

AGL UPSTREAM INVESTMENTS PTY LTD

GLOUCESTER GAS PROJECT

January 2015 Water Monitoring Report Waukivory Pilot Project: Fracture Stimulation and Flow Test EPL 20358

Reporting Period: November - December 2014

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Foreword

PREMISES	Gloucester Coal Seam Gas Project Bucketts Way Gloucester NSW 2422
LICENCE DETAILS	Environment Protection Licence 20358
LICENCEE	AGL Upstream Investments Pty Limited (AGL)
LICENCEE'S ADDRESS	Locked Bag 1837, North Sydney, NSW 2060
MONITORING DATE(s)	12, 17, 18, 20, 24, 26, and 27 November, 2014
MONITORING BY	Parsons Brinckerhoff, on behalf of AGL
ANALYSIS BY	ALS Laboratory, Smithfield (Work order numbers: ES1425853, ES1426054, ES1424868, ES1425545, ES1425638, and ES1425363)
DATE AGL OBTAINED DATA	19 December 2014 and 13 January 2015
REPORT DATE	13 January 2015
REPORT PREPARED BY	James Duggleby, Senior Hydrogeologist

Appendix A - Table 2: Analytes monitored and frequency required for monitoring points in Table 1 (as per EPL 20358)

Appendix B – Table 3: Water quality monitoring data for points 7, 8, 9

Appendix B – Table 4: Water quality monitoring data for points 10, 11, 12, 90 and 91

Appendix C - Table 5: Continuous water level monitoring results for monitoring points 10, 11, 12, 14 and 90 for the period 1 - 31 December 2014

Introduction

AGL is proposing to build the Gloucester Gas Project (GGP) which comprises several stages of development facilitating the extraction of coal seam gas (CSG) from the Gloucester Basin. Concept plan and project approval (Part 3A Approval) for the Stage 1 Gas Field Development Area (GFDA) was granted on 22 February 2011 under Part 3A of the Environmental Planning and Assessment Act (1979) (EP&A Act). In addition the project received approval under the Environment Protection and Biodiversity Conservation Act (1999) (EPBC Act) (EPBC Approval) on 11 February 2013.

The GGP will involve depressurising of deep groundwater and the extraction of gas from multiple coal seams within the Gloucester coal measures. Target coal seam depths will vary from site to site but are expected to range between 200 and 1,000 m below ground level (mbgl). The current GGP includes the construction, operation, and decommissioning of not more than 110 coal seam gas wells and associated infrastructure, including gas and water gathering lines within the Stage 1 GFDA. A comprehensive groundwater investigation (Phase 2 Groundwater Investigations) was completed in early 2012 to confirm the hydrogeological conceptual model across the Stage 1 GFDA (PB, 2012). Surface water and groundwater investigations are ongoing.

The GGP has Environment Protection Licence (EPL 20358) for coal seam gas activities. This Monitoring Report relates to the water monitoring activities specified in Part 5, Monitoring and Recording Conditions, of EPL 20358. This report relates specifically to the monitoring surrounding the Waukivory Pilot Project, and details:

- a) Monitoring results from a sampling event one week after the completion of the fracture stimulation of AGL gas well WK13 12 November 2014;
- b) Monitoring results from a sampling event within 24 hours of the completion of the fracture stimulation of AGL gas well WK14 17 and 18 November 2014;
- c) Monitoring results from sampling events at two weeks after the completion of the fracture stimulation of AGL gas well WK13 20 November 2014;
- d) Monitoring results from a sampling event within 24 hours of the completion of the fracture stimulation of AGL gas well WK12 20 November 2014;
- e) Monitoring results from a sampling event one week after the completion of fracture stimulation at AGL gas well WK14 24 November 2014;
- f) Monitoring results from a sampling event within 24 hours of the completion of the fracture stimulation of AGL gas well WK11 26 and 27 November 2014;
- g) Monitoring results from a sampling event one week after the completion of fracture stimulation at AGL gas well WK12 27 November 2014.

