SHALE light grey			1	
-10 -11 -11 -12 -12 SHALE medium grey -13 -14 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18 -18		-9							
-12 SHALE medium grey -13 -14 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18 -18		- 10			C LE dain groy				
SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18		11							
SHALE medium grey -13 -14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18		- 12							
-14 SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 SILTSTONE dark grey -16 -17 -18 -18					SHALE medium gre	Эу			
SANDSTONE fine grained (0.125-0.25 mm), medium grey, CLAY 10% -15 -16 -17 -18		- 13							
SILTSTONE dark grey		- 14		• . • .	SANDSTONE fine	grained (0.125-0.25 mm), n	nedium grey, CLAY 10%		
		- 15			SILTSTONE dark o	rey			
		- 16			3				
		- 17							
Drawing No.: WRMB01 - Bore Construction					1			1	

DI DOONO	Drawing No.: WRMB	01 - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE COM	PLE	TIC	ЭN	REPORT - WRMB01D		Page 2/8
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
	18			SILTSTONE medium to dark grey		
	- 19 - 20 - 21				**Note: no water being drilled with	cuts or quality due to bore muds
	- 22				-	
	- 23			SANDSTONE fine grained (0.125-0.25 mm), medium grey	-	
	- 24			SILTSTONE dark grey		
	- 25					
	- 26					
	- 27					
	- 28					
	- 29					
	- 30					
	- 31					
	- 32 - 33			SANDSTONE fine grained (0.125-0.25 mm), medium grey, SILTSTONE 20% dark grey	-	
	- 34					
	- 35		· · · ·	SANDSTONE fine grained (0.125-0.25 mm), medium grey, SILTSTONE	-	
	- 36			20% dark grey, rare coaly whisps SANDSTONE fine grained (0.125-0.25 mm), medium grey	-	
	- 37			S. ALSO FOR LINE granica (S. 120 S.20 Hint), modelin groy		
	38		· · · · · · · · · · · · · · · · · · ·			
	39					
	- 40		· · · ·	SANDSTONE fine grained (0.125-0.25 mm), medium grey, SILTSTONE	**Note: no water	cuts or quality due to bore
	- 41		· · · · · · · · · · ·	20% dark grey	being drilled with	muds
	- 42					
	- 43					
	- 44		· · · · · · · · · · · · · · · · · · ·			
	- 45					
	- 46			SILTSTONE dark arev. SANDSTONE 10% fine to medium grained	-	
	47			SILTSTONE dark grey, SANDSTONE 10% fine to medium grained sandstone (0.125-0.50 mm), light to medium grey		

DI DOONO	Drawing No.: WRMB	01 - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE COMPLETION REPORT - WRMB01D						Page 3/8
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
	- 47 - 48 - 49					
	— 50 — 51					
	— 52 — 53 — 54					
	— 55 — 56			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 30% medium to dark grey		
	— 57 — 58 — 59					
	- 60 - 61 - 62			SILTSTONE dark grey, minor black COAL SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium to dark grey, SILTSTONE 5% dark grey	**Note: no water of being drilled with	suts or quality due to bore muds
	- 62 - 63 - 64			SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 5% dark grey		
	- 65 - 66 - 67			SILTSTONE medium to dark grey, SANDSTONE 10% very fine to fine grained (0.0625-0.25 mm), medium grey	-	
	- 68 - 69					
	- 75			SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 10% dark grey, minor black COAL		
PARSONS BRINCKERHOFF	Drawing Revisior Drawn b	n: A		D1 - Bore Construction Date drawn: 10/7/14 Checked by: E. Kwantes AGL Upstream		WRMB01D

Project No. 2193324A

Phase 2 Groundwater Investigation

BORE COMF	PLET		Ν	REPORT - WRMB01D		Page 4/8
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
	— 76 — 77		· · · · · · · · · · · · · · · · · · ·			
	— 78 — 79 — 80		· · ·	SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 5% dark grey	**Note: no water	cuts or quality due to bore
			· · ·		being drilled with	cuts or quality due to bore muds
	— 83 — 84 — 85					
	86 87					
60mm ID / 75mm OD flush threaded steel casing	88 89 90					
	— 93 — 94		· · ·			
5 inch diameter borehole	— 95 — 96 — 97		•] •	SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), medium grey, SILTSTONE 10% dark grey		
Cement grout 14ppg mix, pressure cemented	— 98 — 99		· · ·	SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium to dark grey, SILTSTONE 20% dark grey	-	
pressure cemented	— 100 — 101 — 102		1.1	groy, one i o rome 2070 dain groy	**Note: no water being drilled with	cuts or quality due to bore muds
	103 104					

DI DOONO	Drawing No.: WRMB	01 - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE CONSTRUCTION Name O 00 Here LITHOLOGY WATER QUALITY	BORE COM	PLETI	ON	REPORT - WRMB01D		Page 5/8
- 100 - 107 - 108 - 109 - 109 - 109 - 119 - 112 - 112 - 112 - 113 - 114 - 114 - 114 - 114 - 115 - 115 - 115 - 116 - 116 - 117 - 118 - 118 - 118 - 120 - 121 - 122 - 122 - 122 - 122 - 122 - 122 - 122 - 123 - 124 - 124 - 125 - 124 - 125 - 125 - 127 - 128 -	BORE CONSTRUCTION	DEPTH (m) STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
Drawing No.: WRMB01 - Bore Construction AGL Upstream Investments Pty Ltd		 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 126 127 128 129 130 131 131 132 				

DA DOONIO	Drawing No.: WRMB	01 - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

BORE COM		Page 6/8				
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
	- 134 - 135 - 136 - 137 - 138 - 139 - 140			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, CLAY 10% light grey SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 20% dark grey, CLAY 20% light grey		
	- 141 - 142 - 143 - 144 - 145 - 146			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 20% dark grey, CLAY 10% light grey SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey	**Note: no water being drilled with	uts or quality due to bore muds
	- 147 - 148 - 149 - 150 - 151 - 152	· · · · · · · · · · · · · · · · · · ·		SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 5% dark grey		
	- 153 - 154 - 155 - 156 - 157	-		SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 5% dark grey		
	— 158 — 159 — 160 — 161	•	· · · · · · · · · · · · · · · · · · ·	SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 20% dark grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 10% dark grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 25% dark grey	**Note: no water being drilled with	suts or quality due to bore muds
	— 160	•	· · · · · · · · · · · · · · · · · · ·	grey, SILTSTONE 10% dark grey	being drilled with	muds

DADCONC	Drawing No.: WRMB	01 - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

PLET		REPORT - WRMB01D	Page 7/8
DEPTH (m)	STRATIGRAPHY GRAPHIC LOG	LITHOLOGY	WATER QUALITY
— 163 — 164 — 165 — 166 — 167 — 168		SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 10% dark grey	
— 169 — 170 — 171 — 172		SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 5% dark grey SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), medium greenish grey	
- 173 - 174 - 175 - 176		SANDSTONE very fine to fine grained (0.0625-0.25 mm), light greyish brown, SILTSTONE 5% dark grey SILTSTONE dark grey, SANDSTONE 30% very fine to fine grained (0.0625-0.25 mm), medium greenish grey SILTSTONE dark grey, SANDSTONE 5% very fine to fine grained (0.0625- 0.05 mm) and up gray.	
- 177 - 178 - 179 - 180		SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium greenish grey, SILTSTONE 10% dark grey	**Note: no water cuts or quality due to bore
— 181 — 182 — 183		(0.0625-0.25 mm), medium grey, minor carbonaceous fragments SILTSTONE dark grey, SANDSTONE 50% very fine to fine grained (0.0625-0.25 mm), medium grey	being drilled with muds
— 184 — 185 — 186		SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium to dark grey, SILTSTONE 5% dark grey	-
— 187 — 188 — 189 — 190		SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium greenish grey, SILTSTONE 30% dark grey	
	(b) HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HLd HL	Comparison Comparison (m) DEPTH 163	Image: second

DADOONO	Drawing No.: WRMB	01 - Bore Construction	2	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14	2		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes			Phase 2 Groundwater Investigation
	Project No. 2193324A				

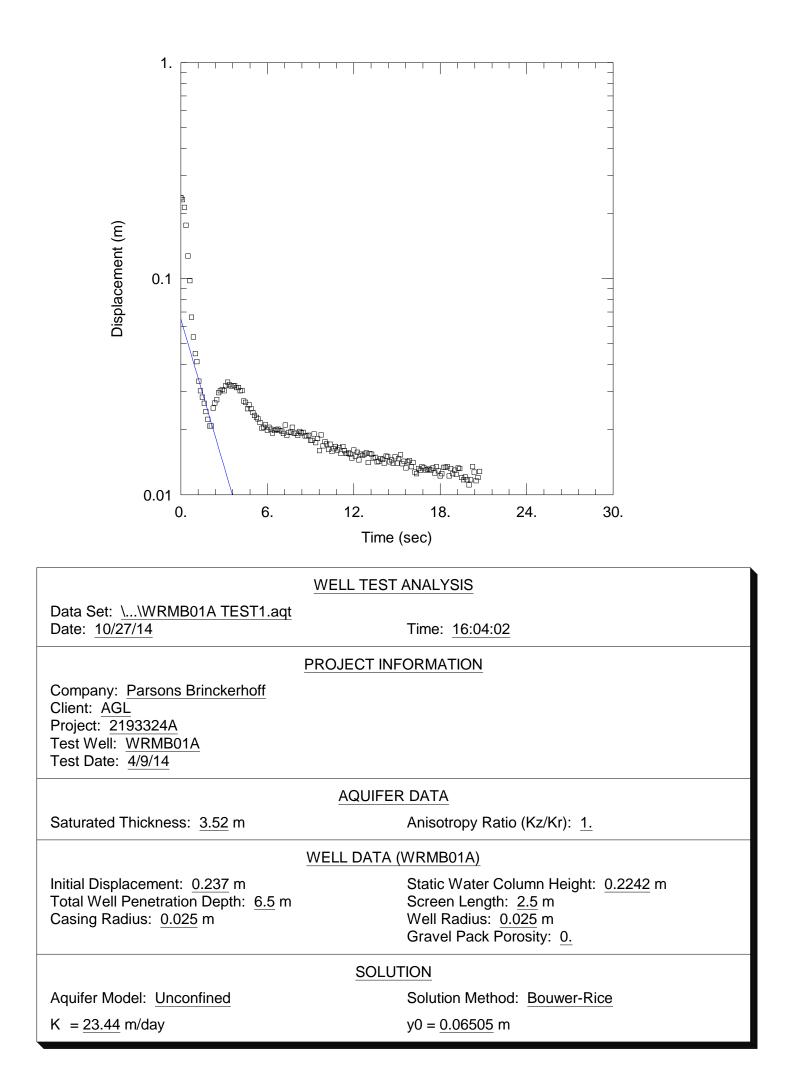
BORE COM	PLE	TIC	ΟN	REPORT - WRMB01D		Page 8/8
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER	QUALITY
Borehole Obstruction (189.8 - 193mbgl)	191 			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), medium greenish grey, SILTSTONE 10% dark grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 30% dark grey		

