AGL Upstream Investments Pty Ltd

Camden Gas Project

2012-2013 Annual Groundwater Monitoring Status Report

25 October 2013

PARSONS BRINCKERHOFF

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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.
Alluvial aquifer	Permeable zones that store and produce groundwater from unconsolidated alluvial sediments. Shallow alluvial aquifers are generally unconfined aquifers.
Anthropogenic	Occurring because of, or influenced by, human activity.
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 properties	The characteristics of an aquifer that determine its hydraulic behaviour and its response to abstraction.
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.
Artesian water	Groundwater that is under pressure when tapped by a bore and is able to rise above the level at which it is first encountered. It may or may not flow at ground level. The pressure in such an aquifer commonly is called artesian pressure, and the formation containing artesian water is a confined aquifer.
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.
Baseline sampling	A period of regular water quality and water level measurements that are carried out over a period long enough to determine the natural variability in groundwater conditions.
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).
Conceptual model	A simplified and idealised representation (usually graphical) of the physical hydrogeologic setting and the hydrogeological understanding of the essential flow processes of the system. This includes the identification and description of the geologic and hydrologic framework, media type, hydraulic properties, sources and sinks, and important aquifer flow and surface-groundwater interaction processes.
Confining layer	Low permeability strata that may be saturated but will not allow water to move through it under natural hydraulic gradients.
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.
Discharge area	An area in which there are upward or lateral components of flow in an aquifer.
Drawdown	A lowering of the water table in an unconfined aquifer or the pressure surface of a confined aquifer caused by pumping of groundwater from bores and wells.
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.
Fractured rock aquifer	These occur in sedimentary, igneous and metamorphosed rocks which have been subjected to disturbance, deformation, or weathering, and which allow water to move through joints, bedding planes, fractures and faults. Although fractured rock aquifers are found over a wide area, they generally contain much less groundwater than alluvial and porous sedimentary rock aquifers.
Groundwater	The water contained in interconnected pores or fractures located below the water table in the saturated zone.
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).
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.
Infiltration	The flow of water downward from the land surface into and through the upper soil layers.
Lithology	The study of rocks and their depositional or formational environment on a large specimen or outcrop scale.
MicroSiemens 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.
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 252 million years before present.
Piezometer	See monitoring bore.
Precipitation	(1) in meteorology and hydrology, rain, snow and other forms of water falling from the sky (2) the formation of a suspension of an insoluble compound by mixing two solutions. Positive values of saturation index (SI) indicate supersaturation and the tendency of the water to precipitate that mineral.
Purging	The removal of groundwater from monitoring wells (typically three well volumes) prior to sampling to ensure that representative groundwater samples are collected for analysis.
Quaternary	The most recent geological period extending from approximately 2.6 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.
Recharge area	A geographic area that directly receives infiltrated water from surface and in which there are downward components of hydraulic head in the aquifer. Recharge generally moves downward from the water table into the deeper parts of an aquifer then moves laterally and vertically to recharge other parts of the aquifer or deeper aquifer zones.
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 µS/cm. Marginal water quality – water that is more saline than freshwater and generally waters between 800 and 1,600 µS/cm. Brackish quality – water that is more saline than freshwater and generally waters between 1,600 and 4,800 µS/cm. Slightly saline quality – water that is more saline than brackish water and generally waters with a salinity between 4,800 and 10,000 µS/cm. Moderately saline quality – water that is more saline than brackish water and generally waters between 10,000 and 20,000 µS/cm. Saline quality – water that is almost as saline as seawater and generally waters with a salinity greater than 20,000 µS/cm. Seawater quality – water that is generally around 55,000 µS/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.
Tertiary	Geologic time at the beginning of the Cainozoic era, 65 to 2.5 million years ago, after the Cretaceous and before the Quaternary.
Total Dissolved Solids (TDS)	A measure of the salinity of water, usually expressed in milligrams per litre (mg/L). See also EC.
Triassic	The first period of the Mesozoic era, occurring between 252 million years and 201 million years ago.

