AGL UPSTREAM INVESTMENTS PTY LTD

CAMDEN GAS PROJECT

Quarterly Produced Water Quality Monitoring Report

- **Addendum 1: to 14 September 2015 Quarterly Produced Water Quality Monitoring Report (resample of monitoring point 9)**
- **Addendum 2: to 28 September 2015 Quarterly Produced Water Quality Monitoring Report (correction of potassium and sodium data)**
- **Addendum 3: to 8 December 2015 Quarterly Produced Water Quality Monitoring Report (correction to analyte name (xylene) in Table 3)**

Reporting Period: FY16, 1st Quarter – July / September 2015

AGL Upstream Investments Pty Ltd
ABN 58 115 063 744
Locked Bag 1837, St Leonards NSW 2065
Level 22, 101 Miller Street, North Sydney NSW 2060
Telephone: 02 9921 2999 Facsimile: 02 9921 2474
Complaints Line (24 hours): 1300 799 716

Foreword

PREMISES	Rosalind Park Gas Plant Lot 35 Medhurst Road GILEAD NSW 2560
LICENCE DETAILS	Environment Protection Licence 12003
LICENCEE	AGL Upstream Investments Pty Limited (AGL)
LICENCEE'S ADDRESS	Locked Bag 1837, North Sydney, NSW 2060
MONITORING DATE	1st Quarter – July / September (19 August 2015; resample on 16 September 2015)
MONITORING BY	AGL
ANALYSIS BY	ALS Laboratory, Smithfield (Work order numbers: ES1528849 and ES1531347)
DATE DATA OBTAINED	27 August 2015; 23 September 2015 (resample)
REPORT DATE	Addendum 3: 12 January 2016; Addendum 2: 8 December 2015; Addendum 1: 28 September 2015; Original: 14 September 2015
REPORT PREPARED BY	N. Fry, Hydrogeologist
REPORT REVIEWED BY	A. Clifton, NSW Environment Manager J. MacMahon, Lead Environment Business Partner

Introduction

The Camden Gas Project (CGP) is owned and operated by AGL and is located in the Macarthur region 65 km southwest of Sydney, in the Wollondilly, Camden and Campbelltown Local Government Areas (Figure 1). The CGP has been producing gas for the Sydney region since 2001 and currently consists of 144 gas wells, low-pressure underground gas gathering pipes and a gas plant facility. Not all production wells are currently operational. The production wells are licensed with Water Access Licences, Works Approvals and Use Approvals under the *Water Management Act 2000* (NSW), including an allocation of 30 megalitres (ML) per year for the existing CGP and associated dewatering activities from the coal seams. In the 2014-15 financial year, approximately 2.2 ML of water was produced from the coal seams for the entire CGP operating wellfield.

This Monitoring Report relates to the groundwater monitoring activities specified in Part 5, Monitoring and Recording Conditions, of the Environment Protection Licence 12003. The Licence conditions stipulate groundwater monitoring is required to be carried out at the locations as shown in Table 1 and Figure 1. The specific analytes and frequency tested are shown in Table 2.

The monitoring points that are the subject of this report are part of the CGP groundwater monitoring network, as described in AGL's CGP Groundwater Management Plan (2012). Water samples are taken from each gas well at the separator. The deep groundwater (when brought to the surface) is known as produced water. 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 dissolved methane, phenols and PAHs, which were analysed with an

alternate method following written approval from the EPA (EPA, 2014) (refer to Table 2 for analytical methodology).

Many of the operating wells within the CGP produce very low volumes of water; frequently, there is not enough water present to allow for sampling at these monitoring points. For the monitoring event in this reporting period (FY16 Q1) only samples from two monitoring points were able to be taken as there was not enough water present to sample at the remaining monitoring points. Samples were tested for all Quarterly and Annual analytes shown in Table 2.

Due to anomalous detections of polynuclear aromatic hydrocarbons (PAHs) measured in the sample taken on 19 August from monitoring point 9, the monitoring point was resampled on 16 September 2015 and analysed for PAHs. These additional results have also been included in this amended report.

This report (including amendments) is prepared in accordance with the *Requirements for Publishing Pollution Monitoring Data* (EPA, 2013) (Publication Requirements).