As per the EPL, monitoring encompasses the monitoring points at the locations as shown in

Table 1 and Figure 1. The specific analytes and frequency tested are shown in Appendix A. The monitoring results for this reporting period are shown in Appendix B and Appendix C.

The monitoring points that are the subject of this report are part of the GGP groundwater and surface water monitoring network, as described in AGL's Surface and Groundwater Management Plan (SGMP) for the Waukivory Pilot Project (AGL, 2014).

Three methods were used to obtain groundwater and surface water samples:

- A submersible pump at groundwater monitoring bores screened within relatively permeable geological materials i.e. monitoring point 90 (12V pump) and monitoring point 91 (240V pump).
- A micro-purge[™] low flow sampling pump at groundwater monitoring points 10, 11 and 12. The micro-purge[™] system allows groundwater to be drawn into the pump intake directly from the screened portion of the aquifer, eliminating the need for excessive groundwater purging.
- A telescopic sampler to collect grab samples from the surface water monitoring points 7, 8 and 9.

EC and pH were monitored during purging to ensure that they had stabilised prior to sample collection. The water quality samples are analysed by an external NATA certified laboratory (ALS Environmental, Smithfield), in accordance with the EPA Approved Methods Publication "*Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales*" (EPA, 2004), with the exception of:

- Methane, which was analysed with a laboratory developed in-house technique which offers high resolution based on the "*Technical Guidance for Natural Attenuation Indicators: Methane, Ethane and Ethene"* (USEPA, 2002). The EPA have acknowledged that this method is a suitable technique for detecting dissolved methane in water (EPA, 2014a).
- Nitrogen, which was analysed using an updated persulphate digestion method based on the "Standard Methods for the Examination of Water and Wastewater: 22nd Edition (APHA, 2012). The EPA have acknowledged that this method is a suitable technique for detecting total nitrogen in water (EPA, 2014a).
- Monoethanolamine borate, which was analysed for monoethanolamine using the Liquid Chromatography Triple Quadruple Mass Spectrometry (LC/MSMS) method. The EPA have acknowledged that this method is a suitable technique for representing detections of monoethanolamine borate in water (EPA, 2014b).
- Sodium hypochlorite, where detections of free and total residual chlorine were used as a proxy. The EPA have acknowledged that this method is a suitable technique for representing detections of sodium hypochlorite in water (EPA, 2014a).

At the time of original analysis of the water samples subject of this report, the EPA was still considering AGL's proposed methodology for Tetrakis (Hydroxymethyl) Phosphonium Sulphate (THPS) analysis. On 19 December 2014 the EPA approved in writing AGL's proposed ultra-High Performance Liquid Chromatography methodology with UV detection (uHPLC-UV), based on NIOSH 5046 (EPA, 2014c). Samples collected prior to this date were stored on ice and are currently undergoing analysis; results will be presented in subsequent reports. Future water samples collected as part of EPL 20358 that require THPS analysis will be analysed using this approved methodology.

This report is prepared in accordance with the *Requirements for Publishing Pollution Monitoring Data* (EPA, 2012) (Publication Requirements).

The remaining water and land monitoring points in EPL 20358 will be reported in subsequent reports when the requirement for monitoring is triggered.

More information on the groundwater monitoring of the GGP is available on the project website: <u>agl.com.au/Gloucester</u>

EPA Identification no.	Monitoring Point	Type of monitoring point	Easting (m)	Northing (m)
7	WKSW03	Stream gauge (surface water)	402486.36	6453090.65
8	WKSW02	Stream gauge (surface water)	402748.00	6452139.00
9	WKSW01	Stream gauge (surface water)	402069.00	6452241.00
10	WKMB01	Groundwater monitoring bore	402153.63	6452566.28
11	WKMB02	Groundwater monitoring bore	402575.54	6452572.49
12	WKMB03	Groundwater monitoring bore	402589.87	6452584.93
14	PL03	Vibrating wire piezometer (groundwater)	402633.90	6449898.67
85	WKMB05 ^a	Packer and piezometer completion (groundwater)	402576.59	6452128.62
86	WK11 ^b	Gas well	402419.02	6452589.82
87	WK12 ^b	Gas well	402748.92	6452883.77
88	WK13 ^b	Gas well	402416.74	6452164.46
89	WK14 ^b	Gas well	402906.10	6452384.08
90	GR-P3	Private groundwater bore	402905.50	6452518.71
91	GW080487	Private groundwater bore	401226.00	6454020.00