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

L/m	Litres per meter
m	Metres
mAHD	Metres Australian height datum
mbgl	Metres below ground level
mbtoc	Metres below top of casing
m/day	Metres per day
m^2/day	Square metres per day
m/sec	Meters per second
m/year	Metres per year
µS/cm	Microsiemens per centimetre
mg/L	Milligrams per litre

AGL	AGL Upstream Investments Pty Ltd
BoM	Bureau of Meteorology
CGP	Camden Gas Project
CSG	Coal seam gas
EC	Electrical Conductivity
LOR	Laboratory Limit of Reporting
PEL	Petroleum Exploration Licence
PPL	Petroleum Production Lease

1. Introduction

1.1 Camden Gas Project (CGP)

AGL Upstream Investments Pty Ltd (AGL) owns and operates the Camden Gas Project (CGP) located in the Macarthur region, 65 km southwest of Sydney, NSW. The CGP has been producing natural gas from coal seams for the Sydney region since 2001 and currently consists of 144 gas wells (of which, 97 were operational at 30 June 2013). The target coal seams are the Bulli and Balgownie coal seams within the Illawarra Coal Measures at depths of approximately 600 - 700 m below ground level (mbgl). Parsons Brinckerhoff was engaged to investigate the hydrogeological environment to characterise the groundwater systems within the region, to assess the degree of connectivity (if any) between the shallow beneficial aquifers and the Permian coal seams, and to monitor trends within the shallow groundwater systems and with respect to the operating gas project.

1.2 Objectives

Parsons Brinckerhoff completed drilling, hydraulic conductivity testing and datalogger installation at three groundwater monitoring bores at the end of 2011 (Parsons Brinckerhoff, 2011a). Between May and June 2013 five additional groundwater monitoring bores were constructed within the CGP area; dataloggers were installed and hydraulic conductivity testing was also carried out at these locations. These bores are described in the *Drilling completion report* (Parsons Brinckerhoff, 2013 (in preparation)) and monitoring data collected from these are included in the 2013-14 annual groundwater monitoring report.

The main objective of this work presented in this report was to collect baseline groundwater level and quality data from three groundwater monitoring bores drilled at the AGL's Denham Court site to various depths across the site (Figure 1.1). The Denham Court site is located approximately 12 km northeast of the CGP. As a result, this monitoring site provides information on the natural groundwater systems within the area, away from coal seam gas development. Monitoring is being undertaken to:

- Characterise the local hydrogeology.
- Define the groundwater regime and water quality of the aquifer systems.
- Collect baseline data on groundwater level and groundwater quality fluctuations.
- Assess the degree of interconnection, if any, between the aquifers.

The purpose of this annual report is to:

- present and interpret groundwater level data collected quarterly since November 2011
- present and interpret groundwater quality data collected in May 2013.

1.3 Report structure

This report provides the first annual review of the monitoring network detailing groundwater level trends since monitoring begun, with focus on the July 2012 to June 2013 data, and groundwater quality analysis for the May 2013 sampling event.

The structure of the report is as follows:

- Chapter 2: provides an overview of the geological and hydrological setting of the southern Sydney Basin.
- Chapter 3: provides an overview of the monitoring network.
- Chapter 4: discusses the groundwater monitoring results for the monitoring period.
- Chapter 5: presents the conclusions and recommendations for future monitoring.
- Chapter 6: outlines limitations relating to analysis and reporting of data.
- Chapter 7: comprises the references used in this report.