Table 3 displays the results of this quarter's monitoring (including the additional results from the resample of monitoring point 9).

Produced water from the coal seams at the CGP ranges in quality as a result of localised natural variations within the coal. Electrical conductivity (which is a measure of salinity) typically varies between about 7,000 and 15,000 μS/cm. However, it is not unusual to see values outside of this range. Low volume water producing wells frequently show very low electrical conductivity values as a result of evaporation and condensation processes occurring in the well bore (PB, 2013). These very low values are not representative of formation water samples. It is noted that the result obtained from this monitoring event (FY16 Q1) at monitoring point 9 (SF08) is a typical value of electrical conductivity for produced water within the CGP. Whereas, the value of electrical conductivity for monitoring point 10 (RB10) is outside (and below) the typical range observed and correlates with a period of low produced water volumes from this well. Resampling and analysis at monitoring point 9 (16 September) measured no detections of PAHs indicating the original results collected on 19 August were anomalous.

More information on the hydrogeology and groundwater of the CGP is available in the Hydrogeological Summary (AGL, 2013) which can be viewed at the CGP website: agl.com.au/Camden

Table 1- Groundwater quality monitoring points (as per EPL 12003)

EPA Identification no.	Location	Easting (m)	Northing (m)
8	EM40	290847.38	6226891.16
9	SF08	291443.09	6228310.08
10	RB10	288211.17	6219746.92
11	MT05	290356.75	6221081.15
12	MP12	293574.90	6224380.09
13	MP30	291760.40	6225066.50
14	RP12	293397.37	6222719.00
15	SL03	294583.77	6224486.19

Coordinate reference system: Map Grid of Australia 1994 Zone 56

Table 2 – Analytes monitored, frequency (as per EPL 12003) and methodology

Analyte	Units of measure	Frequency	Sampling Method	Analytical method
Aluminium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Ammonia	milligrams per litre	Yearly	Grab sample	APHA (1998) section 4500-NH3
Arsenic	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Barium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Benzene	milligrams per litre	Yearly	Grab sample	USEPA (1996b) method 8260B
Beryllium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Bicarbonate	milligrams per litre	Quarterly	Grab sample	APHA (1998) 2320
Boron	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Bromide	milligrams per litre	Quarterly	Grab sample	APHA (1998) section 4110
Cadmium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Calcium	milligrams per litre	Quarterly	Grab sample	APHA (1998) section 3030B then APHA (1998) section 3120
Carbonate	milligrams per litre	Quarterly	Grab sample	APHA (2012) 2320B
Chloride	milligrams per litre	Quarterly	Grab sample	APHA (1998) section 4110
Chromium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Cobalt	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Copper	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Electrical conductivity	microsiemens per centimetre	Quarterly	Grab sample	APHA (1998) section 2510 B
Ethyl benzene	milligrams per litre	Yearly	Grab sample	USEPA (1996b) method 8260B
Fluoride	milligrams per litre	Quarterly	Grab sample	APHA (1998) section 4500-F– C
Iron	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Lead	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Magnesium	milligrams per litre	Quarterly	Grab sample	APHA (1998) section 3030B then APHA (1998) section 3120
Manganese	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Mercury	milligrams per litre	Quarterly	Grab sample	Preliminary treatment APHA (1998) section 3030B;Then APHA (1998) section 3112
Methane	milligrams per litre	Yearly	Grab sample	In house static headspace GC/FID technique
Molybdenum	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Nickel	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Nitrate	milligrams per litre	Yearly	Grab sample	APHA (1998) section 4500-NO3-F
Nitrite	milligrams per litre	Yearly	Grab sample	APHA (1998) section 4500-NO3-F (with cadmium column removed)
Phenols	milligrams per litre	Yearly	Grab sample	USEPA (1996a) method 8270 D
Polycyclic aromatic hydrocarbons	milligrams per litre	Yearly	Grab sample	USEPA (1996a) method 8270 D
Potassium	milligrams per litre	Quarterly	Grab sample	Preliminary treatment APHA (1998) section 3030B then APHA (1998) section 3120
Reactive Phosphorus	milligrams per litre	Yearly	Grab sample	APHA (1998) section 4500-P B; followed by APHA (1998) section 4500-P E