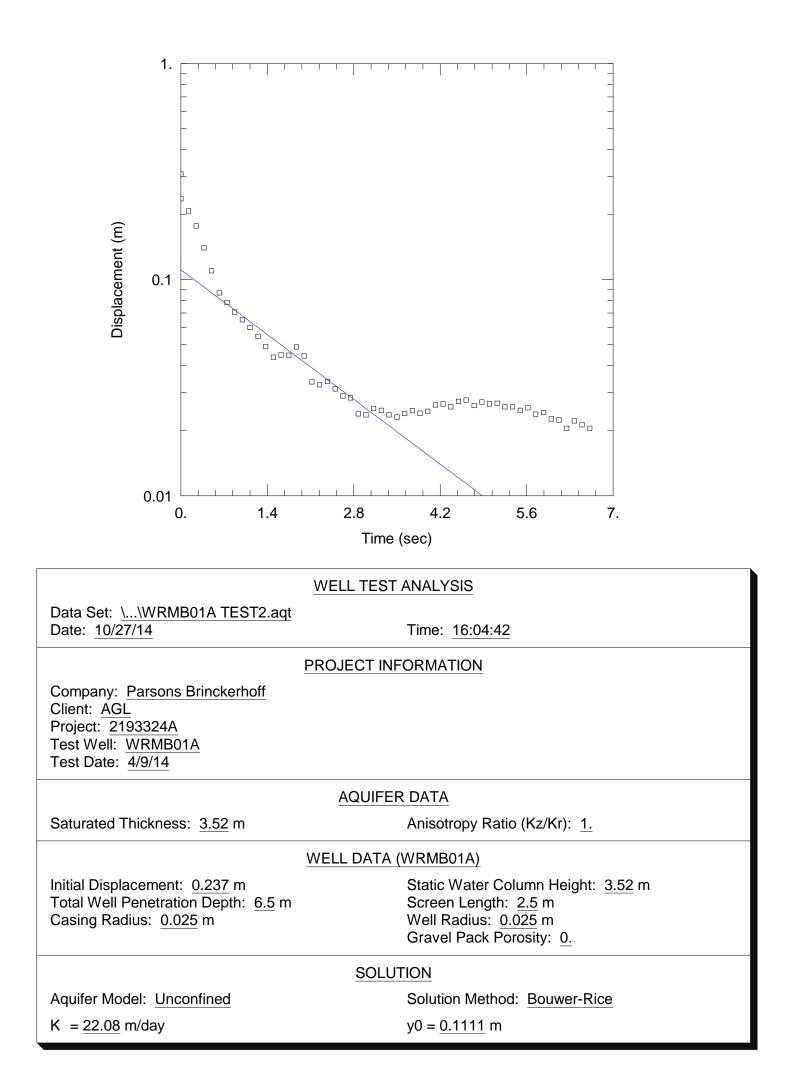
DI DOONO	Drawing No.: WRMB	01 - Bore Construction	MAGL	AGL Upstream Investments Pty Ltd
PARSONS	Revision: A	Date drawn: 10/7/14		WRMB01D
BRINCKERHOFF	Drawn by: K Maher	Checked by: E. Kwantes		Phase 2 Groundwater Investigation
	Project No. 2193324A			