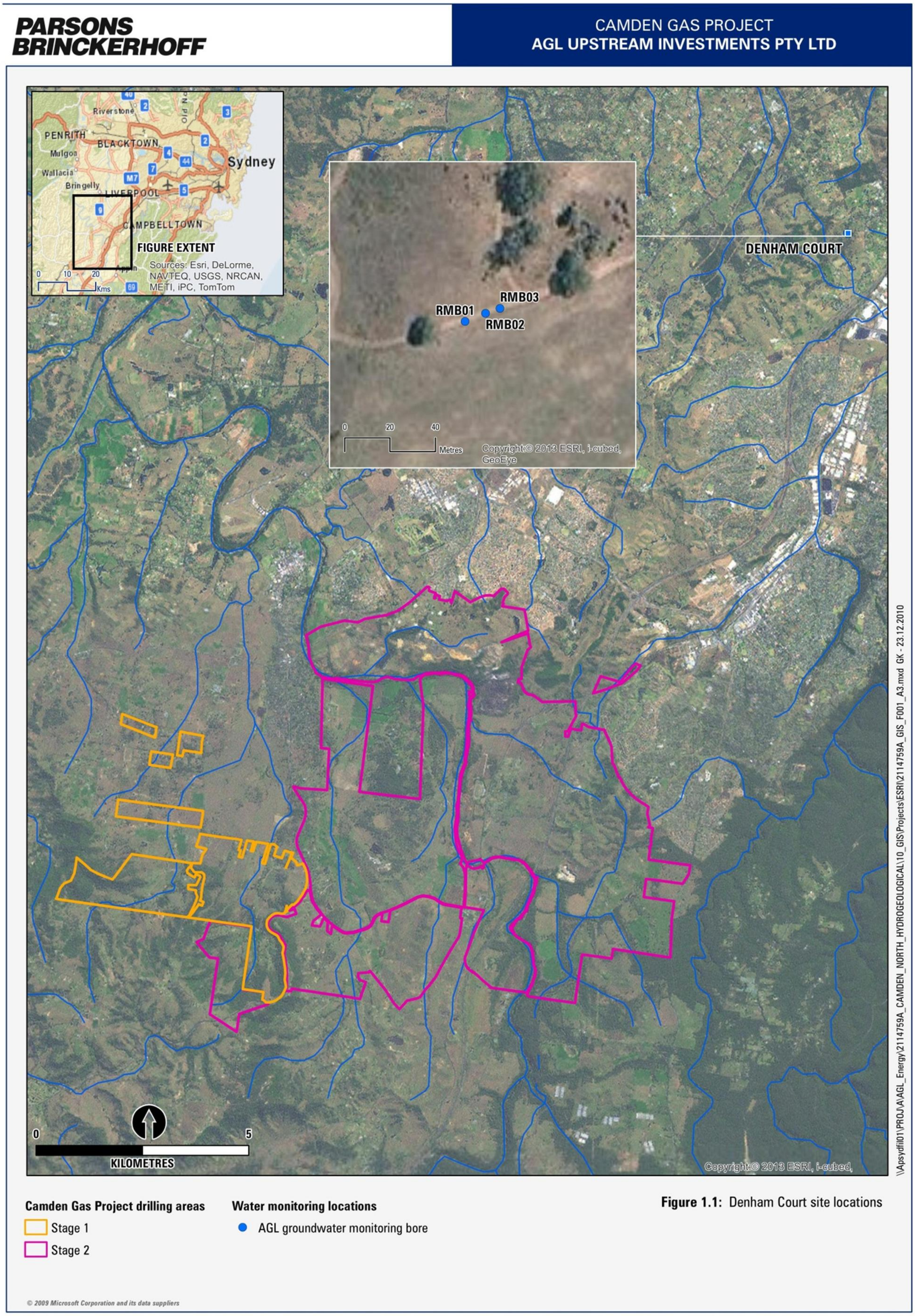

Figure 1.1 Groundwater monitoring network

2. Physical setting

2.1 Regional geology

The CGP is part of the Southern Coalfields of the Sydney Geological Basin. The Basin is primarily a Permo-Triassic sedimentary rock sequence (Parkin 2002) and is underlain by undifferentiated sediments of carboniferous and Devonian age. The stratigraphy of the CGP in the Camden-Campbelltown area is summarised in Table 2.1.

The Illawarra Coal Measures is the economic sequence of interest for CSG development in the area, and consists of interbedded sandstone, shale and coal seams, with a thickness of approximately 300 m. The upper sections of the Permian Illawarra Coal Measures (Sydney Subgroup) contain the major coal seams: Bulli Seam, Balgownie Seam, Wongawilli Seam, and Tongarra Seam. The primary seams targeted for coal seam gas production are the Bulli and Balgownie seams, both of which are approximately 2-5 m thick within the CGP.