Table 1: Waukivory Pilot Project water monitoring points (as per EPL 20358)

Notes:

^a = At the time of writing of this report, finalised data from monitoring point 85 was not yet obtained and will be reported in a subsequent report in accordance with the *Requirements for Publishing Pollution Monitoring Data* (EPA, 2012) (Publication Requirements)

^b = will be sampled/monitored and reported as results are obtained from the commencement of the flow testing program for each individual well (in accordance with the *Requirements for Publishing Pollution Monitoring Data* (EPA, 2012) (Publication Requirements)

Coordinate reference system: Map Grid of Australia 1994

Figure 1: Location of groundwater and surface water quality monitoring points: Waukivory Pilot Program (as per EPL 20358)



References

AGL, 2014. Surface Water and Groundwater Management Plan for the Waukivory Pilot Program – Gloucester Gas Project. Available online:

http://www.resourcesandenergy.nsw.gov.au/ data/assets/pdf file/0007/532942/FinalversionoftheSG MPfortheWaukivoryPilot-Oct2014.pdf

APHA, 2012. Standard Methods for the Examination of Water and Wastewater: 22nd Edition.

Environment Protection Authority (EPA), 2014a. Letter correspondence to AGL Energy Limited. EPA reference: DOC14/192084-03; SF14/602, delivered on the 20 October 2014, signed: Carmen Dwyer, Special Project Manager – Coal Seam Gas.

Environment Protection Authority (EPA), 2014b. Letter correspondence to AGL Energy Limited. EPA reference: DOC14/279381-01; SF14/602, delivered on the 1 December 2014, signed: Brett Nudd, Acting Special Project Manager – Coal Seam Gas.

Environment Protection Authority (EPA), 2014c. Letter correspondence to AGL Energy Limited. EPA reference: DOC14/279381-12; SF14/602, delivered on the 19 December 2014, signed: Jessica Creed, Acting Unit Head – Coal Seam Gas.

Environment Protection Authority (EPA), 2004. Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales, The Department of Environment and Conservation, Sydney, Australia. Available online: <u>http://www.environment.nsw.gov.au/resources/water/approvedmethods-water.pdf</u>

Parsons Brinckerhoff (PB), 2012. Phase 2 Groundwater Investigations – Stage 1 Gas Field Development Area, Gloucester Gas Project. Report dated January 2012, PR_5630. Available online: <u>http://www.agl.com.au/~/media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/</u> <u>CSG%20and%20the%20Environment/Gloucester/Assessments%20and%20Reports/2012/January/PB</u> <u>%20Gloucester%20Groundwater%20Report%20Phase%202%20Appendices%20E-P.pdf</u>

The State of NSW and Environment Protection Authority (EPA), 2012. Requirements for publishing pollution monitoring data. Environment Protection Authority, Sydney, Australia. Available online: http://www.epa.nsw.gov.au/resources/licensing/130742reqpubpmdata.pdf

USEPA, 2002. Technical Guidance for the Natural Attenuation Indicators: Methane, Ethane, and Ethene. Available online: <u>http://www.epa.gov/region1/measure/Natatten.pdf</u>

Appendix A - Table 2: Analytes monitored and frequency required for monitoring points in Table 1 (as per EPL 20358)