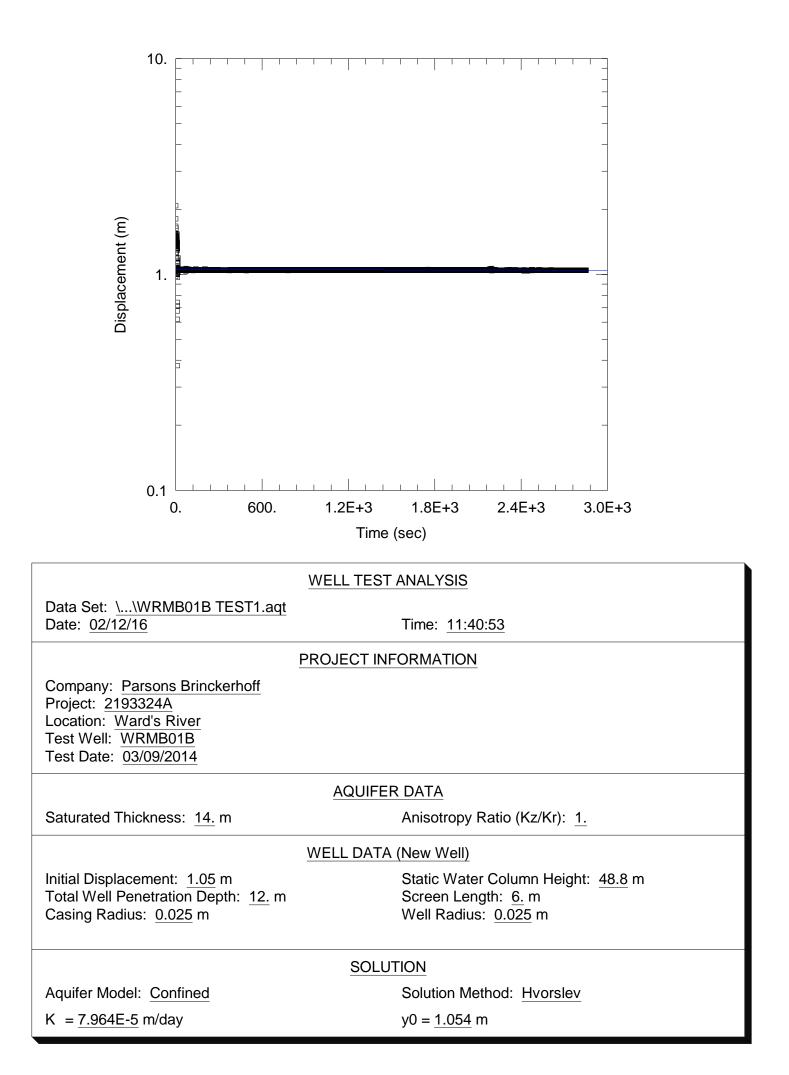
Appendix C

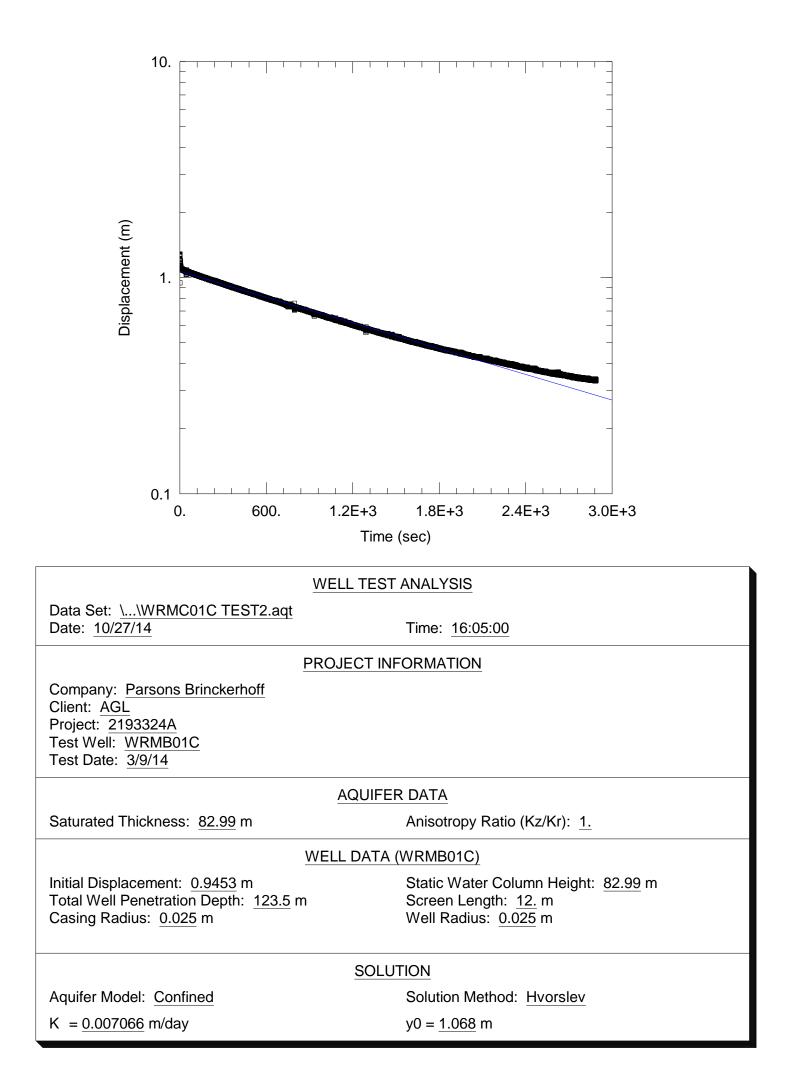
Hydraulic conductivity reports

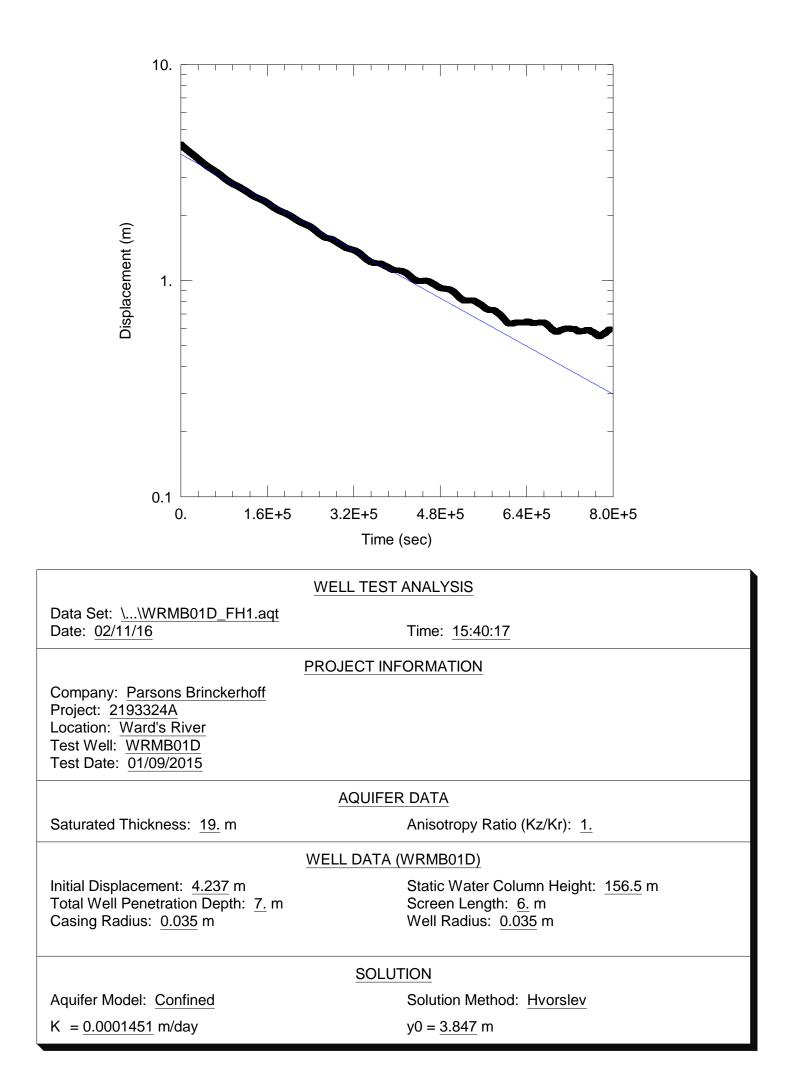


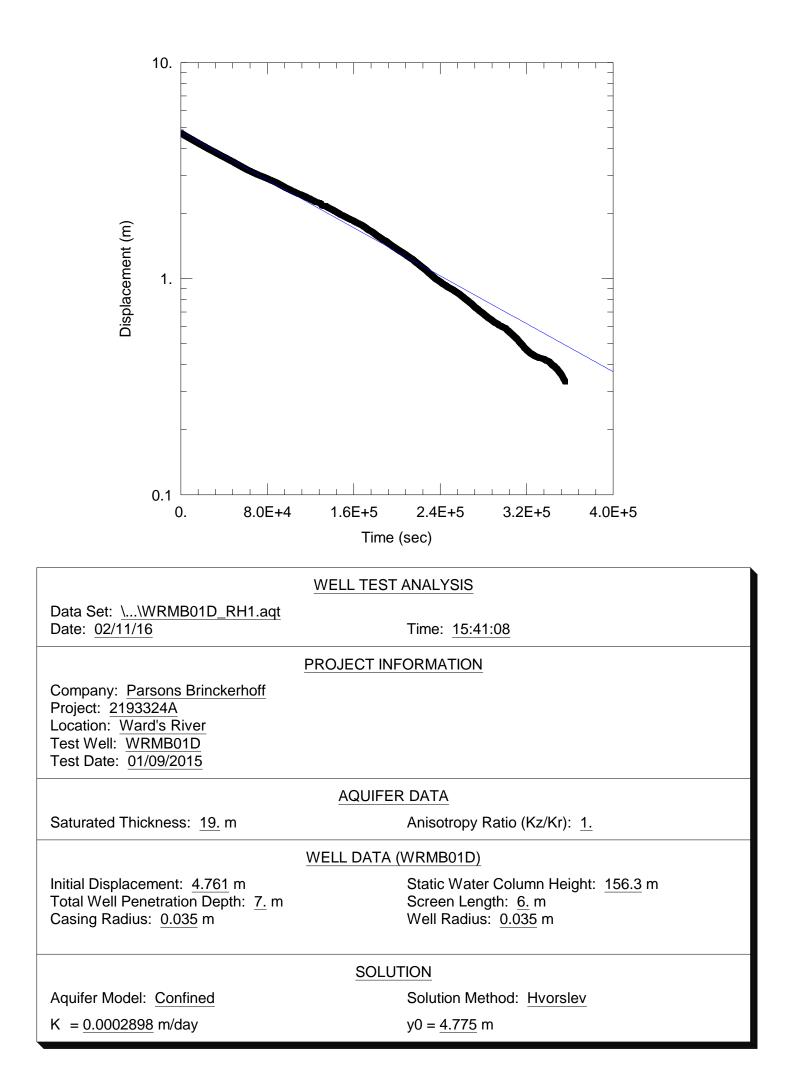








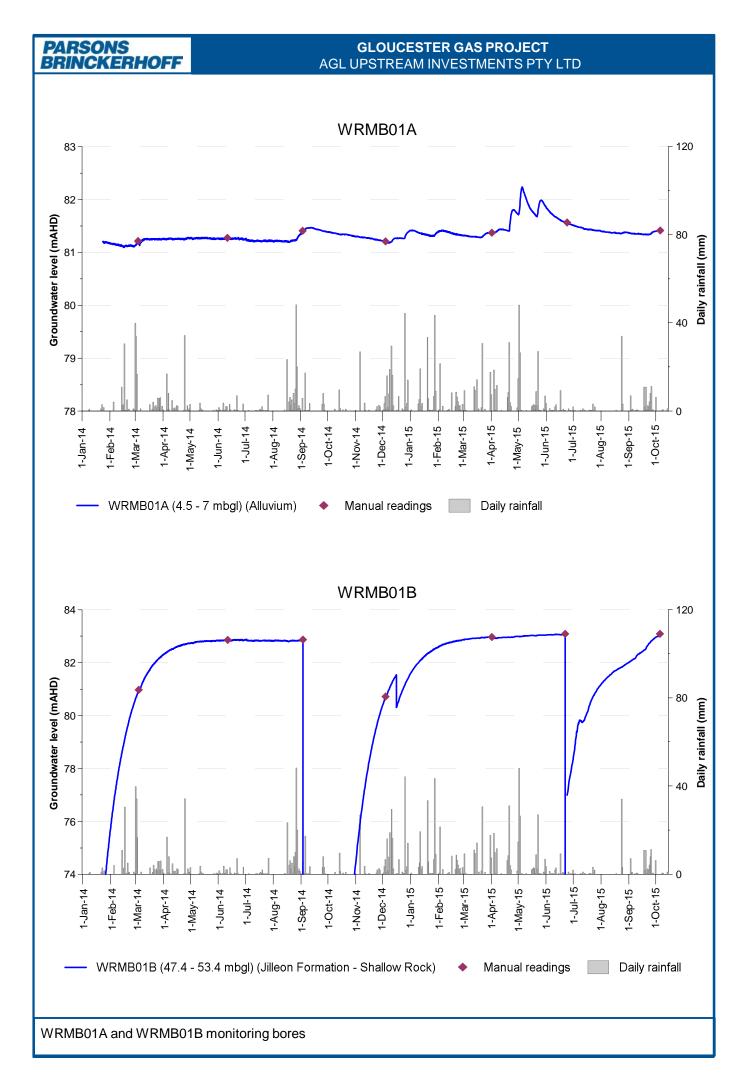




Appendix D

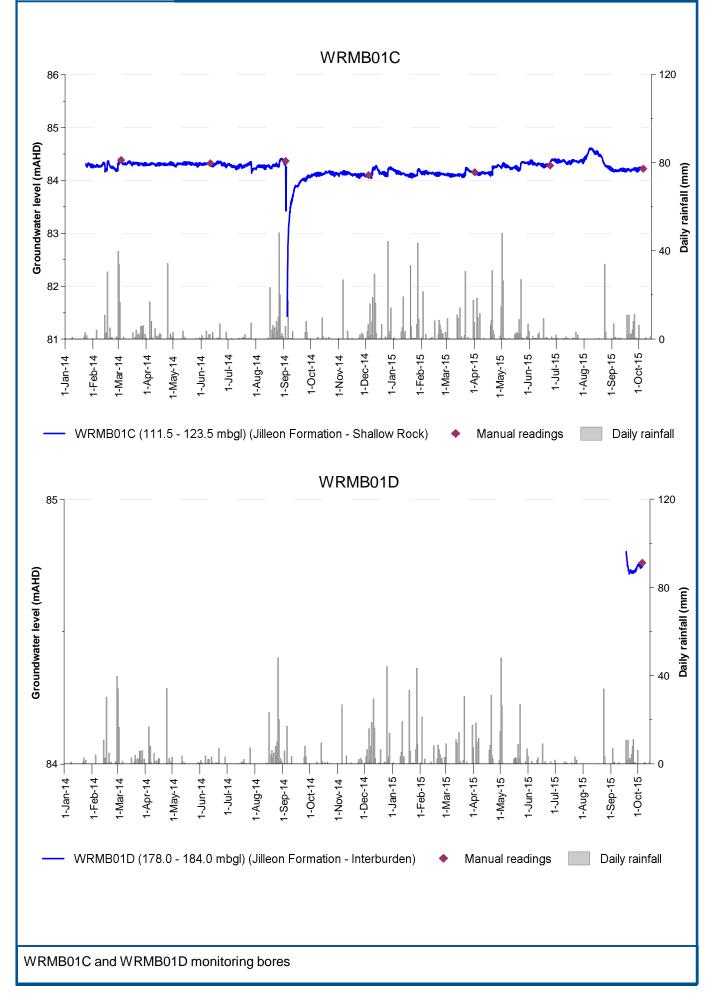
Hydrographs





PARSONS BRINCKERHOFF

GLOUCESTER GAS PROJECT AGL UPSTREAM INVESTMENTS PTY LTD



Appendix E

Water quality summary table



WATER QUALITY RESULTS - Wards River monitoring bores

Non-standNormal personsNormal personsNormal personsNormal personsNormal personsSector100100100100100100100Sector100100100100100100100100100100Sector100 <th>Analyte Sample date</th> <th>Units</th> <th>LOR</th> <th>WRMB01A 4/09/2014</th> <th>WRMB01B 17/09/2014</th> <th>WRMB01C 4/09/2014</th> <th>WRMB01D 9/10/2015</th>	Analyte Sample date	Units	LOR	WRMB01A 4/09/2014	WRMB01B 17/09/2014	WRMB01C 4/09/2014	WRMB01D 9/10/2015
Cardier's pindsScient <th>•</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	•						
The phanyoptPartPartPartPartPartNon-serialNon-PartPartPartPartPartNon-serialNon-PartPartPartPartPartNon-serialNon-PartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serialPartPartPartPartPartPartNon-serial <t< td=""><td></td><td>uS/cm</td><td></td><td>1417</td><td>3032</td><td>3371</td><td>2841</td></t<>		uS/cm		1417	3032	3371	2841
SD ray, Press, PartialSpace		- mg/L					9.02 1843
Back (mag)minminminminminminminminminminpillaisCorrPillaisCorrNo<	DO % (Field)	%			28.1		
Conduction (2.5)Splem(1.1)(1.1)(3.1)(3.0)(3.5)(3.5)(3.5)Conduction (3.5)(1.1)	Redox (Field)	mV		-71.2	96	-81.9	-201.2
TPSmpL10010110601110106010<	Conductivity @ 25 C	µS/cm		1410	3040	3450	2900
Sinter SchwartSinter SchwartSinte							9.1 1470
Bisoboux Allainer actional Alla		•				-	614 - 617 3
Nation (pate action) npl. 1 npl. npl. 1 npl. npl. 1 Npl.	Bicarbonate Alkalinity-mg CaCO3/L	mg/L					440
Observer opt 1 71 6 6 6 Parasasan Opt 1 200 1 400 30 1 Parasasan Opt 1 001 001 001 102 10 100 Parasasan Opt 01 021	Alkalinity (Hydroxide) as CaCO3	mg/L	1	<1	<1	<1	<1
Decom Probab Probab </td <td>Calcium (Filtered)</td> <td>mg/L</td> <td>1</td> <td>71</td> <td>6</td> <td>5</td> <td>6</td>	Calcium (Filtered)	mg/L	1	71	6	5	6
Biologopi0.10.10.40.40.40.40.4one Blanceb,0.010.001.01.00.02sine Blanceb,0.010.020.030.020.03Sine sb02/Persionopi0.010.020.030.020.01Prephronsopi0.010.020.000.020.00Name on Nopi0.010.050.000.000.000.00Name on Nopi0.010.000.000.000.000.00Sector Prephrons a Popi0.010.000.000.000.000.00Sector Prephrons a Popi0.010.00							
Inter. Binner No. 1.22 4.2 3.84 1.85 Binon Binders mpl. 0.01 1.23 1.13 1.14 1.84 Binon Binders mpl. 0.01 0.03 0.03 0.03 0.03 0.03 0.03 Ninter Les N mpl. 0.01 0.03 0.07 0.03 <		-					734 0.1
Needle Bilonop_L0.05NNANNANNANAA222Progebouxmp_L0.010.230.130.120.10Progebouxmp_L0.010.680.000.020.01Needle DataNAA0.010.680.000.020.01Ninni (a Nmp_L0.010.680.000.000.000.00Ninni (a Nmp_L0.010.080.070.000.000.00Ninni (a Nmp_L0.010.010.000.000.000.000.000.00Ninni (a Nmp_L0.010.010.00 <td< td=""><td>. ,</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	. ,						
Phosphone mpL 001 0.25 0.18 0.02 0.18 Name an N mpL 0.01 0.03 0.01 0.00 40.01 Name an N mpL 0.01 0.03 0.057 0.00 40.00 Reactive Prosphone as P mpL 0.01 -0.	Reactive Silica	mg/L	0.05	N/A	N/A	N/A	2.28
Nineting is Ninetin	Phosphorus	mg/L	0.01	0.25	0.18	0.02	0.01
Nine +		•					1.4 <0.01
Rescue Prophones as P mpL 0.01 <0.01 <0.05 (-					<0.01 <0.01
butoms mpL 0.01 4.0.01	Reactive Phosphorus as P	mg/L	0.01	<0.01	0.05	0.01	<0.01
Emma mpi 0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.00 <0.	Butane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
MethanenpiL0.012.646.841.7.823.7.8PropanenpiL0.01-0.01-0.01-0.01-0.01-0.01-0.01PropanenpiL0.01-0.01-0.01-0.01-0.01-0.01-0.00Announ (Filtend)npiL0.010.001-0.001 <t< td=""><td>Ethane</td><td>mg/L</td><td>0.01</td><td><0.01</td><td><0.01</td><td><0.01</td><td><0.01</td></t<>	Ethane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Progene mpL 0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.0	Methane	mg/L	0.01	2.64	6.84	17.8	<0.01 29.7
Boon (Filtered) mgL 0.05 0.05 0.05 0.06	Propene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01 <0.01
Argenc (Filtene) mpl, 0.001	Boron (Filtered)	mg/L	0.05	<0.05	0.05	<0.05	<0.05 <0.01
Benylum (Filtened) opL 0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <th< td=""><td>Arsenic (Filtered)</td><td>mg/L</td><td>0.001</td><td>0.001</td><td>0.005</td><td><0.001</td><td><0.001 <0.213</td></th<>	Arsenic (Filtered)	mg/L	0.001	0.001	0.005	<0.001	<0.001 <0.213
Dromum (Filtered) mpL 0.001 -0.000 -0.001	Berryllium (Filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Copper (Filtened) ngL 0.001 0.002 0.001 0.003 Laad (Filtened) ngL 0.05 17.3 0.001 -0.001<	Chromium (Filtered)	mg/L	0.001	<0.0001	<0.0001	0.0001	<0.001
Lasd (Filtered) mgL 0.011 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0	Copper (Filtered)	mg/L	0.001	0.001	0.002	0.001	0.033