The Illawarra Coal Measures is overlain by the Triassic sandstones, siltstones and claystones of the Narrabeen Group and the Hawkesbury Sandstone. Overlying the Hawkesbury Sandstone is the Triassic Wianamatta Group which comprises the majority of the surficial geology (where thin alluvial deposits are not present).

Structurally, the CGP area and surrounds are dominated by the north-northeast plunging Camden Syncline, which is a broad and gentle warp structure (Alder *et al*. 1991; Bray *et al.* 2010). The Camden Syncline is bounded in the west and truncated in the southwest by the north-south trending Nepean Structural Zone, part of the Lapstone Structural Complex.

The CGP is relatively unaffected by major faulting apart from a set of NW-NNW trending faults associated with the Lapstone Monocline Structure (Alder *et al*. 1991; Blevin *et al*. 2007). These faults have been identified from exploration and 2D seismic studies and they have been identified as high-angle, low to moderate displacement normal faults (Blevin *et al*. 2007). Many of these features intersect coal seams but very few, if any, affect the entire stratigraphic sequence displaying no expression at surface.

Table 2.1 Summary of regional Permo-Triassic geological stratigraphy

Period	Group	Sub-group	Formation	Description	Ave thickness (m)*
Quaternary			Alluvium	Quartz and lithic ‘fluvial’ sand, silt and clay	<20
Tertiary			Alluvium	High level alluvium.	
Triassic	Wianamatta Group		Bringelly Shale	Shale, carbonaceous claystone, laminate, lithic sandstone, rare coal.	80 (top eroded)
			Minchinbury Shale	Fine to medium-grained lithic sandstone.	
			Ashfield Shale	Black to light grey shale and laminate (Bembrick *et al*. 1987).	
			Mittagong Formation	Dark grey to grey alternating beds of shale laminate, siltstone and quartzose sandstone (Alder *et al.* 1991).	11
			Hawkesbury Sandstone	Massive or thickly bedded quartzose sandstone with siltstone, claystone and grey shale lenses up to several metres thick (Bowman, 1974; Moffitt, 2000).	173
	Narrabeen Group	Gosford Sub-group	Newport Formation	Fine-grained sandstone (less than 3 m thick) interbedded with light to dark grey, fine-grained sandstones, siltstones and minor claystones (Bowman, 1974).	35
			Garie Formation	Cream, massive, kaolinite-rich pelletal claystone, which grades upwards to grey, slightly carbonaceous claystone containing plant fossils at the base of the Newport Formation (Moffitt, 2000).	8
		Clifton Subgroup	Bald Hill Claystone	Massive chocolate coloured and cream pelletal claystones and mudstones, and occasional fine-grained channel sand units (Moffitt, 2000).	34
			Bulgo Sandstone	Thickly bedded sandstone with intercalated siltstone and claystone bands up to 3 m thick (Moffitt, 2000).	251
			Stanwell Park Claystone	Red-green-grey shale and quartz sandstone (Moffitt, 1999).	36
			Scarborough Sandstone	Quartz-lithic sandstone, pebbly in part (Moffitt, 1999).	20
			Wombarra Claystone	Grey shale and minor quartz-lithic sandstone (Moffitt, 1999).	32
Permian	Illawarra Coal Measures	Sydney Subgroup	Bulli Coal	Coal interbedded with shale, quartz-lithic sandstone, conglomerate, chert, torbante seams and occasionally carbonaceous mudstone (Moffitt 2000)	4
			Loddon Sandstone		12
			Balmain Coal Member		24
			Balgownie Coal		2
			(Remaining Sydney Subgroup)		?
		Cumberland Subgroup			–
	Shoalhaven Group			Sandstone, siltstone, shale, polymictic conglomerate, claystone; rare tuff, carbonate, evaporate.	–
Palaeozoic	Lachlan Fold Belt			Intensely folded and faulted slates, phyllites, quartzite sandstones and minor limestones of Ordovician to Silurian age (Moffitt 2000)	–

a) *Average thickness from available information on all wells within CGP (AGL, 2013)