	_												
			Monitoring points										
Pollutant Units of measure		7,8,9		10,11,12		14,85		86,87	7,88,89	90		-	91
		Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method
Aluminium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Ammonia	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Arsenic	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Barium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Beryllium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Bicarbonate	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Boron	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Cadmium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Calcium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Carbonate	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Chloride	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Chromium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Cobalt	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Copper	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
conductivity	centimetre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Fluoride	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Iron	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Lead	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Magnesium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Manganese	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Mercury	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Methane	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Molybdenum	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Monoethanolamine Borate	micrograms per	Special Frequency 5	writing by the	Special Frequency 3	writing by the			Special Frequency 4	writing by the	Special Frequency 3	writing by the	Special Frequency 3	writing by the
Nickel	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Nitrate	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Nitrite	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
pН	рН	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Phosphorus (total)	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Potassium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Reactive Phosphorus	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Selenium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grah sample
Silica	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Sodium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Sodium Hunschlau'te	millionana nan litera	Special Frequency 5	Method approved in	Special Frequency 2	Method approved in			Special Frequency 4	Method approved in	Special Frequency 2	Method approved in	Special Frequency 2	Method approved in
Sodium Hypochiorite	miligrams per litre	Special Frequency 5	Authority	Special Frequency 3	Authority			Special Frequency 4	Authority	Special Frequency 3	Authority	Special Frequency 3	Authority
Standing water level	meters (Australian Height Datum)			Special Frequency 8	Special Method 5	Special Frequency 8	Special Method 5	Special Frequency 9	Special Method 3	Special Frequency 8	Special Method 5	Special Frequency 6	Special Method 1
Strontium (discolved)	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Sulfate	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
THPS (Pheenhenium			Method approved in		Method approved in				Method approved in		Method approved in		Method approved in
Tetrakis	micrograms per	Createl Fragmanay F	writing by the	Createl Frequency 2	writing by the			Createl Frequency 4	writing by the	Createl Frequency 2	writing by the	Creatial Francisco av 2	writing by the
(Hydroxymethyl-	litre	Special Frequency 5	data was received for	Special Frequency 3	data was received for			Special Frequency 4	data was received for	Special Frequency 3	data was received for	Special Frequency 3	data was received for
sulfate)	L		this report)		this report)				this report)		this report)		this report)
Total dissolved solids	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Total organic carbon	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Total suspended	milligrams per litre			Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
solids Uranium	milligrams per litre	Special Frequency 5	Grah sample	Special Frequency 3	Grah sample			Special Frequency 4	Grah sample	Special Frequency 3	Grah sample	Special Frequency 3	Grah sample
Vanadium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample
Zinc	milligrams per litro	Special Frequency 5	Grab sample	Special Frequency 2	Grah sample			Special Frequency 4	Grah sample	Special Frequency 2	Grah sample	Special Frequency 3	Grah sample
- inc	mingrams per nice	Special frequency 5	Grab sample	Special Frequency 3	Sian sample			Special Frequency 4	Sian sample	special frequency 3	Sian sample	special frequency 5	Grab sample

Notes:

Special Frequency 3 – One sampling event before the Waukivory Pilot Project fracture stimulation commences, one sampling event within 24 hours of the completion of the fracture stimulation of each well, and one sample at week 2 and week 4 after the completion of the Waukivory Pilot Project fracture stimulation.

Special Frequency 4 – Every fortnight for 8 weeks from the commencement of the Waukivory pilot flow testing, then every 2 months thereafter until the cessation of the Waukivory pilot flow testing.

Special Frequency 5 – One sampling event within 24 hours of the completion of the fracture stimulation of each well, and one sampling event one week after the completion of the fracture stimulation of each well, and one sampling event the cessation of the Waukivory pilot flow testing.

Special Frequency 6 – One monitoring event to determine water level prior to the Waukivory Pilot Project fracture stimulation.

Special Frequency 8 – Every 6 hours

Special Frequency 9 – Every 6 hours when using an automated datalogger, or, once every fortnight using a Sonolog in the event of failure of an automated datalogger.

Special method 1 - manual dip

Special method 3 - Use of an automated datalogger. As a back up contingency, by use of Sonolog in the event of an automated datalogger.