Bins (Filtered) mgL 0.005 0.180 0.083 0.008 <0.000 Monganese (Filtered) mgL 0.001 <0.001	Lead (Filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Monipidemum (Filterend) mgL 0.001 <0.001 0.000 0.000 0.000 Seeniam (Filterend) mgL 0.001 <0.001	Zinc (Filtered)	mg/L	0.005	0.180	0.063	0.008	<0.005
Shenium (Fibred) ngL 0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <td>č</td> <td>-</td> <td></td> <td></td> <td></td> <td></td> <td>0.009 0.008</td>	č	-					0.009 0.008
Strontum (Filterer) mg/L 0.001 2.08 2.46 1.38 0.69 Uranium (Filtered) mg/L 0.001 <0.001		-					0.002 <0.01
Unnium (Filtered) mg/L 0.001 <0.001 <0.004 <0.001 <0.004 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.011 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <	Strontium (Filtered)	mg/L	0.001	2.08	2.46	1.38	0.698
24.5 frichiorgehenol ypl. 1 <1	Uranium (Filtered)	mg/L	0.001	<0.001	0.004	<0.001	<0.001
2.4-dichtoryphenol µgL 1 <1		0					
24-dimbryphenol µg/L 1 <1							
2-chlorophend µgL 1 <1	2,4-dimethylphenol	μg/L	1	<1	<1	<1	<1
2-nitrophenol ingl. 1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1	2-chlorophenol	μg/L	1	<1	<1	<1	<1
4-bitors-3-methylphenol µgL 1 <1	• •						
Pentalhorophenol μgL 2 <2 <2 <2 <2 Phenol μgL 1 <1							
Acenaphthene µgL 1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1	Pentachlorophenol	μg/L	2	<2	<2	<2	<2
Anthracene µgL 1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1	Acenaphthene	μg/L	1	<1	<1	<1	<1
Benzo(a) pyrene $\mu g/L$ 0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <0.5 <td>· · ·</td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td></td>	· · ·		-				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $							<1 <0.5
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Benzo(b)fluoranthene	µg/L	1	<1	<1	<1	<1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1
Fluoranthene $\mu g/L$ 1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <100 <td>Chrysene</td> <td>µg/L</td> <td>1</td> <td><1</td> <td><1</td> <td><1</td> <td><1</td>	Chrysene	µg/L	1	<1	<1	<1	<1
Fluorene $\mu g/L$ 1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1< <1 <1< <1< <1< <1 <1 <1 <1 <1 <1 <1<							
Phenanthrene $\mu g/L$ 1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1<1	Fluorene	µg/L	1	<1	<1	<1	<1
Polycylic aromatic hydrocarbons EPA448 ug/L 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5 < 0.5	Phenanthrene	µg/L	1	<1	<1	<1	<1
C6 C10 Fraction µg/L 20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <20 <2	Polycylic aromatic hydrocarbons EPA448	ug/L	0.5	<0.5	<0.5	<0.5	<0.5
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	C6 - C10 Fraction minus BTEX (F1)						<20 <20
C34 - C40 Fraction $\mu g/L$ 100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100<100 <t< td=""><td>C10 - C16 Fraction</td><td>μg/L</td><td>100</td><td><100</td><td><100</td><td><100</td><td><100 <100</td></t<>	C10 - C16 Fraction	μg/L	100	<100	<100	<100	<100 <100
TRH >C10-C16 less Naphthalene (F2) $\mu g/L$ 100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100	C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	TRH >C10-C16 less Naphthalene (F2)	μg/L	100	<100	<100	<100	<100
C29-C36 Fraction $\mu g/L$ 50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<	C10 - C14 Fraction	µg/L	50	<50	<50	<50	<20 <50
+C10 - C36 (Sum of total) $\mu g/L$ 50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<50<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51<51		µg/L	50	50	50	50	<100 <50
Toluene $\mu g/L$ 2<2<211<2Ethylbenzene $\mu g/L$ 2<2	+C10 - C36 (Sum of total)	µg/L	50	<50	<50	<50	<50
Xylene (m & p) µg/L 2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2	Toluene	µg/L	2	<2	<2	11	<2
Xylene Total µg/L 2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2 <2		μg/L	2	<2	<2	<2	<2
Total BTEX µg/L 1 <1 <1 11 8 Naphthalene µg/L 1 <1		µg/L					
Oxygen-18 % 0.01 -3.68 -4.92 -5.5 -5.3 Deuterium % 0.1 -21.5 -28.2 -31.5 -26.7 Tritium TU 0.001 0.845 ± 0.024 0.052 ± 0.013 -0.010 ± 0.012 0.011 ± 0.011 Radiocarbon pMC 0.1 87.37 ± 0.18 10.3 ± 0.19 0.54 ± 0.21 1.13 ± 0.19 Radiocarbon age (uncorrected) yrs BP 1 1,022 ± 17 18,194 ±151 41,825 ± 3,034 35,958 ± Radiocarbon age (corrected) yrs BP 1 Modern 16,350 37,250 33,30 Carbon-13 in methane VPDB 0.01 -50.87 -49.1 -49.17 -48.6	Total BTEX	µg/L	1	<1	<1	11	8
Tritium TU 0.001 0.845 ± 0.024 0.052 ± 0.013 -0.010 ± 0.012 0.011 ± 0.014 Radiocarbon pMC 0.1 87.37 ± 0.18 10.3 ± 0.19 0.54 ± 0.21 1.13 ± 0.19 Radiocarbon age (uncorrected) yrs BP 1 1,022 ± 17 18,194 ±151 41,825 ± 3,034 35,958 ± Radiocarbon age (corrected) yrs BP 1 Modern 16,350 37,250 33,30 Carbon-13 in methane VPDB 0.01 -50.87 -49.1 -49.17 -48.6	Oxygen-18	‰	0.01	-3.68	-4.92	-5.5	-5.3
Radiocarbon age (uncorrected) yrs BP 1 1,022 ± 17 18,194 ±151 41,825 ± 3,034 35,958 ± Radiocarbon age (corrected) yrs BP 1 Modern 16,350 37,250 33,30 Carbon-13 in methane VPDB 0.01 -50.87 -49.1 -49.17 -48.6	Tritium	TU	0.001	0.845 ± 0.024	0.052 ± 0.013	-0.010 ± 0.012	-26.1 0.011 ± 0.015
Radiocarbon age (corrected) yrs BP 1 Modern 16,350 37,250 33,30 Carbon-13 in methane VPDB 0.01 -50.87 -49.1 -49.17 -48.6							1.13 ± 0.22 35,958 ± 1,564
	Radiocarbon age (corrected)	yrs BP	1	Modern	16,350	37,250	33,300
	Deuterium in methane	VSMOW	0.01	606	2321.1	2103.2	-48.63 -210.6 -13.46