Analyte	Units of measure	Frequency	Sampling Method	Analytical method
Selenium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Silica	milligrams per litre	Quarterly	Grab sample	APHA 21st ed., 3120
Sodium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Strontium (dissolved)	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3030(E-K) then USEPA (1994f) method 6020
Sulfate	milligrams per litre	Quarterly	Grab sample	APHA(1998) section 4500 SO42--E
Toluene	milligrams per litre	Yearly	Grab sample	USEPA (1996b) method 8260B
Total dissolved solids	milligrams per litre	Quarterly	Grab sample	APHA (1998) section 2540C
Total petroleum hydrocarbons	milligrams per litre	Yearly	Grab sample	USEPA (1996h) method 8015B
Uranium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Vanadium	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020
Xylene	milligrams per litre	Yearly	Grab sample	USEPA (1996b) method 8260B
Zinc	milligrams per litre	Quarterly	Grab sample	USEPA (1992a) method 3005A then USEPA (1994f) method 6020

Groundwater Monitoring Results

Table 3 - Produced water monitoring results for 1st Quarter – July / September 2015

			Monitoring point	8	9		10	11	12	13	14	15
			Location	EM40	SF08		RB10	MT05	MP12	MP30	RP12	SL03
			Sampled Date	Not enough water to sample (19/8/2015)	19/08/2015	16/09/2015 (resample)	19/08/2015	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)
			Data obtained	na	27/08/2015	23/09/2015	27/08/2015	na	na	na	na	na
	Analyte	**Units**	**Limit of reporting**									
Physical	**Electrical Conductivity @ 25°C**	µS/cm	1	-	14300	-	3020	-	-	-	-	-
	Total Dissolved Solids @180°C	mg/L	10	-	8780	-	1880	-	-	-	-	-
Major Cations	**Calcium**	mg/L	1	-	17	-	5	-	-	-	-	-
	Magnesium	mg/L	1	-	3	-	1	-	-	-	-	-
	Potassium	mg/L	1	-	19	-	5	-	-	-	-	-
	Sodium	mg/L	1	-	4300	-	935	-	-	-	-	-
Major Anions	**Bicarbonate Alkalinity as CaCO3**	mg/L	1	-	8070	-	1820	-	-	-	-	-
	Carbonate Alkalinity as CaCO3	mg/L	1	-	205	-	<1	-	-	-	-	-
	Chloride	mg/L	0.1	-	741	-	29.8	-	-	-	-	-
	Sulfate	mg/L	1	-	<1	-	<1	-	-	-	-	-
Metals (dissolved)	**Aluminium**	mg/L	0.01	-	<0.10*	-	<0.01	-	-	-	-	-
	Arsenic	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Barium	mg/L	0.001	-	12.5	-	0.859	-	-	-	-	-
	Beryllium	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Boron	mg/L	0.05	-	0.94	-	<0.05	-	-	-	-	-
	Cadmium	mg/L	0.0001	-	<0.0010*	-	<0.0001	-	-	-	-	-
	Chromium	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Cobalt	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Copper	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Iron	mg/L	0.05	-	0.38	-	<0.05	-	-	-	-	-
	Lead	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Manganese	mg/L	0.001	-	<0.010*	-	0.053	-	-	-	-	-
	Mercury	mg/L	0.0001	-	<0.0001	-	<0.0001	-	-	-	-	-
	Molybdenum	mg/L	0.001	-	<0.010*	-	0.012	-	-	-	-	-
	Nickel	mg/L	0.001	-	<0.010*	-	0.003	-	-	-	-	-
	Selenium	mg/L	0.01	-	<0.10*	-	<0.01	-	-	-	-	-