Special method 5 - Automated datalogger

Shaded grey = not required to be analysed

GGP EPL 20358 Water Monitoring Report –Waukivory Pilot Project – January 2015



Appendix B – Table 3: Water quality monitoring data for points 7, 8, 9

Analysis by: ALS Laboratory, Smithfield (Work order numbers: ES1425853, ES1426054, ES1424868, ES1425545, and ES1425638)

																		_
		Monitoring points			7					8					9			
		Location	WKSW03	WKSW03	WKSW03	WKSW03	WKSW03	WKSW02	WKSW02	WKSW02	WKSW02	WKSW02	WKSW01	WKSW01	WKSW01	WKSW01	WKSW01	-
		Sampled date	12/11/2014	18/11/2014	20/11/2014	24/11/2014	27/11/2014	12/11/2014	17/11/2014	20/11/2014	24/11/2014	27/11/2014	12/11/2014	18/11/2014	20/11/2014	24/11/2014	27/11/2014	-
		Date AGL obtained	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	7
		data Monitoring overt																
		(see key below)	а	b	d	е	f, g	а	b	d	e	f, g	а	b	d	e	f, g	
Analyte	Units of	Limit of reporting																Analyte
Aluminium	mg/L	0.01	0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01	< 0.01	0.03	0.02	<0.01	0.05	0.02	0.07	0.03	< 0.01	Aluminium
Ammonia	mg/L	0.01																Ammonia
Arsenic	mg/L	0.001	0.003	0.002	0.002	0.002	0.002	0.003	0.003	0.004	0.003	0.003	0.005	0.002	0.002	0.003	0.002	Arsenic
Barium	mg/L	0.001	0.064	0.059	0.064	0.049	0.061	0.083	0.086	0.087	0.086	0.075	0.044	0.032	0.043	0.033	0.034	Barium
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	Beryllium
Bicarbonate	mg/L	1	108	98	122	100	103	122	111	135	115	117	73	66	78	70	76	Bicarbonate
Boron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	Boron
Cadmium	mg/L	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	Cadmium
Calcium	mg/L	1	25	24	25	36	29	32	31	32	44	36	14	12	18	17	15	Calcium
Carbonate	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	Carbonate
Chioride	mg/L	0.1	106	108	<0.001	115	113	0.004	11/	121	124	121	96	97	99.1	101	96.7	Chioride
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001	<0.001	<0.001	0.004	< 0.001	<0.001	< 0.001	< 0.001	< 0.001	< 0.001	<0.001	<0.001	< 0.001	Cobalt
Copper	mg/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	0.001	0.001	< 0.001	0.005	<0.001	0.002	<0.001	<0.001	Copper
Electrical conductivity	uS/cm	1	568	590	600	606	617	618	642	652	664	665	484	492	495	507	508	Electrical conductivity
Fluoride	mg/L	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.2	0.1	<0.1	0.2	0.1	0.1	0.1	0.1	Fluoride
Iron	mg/L	0.05	0.24	0.18	0.3	0.24	0.45	2.24	2.17	3.68	2.44	1.61	0.77	0.66	0.69	0.43	0.33	Iron
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	Lead
Magnesium	mg/L	1	16	15	15	15	17	17	17	17	17	18	12	12	12	12	13	Magnesium
Manganese	mg/L	0.001	na	na	na	0.424	1.4	na	na	na	0.631	0.782	na	na	na	0.144	0.41	Manganese
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	Mercury
Methane	mg/L	0.010																Methane
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	Molybdenum
Monoethanolamine Borate (reported as (mono) ethanolamine))	µg/L	1	<1	<1	4	<1	<1	<1	<1	10	<1	<1	<1	<1	6	<1	<1	Monoethanolamine Borate (reported as (mono) ethanolamine))
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.002	0.001	<0.001	Nickel
Nitrate	mg/L	0.01																Nitrate
Nitrite	mg/L	0.01																Nitrite
рН	pH Unit	0.01	7.1	6.55	6.93	7.02	8.67	7.33	6.63	6.65	6.83	7.43	7.45	6.63	6.65	7.67	7.45	pH
Phosphorus (total)	mg/L	0.01			_			·						-	_	_	_	Phosphorus (total)
Potassium Repetive Dhoenhowie	mg/L	1	6	6	/	6	6	4	4	4	4	4	6	6	/	/	/	Potassium
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	Selenium
Silica	mg/L	0.05	5.28	6.94	7.53	7.42	8.82	17.4	18.7	19.7	20	21.5	1.61	1.72	1.48	1.51	2.08	Silica
Sodium	mg/L	1	61	59	66	59	64	60	62	61	60	66	59	61	60	65	63	Sodium
Sodium Hypochlorite (reported as free chlorine)	mg/L	0.2	0.8	0.7	<0.2	<0.2	0.3	0.7	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	0.4	Sodium Hypochlorite (reported as free chlorine)
Sodium Hypochlorite (reported as total residual	mg/L	0.2	1.1	0.7	<0.2	<0.2	0.3	0.7	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.6	0.4	Sodium Hypochlorite (reported as total residual chlorine)
Standing water level	mΔHD																	Standing water level
Strontium (dissolved)	mg/L	0.001	0.306	0.342	0.349	0.355	0.348	0.376	0.376	0.412	0.46	0.39	0.217	0.236	0.237	0.273	0.229	Strontium (dissolved)
Sulfate	mg/L	1	<10	<1	5	5	4	<10	<10	3	4	4	<10	<1	7	<10	<1	Sulfate
THPS (Phosphonium, Tetrakis (Hydroxymethylnasulfate)) ⁺	µg/L	50	na	THPS (Phosphonium, Tetrakis (Hydroxymethylnasulfate)) ⁺														
Total dissolved solids	mg/L	10	296	296	311	352	310	336	335	360	378	358	256	269	284	304	260	Total dissolved solids
Total organic carbon	mg/L	1	12	17	13	12	14	14	18	13	14	15	17	22	18	18	20	Total organic carbon
Total suspended solids	mg/L	5																Total suspended solids
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.001	Uranium
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	Vanadium
Zinc	mg/L	0.005	0.019	<0.005	0.006	0.005	<0.005	0.023	0.014	0.034	0.018	0.008	0.022	0.009	0.043	0.009	0.013	Zinc