Appendix F

ALS results





	CERTI	FICATE OF ANALYSIS	
Work Order	[:] ES1419893	Page	: 1 of 8
Amendment	: 2		
Client	: PARSONS BRINCKERHOFF AUST P/L	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Client Services
Address	: PO BOX 1162	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
	NEWCASTLE NSW, AUSTRALIA 2300		
E-mail	amadden@pb.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 4929 7299	Facsimile	: +61-2-8784 8500
Project	: 2193324A	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	:		
C-O-C number	:	Date Samples Received	: 05-SEP-2014
Sampler	: AM	Issue Date	: 18-FEB-2016
Site	:		
		No. of samples received	: 3
Quote number	: EN/008/14	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

Accredited for compliance with

ISO/IEC 17025.

- General Comments
- Analytical Results
- Surrogate Control Limits



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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

Address 277-289 Woodpark Road Smithfield NSW Australia 2164 PHONE +61-2-8784 8555 Facsimile +61-2-8784 8500 Environmental Division Sydney ABN 84 009 936 029 Part of the ALS Group An ALS Limited Company





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

- 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.
- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EP033: Poor matrix spike recovery due to sample matrix interference. Confirmed by re-analysis.
- This report has been amended and re-released to allow the reporting of additional analytical data.(SB, CR,MN, HG added on 12/2/16)
- This report has been amended following the request to link analysis to another container



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	-	WRMB01A	WRMB01C	
	Cli	ent sampli	ng date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	
Compound	CAS Number	LOR	Unit	ES1419893-001	ES1419893-002	ES1419893-003	
EA005P: pH by PC Titrator							
pH Value		0.01	pH Unit		6.90	8.33	
EA010P: Conductivity by PC Titrator							
Electrical Conductivity @ 25°C		1	µS/cm		1410	3450	
EA015: Total Dissolved Solids							
Total Dissolved Solids @180°C		10	mg/L		884	1880	
ED037P: Alkalinity by PC Titrator							
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	22	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		144	650	
Total Alkalinity as CaCO3		1	mg/L		144	672	
ED040F: Dissolved Major Anions							
Silicon as SiO2	14464-46-1	0.1	mg/L		32.9	11.6	
ED041G: Sulfate (Turbidimetric) as SO4	2- by DA						
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		2	<1	
ED045G: Chloride Discrete analyser							
Chloride	16887-00-6	1	mg/L		315	572	
ED093F: Dissolved Major Cations							
Calcium	7440-70-2	1	mg/L		71	5	
Magnesium	7439-95-4	1	mg/L		20	<1	
Sodium	7440-23-5	1	mg/L		157	727	
Potassium	7440-09-7	1	mg/L		4	3	
EG020F: Dissolved Metals by ICP-MS							
Aluminium	7429-90-5	0.01	mg/L		0.09	0.04	
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	
Arsenic	7440-38-2	0.001	mg/L		0.001	<0.001	
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	
Barium	7440-39-3	0.001	mg/L		0.801	0.806	
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L		<0.001	0.001	
Cobalt	7440-48-4	0.001	mg/L		0.002	<0.001	
Copper	7440-50-8	0.001	mg/L		0.001	0.001	
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	
Manganese	7439-96-5	0.001	mg/L		0.300	0.024	



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	-	WRMB01A	WRMB01C	
	Cl	ient sampli	ng date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	
Compound	CAS Number	LOR	Unit	ES1419893-001	ES1419893-002	ES1419893-003	
EG020F: Dissolved Metals by ICP-MS - C	ontinued						
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L		0.002	0.002	
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	
Strontium	7440-24-6	0.001	mg/L		2.08	1.38	
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	
Zinc	7440-66-6	0.005	mg/L		0.180	0.008	
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	
Iron	7439-89-6	0.05	mg/L		17.3	0.05	
Bromine	7726-95-6	0.1	mg/L		0.8	1.0	
EG035F: Dissolved Mercury by FIMS							
Mercury	7439-97-6	-	-		Not Authorised	Not Authorised	
EK040P: Fluoride by PC Titrator							
Fluoride	16984-48-8	0.1	mg/L		<0.1	0.2	
EK055G: Ammonia as N by Discrete Ana							
Ammonia as N	7664-41-7	0.01	mg/L		0.65	1.00	
EK057G: Nitrite as N by Discrete Analys	ser						
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analy	sor						
Nitrate as N	14797-55-8	0.01	mg/L		0.08	0.09	
EK059G: Nitrite plus Nitrate as N (NOx)	by Discrete Ana	lvser					
Nitrite + Nitrate as N		0.01	mg/L		0.08	0.09	
EK067G: Total Phosphorus as P by Disc	rete Analyser						
Total Phosphorus as P		0.01	mg/L		0.25	0.02	
EK071G: Reactive Phosphorus as P by o	discrete analyser						
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	0.01	
EN055: Ionic Balance							
Total Anions		0.01	meq/L		11.8	29.6	
Total Cations		0.01	meq/L		12.1	32.0	
Ionic Balance		0.01	%		1.32	3.84	
EP005: Total Organic Carbon (TOC)							
Total Organic Carbon		1	mg/L		5	1	
						1	



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	-	WRMB01A	WRMB01C	
	Cli	ent sampli	ng date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	
Compound	CAS Number	LOR	Unit	ES1419893-001	ES1419893-002	ES1419893-003	
EP020: Oil and Grease (O&G)							
Oil & Grease		5	mg/L		<5	<5	
EP033: C1 - C4 Hydrocarbon Gases							
Methane	74-82-8	10	µg/L		2640	17800	
Ethene	74-85-1	10	µg/L		<10	<10	
Ethane	74-84-0	10	µg/L		<10	<10	
Propene	115-07-1	10	µg/L		<10	<10	
Propane	74-98-6	10	µg/L		<10	<10	
Butene	25167-67-3	10	µg/L		<10	<10	
Butane	106-97-8	10	µg/L		<10	<10	
EP075(SIM)A: Phenolic Compounds							
Phenol	108-95-2	1.0	µg/L		<1.0	<1.0	
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	<1.0	
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	<1.0	
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	<1.0	
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	<1.0	
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	<1.0	
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	<1.0	
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	<1.0	
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	<1.0	
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	<2.0	
EP075(SIM)B: Polynuclear Aromatic Hy	/drocarbons						
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	-	WRMB01A	WRMB01C	
	C	lient sampli	ng date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	
Compound	CAS Number	LOR	Unit	ES1419893-001	ES1419893-002	ES1419893-003	
EP075(SIM)B: Polynuclear Aromatic F	ydrocarbons - Con	tinued					
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	
Sum of polycyclic aromatic hydrocarbons	s	0.5	µg/L		<0.5	<0.5	
[^] Benzo(a)pyrene TEQ (zero)		0.5	µg/L		<0.5	<0.5	
EP080/071: Total Petroleum Hydrocar	bons						
C6 - C9 Fraction		20	µg/L		<20	20	
C10 - C14 Fraction		50	µg/L		<50	<50	
C15 - C28 Fraction		100	µg/L		<100	<100	
C29 - C36 Fraction		50	µg/L		<50	<50	
[^] C10 - C36 Fraction (sum)		50	µg/L		<50	<50	
EP080/071: Total Recoverable Hydroc	arbons - NEPM 201	3 Fractio	ıs				
C6 - C10 Fraction	C6_C10	20	µg/L		<20	30	
[^] C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	
>C10 - C16 Fraction		100	µg/L		<100	<100	
>C16 - C34 Fraction		100	µg/L		<100	<100	
>C34 - C40 Fraction		100	µg/L		<100	<100	
^ >C10 - C40 Fraction (sum)		100	µg/L		<100	<100	
>C10 - C16 Fraction minus Naphthalene (F2)		100	µg/L		<100	<100	
EP080: BTEXN							
Benzene	71-43-2	1	µg/L		<1	<1	
Toluene	108-88-3	2	µg/L		<2	11	
Ethylbenzene	100-41-4	2	µg/L		<2	<2	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	
ortho-Xylene	95-47-6	2	µg/L		<2	<2	
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	
[^] Sum of BTEX		1	µg/L		<1	11	
Naphthalene	91-20-3	5	µg/L		<5	<5	
EP075(SIM)S: Phenolic Compound Su	ırrogates						



Sub-Matrix: WATER (Matrix: WATER)		Cli	ent sample ID	-	WRMB01A	WRMB01C	
	Cl	ient sampli	ng date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	
Compound	CAS Number	LOR	Unit	ES1419893-001	ES1419893-002	ES1419893-003	
EP075(SIM)S: Phenolic Compound Su	rrogates - Continued	d					
Phenol-d6	13127-88-3	0.1	%		18.0	25.4	
2-Chlorophenol-D4	93951-73-6	0.1	%		29.8	52.4	
2.4.6-Tribromophenol	118-79-6	0.1	%		41.8	61.8	
EP075(SIM)T: PAH Surrogates							
2-Fluorobiphenyl	321-60-8	0.1	%		46.4	72.1	
Anthracene-d10	1719-06-8	0.1	%		56.4	78.5	
4-Terphenyl-d14	1718-51-0	0.1	%		56.4	79.3	
EP080S: TPH(V)/BTEX Surrogates							
1.2-Dichloroethane-D4	17060-07-0	0.1	%		93.5	95.3	
Toluene-D8	2037-26-5	0.1	%		106	107	
4-Bromofluorobenzene	460-00-4	0.1	%		107	105	