2.2 Regional hydrogeology

The Southern Coalfields are located within the Sydney Basin sedimentary rock groundwater system. The recognised aquifers/water bearing zones within the CGP are:

- Unconfined Quaternary and Tertiary alluvium/sediment aquifers
- Late Triassic Wianamatta Group rocks (minor aquifers or aquitards)
- Middle Triassic Hawkesbury Sandstone aquifers
- Lower Triassic Narrabeen Group sandstone aquifers
- Permian water bearing zones (Illawarra Coal Measures).

A summary of the hydrogeological properties for stratigraphic units (where known) is provided in Table 3.2.

Alluvium occurs along the floodplain of the Nepean River and its tributaries. The alluvium deposits are generally shallow, discontinuous (except along the Nepean River) and relatively permeable. The unconfined aquifers within the alluvium are responsive to rainfall and stream flow and form a minor beneficial aquifer.

The Wianamatta Group Shales (which outcrop across the majority of the CGP) are generally considered as aquitards due to low permeability and yields; however small aquifer zones are sometimes present. Water is typically brackish to saline, especially in low relief areas of western Sydney (due to the marine depositional environment of the shales) (Old, 1942). Locally, the Wianamatta Group is low yielding, with average yields of 1.3 litres per second (L/s).

The Hawkesbury Sandstone and Narrabeen Group form part of an extensive confined to partially confined, regional aquifer system within the Sydney Basin sequence. The Hawkesbury Sandstone is more widely exploited for groundwater than the overlying and underlying formations, being of generally higher yield, better water quality and either outcropping or buried to shallow depths over the basin. Groundwater flow within the Hawkesbury Sandstone and Narrabeen Group aquifers at a regional scale has a major horizontal component due to the alternation of sheet and massive facies, with some vertical leakage. Both units are characterised by dual porosity, whereby the primary porosity is imparted by connected void space between sand grains and the secondary porosity is due to the interconnected rock defects such as joints, fractures, faults and bedding planes. Superior bore yield in the sandstone aquifers is often associated with major fractures or a high fracture zone density, and yields of >40 L/s have been recorded in bores intercepting these zones within deformed areas of the Sydney Basin (McLean and Ross, 2009). Typically within the CGP area bore yields rarely exceed 2 L/s.

Within the CGP, the aquifers within the Hawkesbury Sandstone are mostly primary permeability aquifers due to the lack of major fracturing and fault systems. Yields are highest and salinities freshest south of the Nepean River because of the proximity to recharge areas, however, north of the Nepean River, the salinities increase and become moderately saline in all aquifers within the sandstone. Groundwater is used for irrigation and domestic use south of the Nepean River and immediately to the north; however, further north of the river, groundwater quality is typically only suitable for stock (AGL, 2012).

Within the Narrabeen Group, both regionally and locally, aquifers are lower yielding and have poorer water quality than the overlying Hawkesbury Sandstone (Parsons Brinckerhoff, 2012).

All aquifer systems within the CGP are separated by low permeability aquitards which act as confining layers and limit vertical flow between aquifers. The main aquitards within the CGP include the Bald Hill Claystone, Stanwell Park Claystone and the Wombarra Claystone.

The coal seams present in the Illawarra Coal Measures are both regionally and locally minor water bearing zones. Due to the greater depth of burial of the coal measures and fine-grained nature of the sedimentary rocks, the permeability is generally lower than the overlying sandstone aquifers. Recharge to the Permian water bearing zones is likely to occur where the formations are outcropping, which is remote (and to the south) from the CGP. Salinity of the water bearing zones is typically brackish to moderately saline.