Key:

Shaded grey = not required to be reported

na = not analysed

+ = THPS (Phosphonium, Tetrakis (Hydroxymethyl-sulfate)) was not able to be analysed by the date of this report pending development and validation of an approved method of analysis. Samples have been collected and stored in anticipation of the approved method. Monitoring event:

- a one week after the completion of the fracture stimulation of WK13
- b 24 hours after the completion of the fracture stimulation of WK14
- c two weeks after the completion of the fracture stimulation of WK13
- d 24 hours after the completion of the fracture stimulation of WK12
- e one week after the completion of the fracture stimulation of WK14
- f 24 hours after the completion of the fracture stimulation of WK11
- g one week after the completion of the fracture stimulation of WK12



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Appendix B – Table 4: Water quality monitoring data for points 10, 11, 12, 90, 91

Analysis by: ALS Laboratory, Smithfield (Work order numbers: ES1426054, ES1424868, ES1425545, ES1425638, and ES1425363)

		Manifestor asists				11		12			90			01				
		Monitoring points		10			-11			12			90			91		4
		Location	WKMB01	WKMB01	WKMB01	WKMB02	WKMB02	WKMB02	WKMB03	WKMB03	WKMB03	GR-P3	GR-P3	GRP3	GW080487	GW080487	GW080487	
		Sampled date	17/11/2014	20/11/2014	26/11/2014	17/11/2014	20/11/2014	26/11/2014	17/11/2014	20/11/2014	26/11/2014	17/11/2014	20/11/2014	26/11/2014	17/11/2014	20/11/2014	26/11/2014	
		Date AGL obtained data	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	19/12/2014	
		Monitoring event (see key below)	b	c, d	f													
Analyte	Units of measure	Limit of reporting																Analyte
Aluminium	mg/L	0.01	0.03	0.02	0.01	0.1	0.13	0.16	0.06	0.04	0.03	0.02	<0.01	0.05	<0.01	0.02	<0.01	Aluminium
Ammonia	mg/L	0.01	0.63	0.63	0.6	0.29	0.25	0.3	19.7	21.6	17.7	0.02	<0.01	<0.01	0.46	0.43	0.41	Ammonia
Arsenic	mg/L	0.001	0.008	0.002	0.001	0.004	0.001	0.001	0.004	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	Arsenic
Barium	mg/L	0.001	0.231	0.204	0.214	0.068	0.065	0.072	0.769	0.881	0.88	0.468	0.476	0.474	0.174	0.16	0.135	Barium
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	Beryllium
Bicarbonate	mg/L	1	802	969	812	257	306	243	11	15	<1	332	401	334	967	1180	976	Bicarbonate
Boron	mg/L	0.05	0.09	0.11	0.1	<0.05	0.07	<0.05	0.08	0.09	0.08	< 0.05	<0.05	<0.05	<0.05	0.06	< 0.05	Boron
Calcium	mg/L	0.0001	16	<0.0001	16	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	Cadmium
Carbonate	mg/l	1	17	20	<1	46	58	56	1030	1230	1060	<1	<1	<1	<1	<1	<1	Carbonate
Chloride	mg/L	0.1	1090	1060	966	60.7	60.1	58.4	391	376	355	1070	1100	1060	636	637	608	Chloride
Chromium	mg/L	0.001	< 0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.001	<0.001	<0.001	<0.001	< 0.001	< 0.001	Chromium
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	Cobalt
Copper	mg/L	0.001	0.006	0.001	0.003	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.002	<0.001	Copper
Electrical conductivity	μS/cm	1	5150	4980	4760	880	875	855	3390	3320	3290	4090	4090	4020	3950	3900	3780	Electrical conductivity
Fluoride	mg/L	0.1	1.4	1.4	1.5	0.3	0.2	0.3	2.1	1.9	2.1	0.2	0.2	0.2	0.2	0.2	0.2	Fluoride