			Monitoring point	8	9		10	11	12	13	14	15
			Location	EM40	SF08		RB10	MT05	MP12	MP30	RP12	SL03
			Sampled Date	Not enough water to sample (19/8/2015)	19/08/2015	16/09/2015 (resample)	19/08/2015	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)
			Data obtained	na	27/08/2015	23/09/2015	27/08/2015	na	na	na	na	na
	Analyte	**Units**	**Limit of reporting**									
	Strontium	mg/L	0.001	-	3.34	-	0.508	-	-	-	-	-
	Uranium	mg/L	0.001	-	<0.010*	-	<0.001	-	-	-	-	-
	Vanadium	mg/L	0.01	-	<0.10*	-	<0.01	-	-	-	-	-
	Zinc	mg/L	0.005	-	<0.050*	-	<0.005	-	-	-	-	-
Other	**Bromide**	mg/L	0.01	-	3.28	-	0.136	-	-	-	-	-
	Fluoride	mg/L	0.1	-	2.4	-	0.4	-	-	-	-	-
	Silicon as Silica	mg/L	0.1	-	19.2	-	3.8	-	-	-	-	-
	Methane	mg/L	0.01	-	3.65	-	7.18	-	-	-	-	-
Nutrients	**Ammonia as N**	mg/L	0.01	-	4.1	-	0.90	-	-	-	-	-
	Nitrate as N	mg/L	0.01	-	<0.10*	-	0.01	-	-	-	-	-
	Nitrite as N	mg/L	0.01	-	<0.10*	-	<0.01	-	-	-	-	-
	Reactive Phosphorus as P	mg/L	0.01	-	0.28	-	0.06	-	-	-	-	-
Phenols	**Phenol**	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2-Chlorophenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2-Methylphenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	3- & 4-Methylphenol	mg/L	0.002	-	<0.002	-	<0.002	-	-	-	-	-
	2-Nitrophenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2.4-Dimethylphenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2.4-Dichlorophenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2.6-Dichlorophenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	4-Chloro-3-methylphenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2.4.6-Trichlorophenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	2.4.5-Trichlorophenol	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	Pentachlorophenol	mg/L	0.002	-	<0.002	-	<0.002	-	-	-	-	-
PAH	**Naphthalene**	mg/L	0.001	-	0.0045	<0.001	<0.001	-	-	-	-	-
	Acenaphthylene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Acenaphthene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Fluorene	mg/L	0.001	-	0.0045	<0.001	<0.001	-	-	-	-	-
	Phenanthrene	mg/L	0.001	-	0.0078	<0.001	<0.001	-	-	-	-	-
	Anthracene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Fluoranthene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-

			Monitoring point	8	9		10	11	12	13	14	15
			Location	EM40	SF08		RB10	MT05	MP12	MP30	RP12	SL03
			Sampled Date	Not enough water to sample (19/8/2015)	19/08/2015	16/09/2015 (resample)	19/08/2015	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)	Not enough water to sample (19/8/2015)
			Data obtained	na	27/08/2015	23/09/2015	27/08/2015	na	na	na	na	na
	Analyte	**Units**	**Limit of reporting**									
	Pyrene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Benz(a)anthracene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Chrysene	mg/L	0.001	-	0.0029	<0.001	<0.001	-	-	-	-	-
	Benzo(b+j)fluoranthene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Benzo(k)fluoranthene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Benzo(a)pyrene	mg/L	0.0005	-	<0.0005	<0.0005	<0.0005	-	-	-	-	-
	Indeno(1.2.3.cd)pyrene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Dibenz(a.h)anthracene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Benzo(g.h.i)perylene	mg/L	0.001	-	<0.001	<0.001	<0.001	-	-	-	-	-
	Sum of polycyclic aromatic hydrocarbons	mg/L	0.0005	-	0.0197	<0.0005	<0.0005	-	-	-	-	-
	Benzo(a)pyrene TEQ (zero)	mg/L	0.0005	-	<0.0005	<0.0005	<0.0005	-	-	-	-	-
BTEX	**Benzene**	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
	Toluene	mg/L	0.002	-	<0.002	-	<0.002	-	-	-	-	-
	Ethylbenzene	mg/L	0.002	-	<0.002	-	<0.002	-	-	-	-	-
	Total Xylenes	mg/L	0.002	-	<0.002	-	<0.002	-	-	-	-	-
	Sum of BTEX	mg/L	0.001	-	<0.001	-	<0.001	-	-	-	-	-
TPH	**C6 - C9 Fraction**	mg/L	0.02	-	<0.02	-	<0.02	-	-	-	-	-
	C10 - C14 Fraction	mg/L	0.05	-	0.06	-	<0.05	-	-	-	-	-
	C15 - C28 Fraction	mg/L	0.10	-	0.96	-	2.11	-	-	-	-	-
	C29 - C36 Fraction	mg/L	0.05	-	0.83	-	0.15	-	-	-	-	-
	C10 - C36 Fraction (sum)	mg/L	0.05	-	1.85	-	2.26	-	-	-	-	-

Key:
- - not analysed
- na not applicable
- * LOR for particular analytes raised due to matrix interference within the sample.