Within the CGP, there is limited rainfall recharge to the Wianamatta Group shales with most rainfall generating runoff and overland flow. There is expected to be some leakage through the Wianamatta Group into the Hawkesbury Sandstone where there is adequate fracture spacing, however, it is anticipated that most recharge to the sandstone aquifers occurs via lateral groundwater through-flow from upgradient and updip areas to the south. Outside of the CGP, the dominant recharge mechanism is likely to be infiltration of rainfall and runoff through alluvial deposits in valleys, particularly where they are incised into weathered Hawkesbury Sandstone (Parsons Brinkerhoff, 2011b). There is insufficient data within the CGP to define local flow paths and natural discharge zones; however, regionally groundwater flow is predominantly towards the north or northeast, eventually discharging via the Georges, Parramatta or Hawkesbury River systems, and ultimately offshore to the east. Locally, there may be a small base flow or interflow discharge component to local stream headwaters during wet periods; however groundwater-surface water interactions are not well defined within the area (Parsons Brinckerhoff, 2011b)

Table 2.2 Hydrogeological properties for stratigraphic units where available[1]

Age	Stratigraphic unit	Type of hydrogeological unit	Hydraulic conductivity – horizontal (m/day)	Hydraulic conductivity – vertical (m/day)	Transmissivity (m2/day)	Permeability (m/s)*	TDS (mg/L)
Quaternary /Tertiary	Alluvial deposits	Unconfined aquifer	1 -10		>20		
Triassic	Wianamatta group	Aquitard or unconfined/ perched	0.01	0.05	<1 (Ashfield Shale)		>3,000
	Hawkesbury sandstone	Unconfined/semi-confined aquifer	0.1	0.05 – 6 $x10^{-4}$	1 – 5	3 x 10^{-8}	<500 – 10,000
	Bald Hill claystone	Aquitard	1 $x10^{-5}$	5 – 10		5 x 10^{-9}	
	Bulgo sandstone	Minor confined aquifer	5 $x10^{-4}$	1 x10-4	0.1 – 0.5	6 x 10^{-8}	1,500- 5,000
	Stanwell Park claystone	Aquitard	3 $x10^{-5}$	6 x10-6		3 x 10^{-9}	
	Scarborough sandstone	Minor confined aquifer	0.01	5 x10-3	0.1 – 0.5	2 x 10^{-7}	
	Wombarra claystone	Aquitard	3 $x10^{-5}$	6x10-6		1 x 10^{-9}	
Permian	Illawarra Coal measures	Confined water bearing zones	5 $x10^{-2}$ (Bulli)	2.5x10-2 (Bulli)	0.005 – 0.1	1 x 10^{-5} (Bulli)	>2,000

Table summarises data from a number of investigations including SCA (2005); GHD (2007); Broadstock (2011); Parsons Brinkerhoff (2011b); AGL (2013)

3. Monitoring network

3.1 Monitoring network

Table 3.1 provides construction details for the 3 monitoring bores at the Denham Court site (Figure 1.1).

Table 3.1 Groundwater monitoring bore construction details

Monitoring bore	Location	Total depth (m)	Screened interval (mbgl)	Lithology	Casing material	Formation
RMB01	Denham court site	84	69 – 81 (12 m)	Siltstone	50 mm, class 18 u PVC, screwed casing	Wianamatta Group, Ashfield shale
RMB02	Denham court site	150	135 – 147 (12 m)	Sandstone	50 mm, class 18 u PVC, screwed casing	Upper Hawkesbury sandstone
RMB03	Denham court site	300	290 – 299 (9 m)	Sandstone	50 mm, galvanised/stainless steel, screwed casing	Lower Hawkesbury sandstone

The groundwater monitoring bores were drilled through the following Triassic formations within the Sydney Basin: Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone. Some shale lenses, up to seven metres thick, were observed in the Hawkesbury Sandstone.

Minor seeps were only encountered in the Ashfield Shale at depth. Groundwater was encountered in the Hawkesbury Sandstone (starting at approximately 108 – 114 mbgl) and minimal flows were recorded throughout (a maximum value of 0.9 litres per second when airlifting). No fractures were encountered during drilling and therefore groundwater flow is assumed to be via primary permeability. There are no major fault zones in this area.