Iron	mg/L	0.05	0.07	0.07	0.06	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	0.18	0.26	0.25	0.32	0.41	0.34	Iron
Lead	mg/L	0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.01	0.006	0.012	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	Lead
Magnesium	mg/L	1	2	1	2	<1	<1	<1	<1	<1	<1	67	67	72	39	38	41	Magnesium
Manganese	mg/L	0.001	na	na	0.01	na	na	0.006	na	na	0.001	na	na	0.672	na	na	0.046	Manganese
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	Mercury
Methane	mg/L	0.010	21.900	31.800	40.600	4.160	4.180	3.800	18.500	18.100	27.500	<0.010	< 0.010	< 0.010	0.118	0.380	0.083	Methane
Molybdenum Monoothanolamino Borato	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.004	0.007	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	Molybdenum Monoothanolamino Borato
(reported as (mono) ethanolamine))	µg/L	1	3	4	<1	<1	60	<1	<1	12	<1	<1	2	<1	<1	4	<1	(reported as (mono) ethanolamine))
Nickel	mg/L	0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	Nickel
Nitrate	mg/L	0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	Nitrate
Nitrite	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	Nitrite
pH	pH Unit	0.01	8.17	8.28	8.22	9.03	9.12	9.13	10.8	10.8	10.8	7.08	7.02	7.09	7.32	7.34	7.42	pH
Phosphorus (total)	mg/L	0.01	0.04	0.03	0.04	0.12	0.06	0.09	0.08	<0.05	0.08	0.04	0.04	0.09	0.01	<0.01	<0.01	Phosphorus (total)
Potassium Reactive Phosphorus	mg/L	0.01	3	4	3	0.06	4	0.08	0.06	29	20	2	2	2	ь <0.01	6	0 01	Potassium Reactive Phosphorus
Selenium	mg/L	0.01	<0.05	<0.04	<0.04	<0.00	<0.00	<0.08	<0.00	<0.01	< 0.00	<0.01	<0.02	< 0.02	<0.01	<0.01	<0.01	Selenium
Silica	mg/L	0.05	16.9	16.8	15.5	21	21.9	20.6	38.8	34.9	31.8	35.1	35.7	33.5	20	18.5	19.4	Silica
Sodium	mg/L	1	1070	1080	1090	187	193	197	704	774	740	575	614	615	753	788	772	Sodium
Sodium Hypochlorite (reported as free chlorine)	mg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	Sodium Hypochlorite (reported as free chlorine)
Sodium Hypochlorite (reported as total residual chlorine)	mg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	Sodium Hypochlorite (reported as total residual chlorine)
Standing water level	mAHD			1	1			Refer	to Table 4	1	1	1	1	<u> </u>				Standing water level
Strontium (dissolved)	mg/L	0.001	2.21	2.13	1.86	0.218	0.224	0.209	1.09	1.19	1.02	2.36	2.29	2.16	5.69	5.22	5.34	Strontium (dissolved)
Sulfate	mg/L	1	176	163	123	14	2	19	2	25	35	97	93	83	129	91	101	Sulfate
THPS (Phosphonium, Tetrakis (Hydroxymethylnasulfate)) ⁺	μg/L	50	na	THPS (Phosphonium, Tetrakis (Hydroxymethylnasulfate)) ⁺														
Total discolved colida	mc/l	10	2720	2560	2500	440	470	176	2210	2120	2000	2010	1070	2100	2150	2120	2160	Total dissolved collida
Total organic carbon	ma/l	10	34	13	14	449 7	4/2 2	470 R	171	82	2080	2010	13/0	£190	2150 A	<1	14	Total organic carbon
Total suspended solids	mg/l	5	14	<5	<5	, 15	<5	<5	21	22	24	11	21	14	<5	<5	<5	Total suspended solids
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.003	<0.001	<0.001	<0.001	Uranium
Vanadium	mg/L	0.01	<0.01	<0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	Vanadium
Zinc	mg/L	0.005	0.194	<0.005	0.023	<0.005	<0.005	0.007	10.7	5.26	9.52	0.009	0.016	0.009	0.019	0.019	0.012	Zinc