ALS

Surrogate Control Limits

Sub-Matrix: WATER		Recovery	Limits (%)
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	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	27.4	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



(P)	CERTI	FICATE OF ANALYSIS	
Work Order	[:] ES1421004	Page	: 1 of 8
Amendment	÷ 1		
Client	: PARSONS BRINCKERHOFF AUST P/L	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Loren Schiavon
Address	: PO BOX 1162	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
	NEWCASTLE NSW, AUSTRALIA 2300		
E-mail	: amadden@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 4929 7299	Facsimile	: +61 2 8784 8500
Project	: 2193324A	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	:		
C-O-C number	:	Date Samples Received	: 18-SEP-2014
Sampler	: AM	Issue Date	: 18-FEB-2016
Site	:		
		No. of samples received	: 1
Quote number	: EN/008/14	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Address 277-289 Woodpark Road Smithfield NSW Australia 2164 | PHONE +61-2-8784 8555 | Facsimile +61-2-8784 8500 Environmental Division Sydney ABN 84 009 936 029 Part of the ALS Group An ALS Limited Company



www.alsglobal.com



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

- 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.
- EG020: 'Bromine/lodine' quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- This report has been amended and re-released to allow the reporting of additional analytical data. (Sb, Cr, and Mn added on 12/02/16)

	NATA Accredited Laboratory 825	Signatories This document has been electronically	signed by the authorized signatories indic	ated below. Electronic signing has been carried out in			
NATA	Accredited for compliance with	compliance with procedures specified in 21 C	CFR Part 11.				
	ISO/IEC 17025.	Signatories	Position	Accreditation Category			
	Ankit Joshi	Inorganic Chemist	Sydney Inorganics				
		Celine Conceicao	Senior Spectroscopist	Sydney Inorganics			
WORLD RECOGNISED		Dian Dao	Inorganic Chemist	Sydney Inorganics			
		Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics			
		Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics			
		Shobhna Chandra	Metals Coordinator	Sydney Inorganics			



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01B	 	
	Cl	ient samplii	ng date / time	17-SEP-2014 15:15	 	
Compound	CAS Number	LOR	Unit	ES1421004-001	 	
EA005: pH						
pH Value		0.01	pH Unit	8.09	 	
EA010P: Conductivity by PC Titrator						
Electrical Conductivity @ 25°C		1	µS/cm	3040	 	
EA015: Total Dissolved Solids						
Total Dissolved Solids @180°C		10	mg/L	1550	 	
ED037P: Alkalinity by PC Titrator						
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	 	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	 	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	738	 	
Total Alkalinity as CaCO3		1	mg/L	738	 	
ED040F: Dissolved Major Anions						
Silicon as SiO2	14464-46-1	0.1	mg/L	12.8	 	
ED041G: Sulfate (Turbidimetric) as SO4 2	2- by DA					
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	65	 	
ED045G: Chloride Discrete analyser						
Chloride	16887-00-6	1	mg/L	468	 	
ED093F: Dissolved Major Cations						
Calcium	7440-70-2	1	mg/L	6	 	
Magnesium	7439-95-4	1	mg/L	1	 	
Sodium	7440-23-5	1	mg/L	605	 	
Potassium	7440-09-7	1	mg/L	4	 	
EG020F: Dissolved Metals by ICP-MS						
Aluminium	7429-90-5	0.01	mg/L	0.08	 	
Antimony	7440-36-0	0.001	mg/L	0.001	 	
Arsenic	7440-38-2	0.001	mg/L	0.005	 	
Beryllium	7440-41-7	0.001	mg/L	< 0.001	 	
Barium	7440-39-3	0.001	mg/L	1.09	 	
Cadmium	7440-43-9	0.0001	mg/L	0.0002	 	
Chromium	7440-47-3	0.001	mg/L	< 0.001	 	
Cobalt	7440-48-4	0.001	mg/L	< 0.001	 	
Copper	7440-50-8	0.001	mg/L	0.002	 	
Lead	7439-92-1	0.001	mg/L	< 0.001	 	
Manganese	7439-96-5	0.001	mg/L	0.041	 	



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01B				
	Cl	ient samplir	ng date / time	17-SEP-2014 15:15				
Compound	AS Number	LOR	Unit	ES1421004-001				
EG020F: Dissolved Metals by ICP-MS - Continu	ued							
Molybdenum	7439-98-7	0.001	mg/L	0.008				
Nickel	7440-02-0	0.001	mg/L	0.006				
Selenium	7782-49-2	0.01	mg/L	<0.01				
Strontium	7440-24-6	0.001	mg/L	2.46				
Tin	7440-31-5	0.001	mg/L	<0.001				
Uranium	7440-61-1	0.001	mg/L	0.004				
Vanadium	7440-62-2	0.01	mg/L	<0.01				
Zinc	7440-66-6	0.005	mg/L	0.063				
Boron	7440-42-8	0.05	mg/L	0.05				
Iron	7439-89-6	0.05	mg/L	0.09				
Bromine	7726-95-6	0.1	mg/L	1.0				
EK040P: Fluoride by PC Titrator			_					
Fluoride	16984-48-8	0.1	mg/L	0.4				
EK055G: Ammonia as N by Discrete Analyser	r							
Ammonia as N	7664-41-7	0.01	mg/L	0.98				
EK057G: Nitrite as N by Discrete Analyser								
	14797-65-0	0.01	mg/L	0.07				
EK058G: Nitrate as N by Discrete Analyser								
	14797-55-8	0.01	mg/L	<0.01				
EK059G: Nitrite plus Nitrate as N (NOx) by D		lyeor						
Nitrite + Nitrate as N		0.01	mg/L	0.07				
EK067G: Total Phosphorus as P by Discrete			- -					
Total Phosphorus as P		0.01	mg/L	0.18				
EK071G: Reactive Phosphorus as P by discre								
	14265-44-2	0.01	mg/L	0.05				
EN055: Ionic Balance								
Total Anions		0.01	meq/L	29.3				
Total Cations		0.01	meg/L	26.8				
Ionic Balance		0.01	%	4.50				
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon (TOC)		1	mg/L	7				
EP020: Oil and Grease (O&G)			J					
Oil & Grease		5	mg/L	<5				
		-		Ŭ	ļ	ļ	ļ	ļ



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01B	 	
	Clie	ent samplii	ng date / time	17-SEP-2014 15:15	 	
Compound	CAS Number	LOR	Unit	ES1421004-001	 	
EP033: C1 - C4 Hydrocarbon Gases						
Methane	74-82-8	10	µg/L	6840	 	
Ethene	74-85-1	10	µg/L	<10	 	
Ethane	74-84-0	10	µg/L	<10	 	
Propene	115-07-1	10	µg/L	<10	 	
Propane	74-98-6	10	µg/L	<10	 	
Butene	25167-67-3	10	µg/L	<10	 	
Butane	106-97-8	10	µg/L	<10	 	
EP075(SIM)A: Phenolic Compounds						
Phenol	108-95-2	1.0	µg/L	<1.0	 	
2-Chlorophenol	95-57-8	1.0	µg/L	<1.0	 	
2-Methylphenol	95-48-7	1.0	μg/L	<1.0	 	
3- & 4-Methylphenol	1319-77-3	2.0	µg/L	<2.0	 	
2-Nitrophenol	88-75-5	1.0	µg/L	<1.0	 	
2.4-Dimethylphenol	105-67-9	1.0	μg/L	<1.0	 	
2.4-Dichlorophenol	120-83-2	1.0	µg/L	<1.0	 	
2.6-Dichlorophenol	87-65-0	1.0	µg/L	<1.0	 	
4-Chloro-3-methylphenol	59-50-7	1.0	μg/L	<1.0	 	
2.4.6-Trichlorophenol	88-06-2	1.0	μg/L	<1.0	 	
2.4.5-Trichlorophenol	95-95-4	1.0	μg/L	<1.0	 	
Pentachlorophenol	87-86-5	2.0	µg/L	<2.0	 	
EP075(SIM)B: Polynuclear Aromatic Hy	drocarbons					
Naphthalene	91-20-3	1.0	µg/L	<1.0	 	
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	 	
Acenaphthene	83-32-9	1.0	µg/L	<1.0	 	
Fluorene	86-73-7	1.0	µg/L	<1.0	 	
Phenanthrene	85-01-8	1.0	µg/L	<1.0	 	
Anthracene	120-12-7	1.0	µg/L	<1.0	 	
Fluoranthene	206-44-0	1.0	µg/L	<1.0	 	
Pyrene	129-00-0	1.0	µg/L	<1.0	 	
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	 	
Chrysene	218-01-9	1.0	µg/L	<1.0	 	
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	 	
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	 	
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	 	



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01B	 	
	Cli	ent sampli	ng date / time	17-SEP-2014 15:15	 	
Compound	CAS Number	LOR	Unit	ES1421004-001	 	
EP075(SIM)B: Polynuclear Aromatic Hy	drocarbons - Cont	inued				
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	μg/L	<1.0	 	
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	 	
Benzo(g.h.i)perylene	191-24-2	1.0	μg/L	<1.0	 	
^ Sum of polycyclic aromatic hydrocarbons		0.5	μg/L	<0.5	 	
^ Benzo(a)pyrene TEQ (zero)		0.5	µg/L	<0.5	 	
EP080/071: Total Petroleum Hydrocarbo	ons					
C6 - C9 Fraction		20	µg/L	<20	 	
C10 - C14 Fraction		50	µg/L	<50	 	
C15 - C28 Fraction		100	µg/L	<100	 	
C29 - C36 Fraction		50	µg/L	<50	 	
[^] C10 - C36 Fraction (sum)		50	µg/L	<50	 	
EP080/071: Total Recoverable Hydroca	rbons - NEPM 201	3 Fractio				
C6 - C10 Fraction	C6_C10	20	µg/L	<20	 	
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	 	
>C10 - C16 Fraction		100	μg/L	<100	 	
>C16 - C34 Fraction		100	µg/L	<100	 	
>C34 - C40 Fraction		100	µg/L	<100	 	
>C10 - C40 Fraction (sum)		100	µg/L	<100	 	
^ >C10 - C16 Fraction minus Naphthalene		100	µg/L	<100	 	
(F2)						
EP080: BTEXN						
Benzene	71-43-2	1	µg/L	<1	 	
Toluene	108-88-3	2	µg/L	<2	 	
Ethylbenzene	100-41-4	2	µg/L	<2	 	
	108-38-3 106-42-3	2	µg/L	<2	 	
ortho-Xylene	95-47-6	2	µg/L	<2	 	
^ Total Xylenes	1330-20-7	2	µg/L	<2	 	
[^] Sum of BTEX		1	µg/L	<1	 	
Naphthalene	91-20-3	5	µg/L	<5	 	
EP075(SIM)S: Phenolic Compound Sur	rogates					
Phenol-d6	13127-88-3	0.1	%	20.8	 	
2-Chlorophenol-D4	93951-73-6	0.1	%	46.6	 	
2.4.6-Tribromophenol	118-79-6	0.1	%	67.0	 	