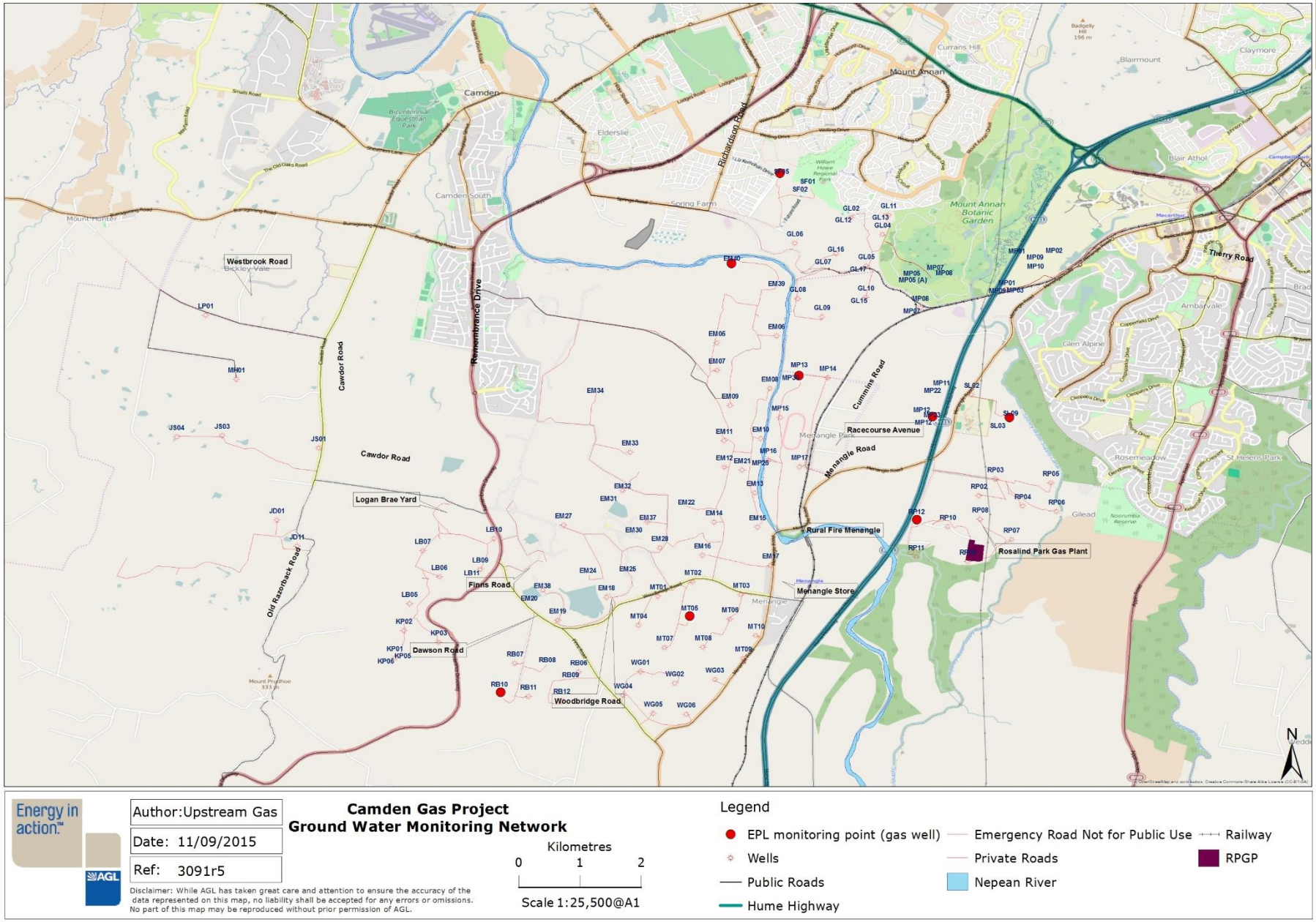

Figure 1- CGP and produced water monitoring locations as listed in EPL12003 (CSG wells)

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