Key:

Shaded grey = not required to be reported

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- a one week after the completion of the fracture stimulation of WK13
- b 24 hours after the completion of the fracture stimulation of WK14
- c two weeks after the completion of the fracture stimulation of WK13
- d 24 hours after the completion of the fracture stimulation of WK12
- e one week after the completion of the fracture stimulation of WK14
- f 24 hours after the completion of the fracture stimulation of WK11
- g one week after the completion of the fracture stimulation of WK12

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Monitoring point	10	11	12	1	90								
Location		WKWB02	WKWB03	PL03	PL03	CP-D2							
	WKMD01	WKMD02	WKMD05	Sensor 2	Sensor 3	GK-FJ							
Data type	Standing Water Level												
Units	mAHD (metres (Australian Height Datum))												
Data date range	01/12/14 - 31/12/14												
Date data downloaded	12/01/2015	12/01/2015	12/01/2015	12/01/2015	12/01/2015	12/01/2015							
Date data supplied to AGL	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015							
Monitoring frequency required by licence	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours							
No. of times measured during monitoring period	124	124	124	124	124	124							
Min. value	91.4	95.6	94.6	86.8	45.5	96.6							
Mean value	95.0	95.7	97.9	87.2	47.2	96.6							
Median value	95.1	95.7	97.9	87.2	47.2	96.6							
Max. value	95.2	95.9	98.1	87.6	49.0	96.7							

Appendix C - Table 4: Continuous water level monitoring results for monitoring points 10, 11, 12, 14, 90 for the period 1 - 31 December 2014

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