Sub-Matrix: WATER (Matrix: WATER)	R) Client sample ID			WRMB01B	 	
	Cli	ent sampli	ing date / time	17-SEP-2014 15:15	 	
Compound	CAS Number	LOR	Unit	ES1421004-001	 	
EP075(SIM)S: Phenolic Compound Sur	rogates - Continued	i				
EP075(SIM)T: PAH Surrogates						
2-Fluorobiphenyl	321-60-8	0.1	%	71.1	 	
Anthracene-d10	1719-06-8	0.1	%	64.0	 	
4-Terphenyl-d14	1718-51-0	0.1	%	57.2	 	
EP080S: TPH(V)/BTEX Surrogates						
1.2-Dichloroethane-D4	17060-07-0	0.1	%	95.2	 	
Toluene-D8	2037-26-5	0.1	%	102	 	
4-Bromofluorobenzene	460-00-4	0.1	%	101	 	

ALS

Surrogate Control Limits

Sub-Matrix: WATER		Recovery	Limits (%)
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	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	27.4	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



CERTIFICATE OF ANALYSIS

Work Order	ES1533252	Page	: 1 of 9
Client	PARSONS BRINCKERHOFF AUST P/L	Laboratory	Environmental Division Sydney
Contact	: MR ANGUS MCFARLANE	Contact	: Loren Schiavon
Address	: GPO BOX 5394	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
	SYDNEY NSW, AUSTRALIA 2001		
E-mail	: amcfarlane@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5100	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 9272 5101	Facsimile	: +61-2-8784 8500
Project	: 2193324A	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	:	Date Samples Received	: 09-Oct-2015 14:30
C-O-C number	:	Date Analysis Commenced	: 09-Oct-2015
Sampler	: ANDREW FARINA, ANGUS MCFARLANE	Issue Date	: 16-Oct-2015 17:30
Site	:		
		No. of samples received	:1
Quote number	:	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

	NATA Accredited Laboratory 825	<i>Signatories</i> This document has been ele	ctronically signed by the authorized signatorie	s indicated below. Electronic signing has	been
NATA	Accredited for compliance with ISO/IEC 17025.		cedures specified in 21 CFR Part 11.	Accreditation Category	
\mathbf{V}		Ankit Joshi	Inorganic Chemist	Sydney Inorganics	
WORLD RECOGNISED		Merrin Avery	Supervisor - Inorganic	Newcastle - Inorganics	
ACCREDITATION		Pabi Subba Phalak Inthakesone	Senior Organic Chemist Laboratory Manager - Organics	Sydney Organics Sydney Organics	
		Shobhna Chandra	Metals Coordinator	Sydney Inorganics	



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.

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.
- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG020: Poor matrix spike recovery was obtained for many elements on sample ES1533149-002. Results have been confirmed by re-analysis.
- 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.

Page : 3 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01D				
	Cl	ient sampli	ng date / time	09-Oct-2015 12:00				
Compound	CAS Number	LOR	Unit	ES1533252-001				
				Result	Result	Result	Result	Result
EA005: pH								
pH Value		0.01	pH Unit	9.10				
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C		1	µS/cm	2900				
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C		10	mg/L	1470				
EA025: Suspended Solids								
[^] Suspended Solids (SS)		5	mg/L	<5				
ED009: Anions								
Chloride	16887-00-6	0.1	mg/L	614				
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1				
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	114				
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	440				
Total Alkalinity as CaCO3		1	mg/L	554				
ED041G: Sulfate (Turbidimetric) as SC	04 2- by DA							
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	3				
ED045G: Chloride by Discrete Analyse	ər							
Chloride	16887-00-6	1	mg/L	617				
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	6				
Magnesium	7439-95-4	1	mg/L	1				
Sodium	7440-23-5	1	mg/L	734				
Potassium	7440-09-7	1	mg/L	11				
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01				
Arsenic	7440-38-2	0.001	mg/L	<0.001				
Boron	7440-42-8	0.05	mg/L	<0.05				
Strontium	7440-24-6	0.001	mg/L	0.698				
Barium	7440-39-3	0.001	mg/L	0.213				
Beryllium	7440-41-7	0.001	mg/L	<0.001				
Cadmium	7440-43-9	0.0001	mg/L	<0.0001				
Cobalt	7440-48-4	0.001	mg/L	<0.001				
Uranium	7440-61-1	0.001	mg/L	<0.001				
Chromium	7440-47-3	0.001	mg/L	<0.001				

Page : 4 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01D				
	Client sampling date / time			09-Oct-2015 12:00				
Compound	CAS Number	LOR	Unit	ES1533252-001				
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS -	Continued							
Copper	7440-50-8	0.001	mg/L	0.033				
Manganese	7439-96-5	0.001	mg/L	0.009				
Molybdenum	7439-98-7	0.001	mg/L	0.008				
Nickel	7440-02-0	0.001	mg/L	0.002				
Lead	7439-92-1	0.001	mg/L	<0.001				
Antimony	7440-36-0	0.001	mg/L	<0.001				
Selenium	7782-49-2	0.01	mg/L	<0.01				
Tin	7440-31-5	0.001	mg/L	<0.001				
Vanadium	7440-62-2	0.01	mg/L	<0.01				
Zinc	7440-66-6	0.005	mg/L	<0.005				
Iron	7439-89-6	0.05	mg/L	<0.05				
Bromine	7726-95-6	0.1	mg/L	0.7				
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001				
EG052G: Silica by Discrete Analyser								
Reactive Silica		0.05	mg/L	2.28				
EK010/011: Chlorine								
Chlorine - Free		0.2	mg/L	<0.2				
Chlorine - Total Residual		0.2	mg/L	<0.2				
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.1				
EK055G: Ammonia as N by Discrete A	nalvser							
Ammonia as N	7664-41-7	0.01	mg/L	1.40				
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	0.98				
EK057G: Nitrite as N by Discrete Analy Nitrite as N	14797-65-0	0.01	mg/L	<0.01				
		0.01	mg/∟	-0.01				
EK058G: Nitrate as N by Discrete Anal		0.01	mg/l	<0.01				
	14797-55-8	0.01	mg/L	NU.UI				
EK059G: Nitrite plus Nitrate as N (NOx	I							
Nitrite + Nitrate as N		0.01	mg/L	<0.01				
EK061G: Total Kjeldahl Nitrogen By Di	iscrete Analyser							
Total Kjeldahl Nitrogen as N		0.1	mg/L	1.9				

Page : 5 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01D				
	Cli	ent sampli	ing date / time	09-Oct-2015 12:00				
Compound	CAS Number	LOR	Unit	ES1533252-001				
			-	Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN	+ NOx) by Discrete An	alyser						
^ Total Nitrogen as N		0.1	mg/L	1.9				
EK067G: Total Phosphorus as P by	/ Discrete Analyser							
Total Phosphorus as P		0.01	mg/L	0.01				
EK071G: Reactive Phosphorus as I	P bv discrete analyser							
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01				
EN055: Ionic Balance								
 Total Anions 		0.01	meq/L	28.5				
^ Total Cations		0.01	meq/L	32.6				
^ Ionic Balance		0.01	%	6.59				
EP005: Total Organic Carbon (TOC								
Total Organic Carbon		1	mg/L	10				
EP020: Oil and Grease (O&G)								
^ Oil & Grease		5	mg/L	<5				
EP033: C1 - C4 Hydrocarbon Gases			<u> </u>					
Methane	74-82-8	10	µg/L	29700				
Ethene	74-85-1	10	μg/L	<10				
Ethane	74-84-0	10	μg/L	<10				
Propene	115-07-1	10	μg/L	<10				
Propane	74-98-6	10	μg/L	<10				
Butene	25167-67-3	10	µg/L	<10				
Butane	106-97-8	10	μg/L	<10				
EP074A: Monocyclic Aromatic Hyd	rocarbons							
Styrene	100-42-5	5	μg/L	<5				
Isopropylbenzene	98-82-8	5	μg/L	<5				
n-Propylbenzene	103-65-1	5	μg/L	<5				
1.3.5-Trimethylbenzene	108-67-8	5	μg/L	<5				
sec-Butylbenzene	135-98-8	5	µg/L	<5				
1.2.4-Trimethylbenzene	95-63-6	5	μg/L	<5				
tert-Butylbenzene	98-06-6	5	µg/L	<5				
p-Isopropyltoluene	99-87-6	5	µg/L	<5				
n-Butylbenzene	104-51-8	5	µg/L	<5				
EP074B: Oxygenated Compounds								
Vinyl Acetate	108-05-4	50	μg/L	<50				
2-Butanone (MEK)	78-93-3	50	µg/L	<50				

Page : 6 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01D				
	Clie	ent sampli	ng date / time	09-Oct-2015 12:00				
Compound	CAS Number	LOR	Unit	ES1533252-001				
				Result	Result	Result	Result	Result
EP074B: Oxygenated Compounds -	Continued							
4-Methyl-2-pentanone (MIBK)	108-10-1	50	μg/L	<50				
2-Hexanone (MBK)	591-78-6	50	µg/L	<50				
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	5	μg/L	<5				
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	5	μg/L	<5				
1.2-Dichloropropane	78-87-5	5	μg/L	<5				
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5				
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5				
1.2-Dibromoethane (EDB)	106-93-4	5	μg/L	<5				
EP074E: Halogenated Aliphatic Com	npounds							
Dichlorodifluoromethane	75-71-8	50	μg/L	<50				
Chloromethane	74-87-3	50	µg/L	<50				
Vinyl chloride	75-01-4	50	µg/L	<50				
Bromomethane	74-83-9	50	µg/L	<50				
Chloroethane	75-00-3	50	µg/L	<50				
Trichlorofluoromethane	75-69-4	50	µg/L	<50				
1.1-Dichloroethene	75-35-4	5	µg/L	<5				
lodomethane	74-88-4	5	µg/L	<5				
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5				
1.1-Dichloroethane	75-34-3	5	µg/L	<5				
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5				
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5				
1.1-Dichloropropylene	563-58-6	5	µg/L	<5				
Carbon Tetrachloride	56-23-5	5	µg/L	<5				
1.2-Dichloroethane	107-06-2	5	µg/L	<5				
Trichloroethene	79-01-6	5	µg/L	<5				
Dibromomethane	74-95-3	5	µg/L	<5				
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5				
1.3-Dichloropropane	142-28-9	5	µg/L	<5				
Tetrachloroethene	127-18-4	5	µg/L	<5				
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5				
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5				
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5				

Page : 7 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



ub-Matrix: WATER Matrix: WATER)		Clie	ent sample ID	WRMB01D				
	Cli	ent sampli	ng date / time	09-Oct-2015 12:00				
ompound	CAS Number	LOR	Unit	ES1533252-001				
			-	Result	Result	Result	Result	Result
P074E: Halogenated Aliphatic Com	pounds - Continued							
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5				
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5				
Pentachloroethane	76-01-7	5	µg/L	<5				
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5				
Hexachlorobutadiene	87-68-3	5	µg/L	<5				
P074F: Halogenated Aromatic Com	pounds							
Chlorobenzene	108-90-7	5	µg/L	<5				
Bromobenzene	108-86-1	5	µg/L	<5				
2-Chlorotoluene	95-49-8	5	µg/L	<5				
4-Chlorotoluene	106-43-4	5	µg/L	<5				
1.3-Dichlorobenzene	541-73-1	5	µg/L	<5				
1.4-Dichlorobenzene	106-46-7	5	µg/L	<5				
1.2-Dichlorobenzene	95-50-1	5	µg/L	<5				
1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5				
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5				
P074G: Trihalomethanes								
Chloroform	67-66-3	5	µg/L	<5				
Bromodichloromethane	75-27-4	5	µg/L	<5				
Dibromochloromethane	124-48-1	5	µg/L	<5				
Bromoform	75-25-2	5	µg/L	<5				
P075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	2.3				
2-Chlorophenol	95-57-8	1	µg/L	<1.0				
2-Methylphenol	95-48-7	1	µg/L	<1.0				
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0				
2-Nitrophenol	88-75-5	1	µg/L	<1.0				
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0				
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0				
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0				
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0				
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0				
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0				
Pentachlorophenol	87-86-5	2	µg/L	<2.0				

Page : 8 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01D				
	Cl	ient sampli	ng date / time	09-Oct-2015 12:00				
Compound	CAS Number	LOR	Unit	ES1533252-001				
				Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic H		inued						
Naphthalene	91-20-3	1	µg/L	<1.0				
Acenaphthylene	208-96-8	1	µg/L	<1.0				
Acenaphthene	83-32-9	1	µg/L	<1.0				
Fluorene	86-73-7	1	µg/L	<1.0				
Phenanthrene	85-01-8	1	µg/L	<1.0				
Anthracene	120-12-7	1	µg/L	<1.0				
Fluoranthene	206-44-0	1	µg/L	<1.0				
Pyrene	129-00-0	1	µg/L	<1.0				
Benz(a)anthracene	56-55-3	1	µg/L	<1.0				
Chrysene	218-01-9	1	µg/L	<1.0				
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0				
Benzo(k)fluoranthene	207-08-9	1	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	µg/L	<1.0				
Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0				
Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0				
^ Sum of polycyclic aromatic hydrocarbo	ns	0.5	µg/L	<0.5				
^ Benzo(a)pyrene TEQ (zero)		0.5	µg/L	<0.5				
EP080/071: Total Petroleum Hydrocar	bons							
C6 - C9 Fraction		20	µg/L	<20				
C10 - C14 Fraction		50	µg/L	<50				
C15 - C28 Fraction		100	µg/L	<100				
C29 - C36 Fraction		50	µg/L	<50				
^ C10 - C36 Fraction (sum)		50	µg/L	<50				
EP080/071: Total Recoverable Hydrod	arbons - NEPM 201	3 Fractio	ns					
C6 - C10 Fraction	C6_C10	20	µg/L	<20				
[^] C6 - C10 Fraction minus BTEX	C6_C10-BTEX	20	μg/L	<20				
(F1)	-							
>C10 - C16 Fraction	>C10_C16	100	µg/L	<100				
>C16 - C34 Fraction		100	µg/L	<100				
>C34 - C40 Fraction		100	µg/L	<100				
>C10 - C40 Fraction (sum)		100	µg/L	<100				
^ >C10 - C16 Fraction minus Naphthalene		100	µg/L	<100				
(F2)								
EP080: BTEXN								

Page : 9 of 9 Work Order : ES1533252 Client : PARSONS BRINCKERHOFF AUST P/L Project : 2193324A



Result Result Result Result Result Result Result EP080: BTEXN - Continued 71-43.2 1 µg/L 8	Sub-Matrix: WATER (Matrix: WATER)		Clie	ent sample ID	WRMB01D				
Normal and the second of the second		Cl	ient sampli	ng date / time	09-Oct-2015 12:00				
EP080: BTEXN - Continued U 8 IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Compound	CAS Number	LOR	Unit	ES1533252-001				
Benzone71,4521µg/L8** Durb More108-33108 <th></th> <th></th> <th></th> <th></th> <th>Result</th> <th>Result</th> <th>Result</th> <th>Result</th> <th>Result</th>					Result	Result	Result	Result	Result
Toluene 108.48-3 2 µgL <2 Ethylbenzene 100.41.4 2 µgL <2	EP080: BTEXN - Continued								
Ethylbenzene 100.414 2 µg/L <2	Benzene	71-43-2	1	µg/L	8				
mea. & para. Xylene 108.38.3 106 42.3 2 µg/L <2 µg/L <2 <th< td=""><td>Toluene</td><td>108-88-3</td><td>2</td><td>µg/L</td><td><2</td><td></td><td></td><td></td><td></td></th<>	Toluene	108-88-3	2	µg/L	<2				
ortho-Xylene 664-76 2 µg/L <2 Total Xylenes 130-20.7 2 µg/L <2	Ethylbenzene	100-41-4	2	µg/L	<2				
^A Total Xylenes 1302.07 2 μg/L <2 <td>meta- & para-Xylene</td> <td>108-38-3 106-42-3</td> <td>2</td> <td>µg/L</td> <td><2</td> <td></td> <td></td> <td></td> <td></td>	meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2				
Sum of BTEX 1 µµ/L 8	ortho-Xylene	95-47-6	2	µg/L	<2				
Naphthalene 91-20-3 5 µg/L < EP262: Ethanolamine 141-43-5 1 µg/L <1	^ Total Xylenes	1330-20-7	2	µg/L	<2				
Production Product	^ Sum of BTEX		1	µg/L	8				
Ethanolamine 114.43.5 1 µg/L <1 Dictanolamine 111.42.2 1 µg/L <1	Naphthalene	91-20-3	5	µg/L	<5				
Initial of the second	EP262: Ethanolamines								
Methyl diethanolamine (MDEA) 105-59-9 1 µg/L <1 EP074S: VOC Surrogates 12-Dichloroethane-D4 17060-07-0 5 % 114 </td <td>Ethanolamine</td> <td>141-43-5</td> <td>1</td> <td>µg/L</td> <td><1</td> <td></td> <td></td> <td></td> <td></td>	Ethanolamine	141-43-5	1	µg/L	<1				
EP074S: VOC Surrogates 1.2-Dichloroethane-D4 17060-07-0 5 % 114	Diethanolamine	111-42-2	1	µg/L	<1				
1.2.Dichloroethane-D4 17060-07-0 5 % 114 Toluene-D8 2037-26-5 5 % 123	Methyl diethanolamine (MDEA)	105-59-9	1	µg/L	<1				
1.2.Dichloroethane-D4 17060-07-0 5 % 114 Toluene-D8 2037-26-5 5 % 123	EP074S: VOC Surrogates								
4-Bromofluorobenzene 460-00-d 5 % 104	1.2-Dichloroethane-D4	17060-07-0	5	%	114				
EP075(SIM)S: Phenolic Compound Surrogates Image: Compound Surrogates </td <td>Toluene-D8</td> <td>2037-26-5</td> <td>5</td> <td>%</td> <td>123</td> <td></td> <td></td> <td></td> <td></td>	Toluene-D8	2037-26-5	5	%	123				
Phenol-d6 13127-88-3 1 % 24.2	4-Bromofluorobenzene	460-00-4	5	%	104				
Phenol-d6 13127-88-3 1 % 24.2	EP075(SIM)S: Phenolic Compound	Surrogates							
2.4.6-Tribromophenol 118-79-6 1 % 35.1 <td></td> <td></td> <td>1</td> <td>%</td> <td>24.2</td> <td></td> <td></td> <td></td> <td></td>			1	%	24.2				
EP075(SIM)T: PAH Surrogates S21-60-8 1 % 71.8 <th< td=""><td>2-Chlorophenol-D4</td><td>93951-73-6</td><td>1</td><td>%</td><td>39.5</td><td></td><td></td><td></td><td></td></th<>	2-Chlorophenol-D4	93951-73-6	1	%	39.5				
2-Fluorobiphenyl 321-60-8 1 % 71.8	2.4.6-Tribromophenol	118-79-6	1	%	35.1				
2-Fluorobiphenyl 321-60-8 1 % 71.8	EP075(SIM)T: PAH Surrogates								
4-Terphenyl-d14 1718-51-0 1 % 84.6 <th< td=""><td></td><td>321-60-8</td><td>1</td><td>%</td><td>71.8</td><td></td><td></td><td></td><td></td></th<>		321-60-8	1	%	71.8				
EP080S: TPH(V)/BTEX Surrogates 1.2-Dichloroethane-D4 17060-07-0 2 % 117	Anthracene-d10	1719-06-8	1	%	60.3				
1.2-Dichloroethane-D4 17060-07-0 2 % 117	4-Terphenyl-d14	1718-51-0	1	%	84.6				
1.2-Dichloroethane-D4 17060-07-0 2 % 117	EP080S: TPH(V)/BTEX Surrogates								
Toluene-D8 2037-26-5 2 % 120		17060-07-0	2	%	117				
	Toluene-D8		2	%	120				
	4-Bromofluorobenzene	460-00-4	2	%	105				