The groundwater monitoring bore locations were surveyed by registered surveys (SMEC Pty Ltd) to MGA, a grid coordinate system based on the Geocentric Datum of Australia 1994. The bores were also surveyed for surface elevation to Australian Height Datum (AHD). The survey results are detailed in Table 3.2.

Table 3.2 Monitoring bore coordinates and elevations

Monitoring bore	Easting	Northing	Ground level (mAHD)	Top of casing (mAHD)
RMB01	300465.86	6237305.08	72.42	72.94
RMB02	300474.93	6237308.70	72.80	73.34
RMB03	300481.29	6237310.92	73.00	73.54

3.2 Water level monitoring

Groundwater level monitoring commenced in November 2011 as part of the Camden Phase 2 Groundwater program, as described in Parsons Brinckerhoff (2011a).

Dataloggers are installed in each of the groundwater monitoring bores to monitor groundwater levels every six hours. To calibrate the level recorded by the dataloggers, manual groundwater level measurements are recorded every three months using an electronic dip meter.

A barometric datalogger installed above the water table at RMB01 records changes in atmospheric pressure. Data from this logger are used to correct for the effects of changing barometric pressure and barometric efficiency on groundwater levels.

Measured water levels in bores can be influenced by atmospheric pressure fluctuations in two main ways. Firstly, automated dataloggers measure absolute pressure including the atmospheric pressure that acts on the water column in the bore. Logger data are therefore corrected for this effect (manual water measurements do not need this correction). Secondly, in confined or semi-confined aquifers, changes in atmospheric pressure can cause water in the bore to be forced into (during a pressure increase), or drawn from (pressure decrease) elastic aquifer storage, thereby affecting the measured water level. Groundwater level data presented in this report have also been corrected to remove these responses so that any anthropogenic groundwater influences (such as pumping) can be more easily identified.

Atmospheric pressure fluctuates over daily to weekly periods as weather systems pass over the site.

In general, the mean atmospheric pressure is slightly higher, and the amplitude of pressure fluctuation (between high and low pressure systems) larger in the winter than in the summer months. The amplitude of pressure fluctuation can be 20 mbar in the summer months and up to 30 mbar during the winter months.

Given that 1 mbar is equivalent to 1.02 cm of water depth, atmospheric pressure fluctuations can result in observed bore level fluctuations of up to 20 to 30 cm, depending on the barometric efficiency of the bore.

As noted above, this effect has been removed from the monitoring data presented here.

3.3 Water quality monitoring

The monitoring bores were sampled in November 2011 (Parsons Brinkerhoff, 2012) and in May 2013. No sample was collected from RMB01 during both occasions, as there was insufficient groundwater in the bore to obtain a representative sample.

A micro-purge™ low flow sampling system was deployed allowing a representative groundwater sample 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. Water levels and water quality parameters were monitored with a calibrated YSI water quality meter during the micro-purge™ pumping to ensure that a representative groundwater sample was collected.

Table 3.3 details the analytical suite for the May 2013 groundwater quality sampling event.

Table 3.3 Analytical suite

Category	Parameters	
Field parameters	EC	Redox potential
	Temperature	pH
	Dissolved oxygen	
General parameters	EC	Total dissolved solids (TDS)
	Total suspended solids	
Major ions	Calcium Magnesium Sodium Potassium	Chloride Bicarbonate Sulphate Dissolved silica
Metals and minor/trace elements	Aluminium Antimony Arsenic Barium Beryllium Boron Bromine Cadmium Chromium Cobalt Copper	Cyanide Iron Manganese Molybdenum Nickel Lead Selenium Strontium Uranium Vanadium Zinc
Nutrients	Total nitrogen Ammonia Phosphorus (reactive)	Nitrate Nitrite Total organic carbon (TOC)
Hydrocarbons	Phenol compounds Polycyclic aromatic hydrocarbons (PAH)	Total petroleum hydrocarbons (TPH) /Total recoverable hydrocarbons (TRH) Benzene, toluene, ethyl benzene and xylenes (BTEX)
Dissolved gases	Methane Ethene Ethane Propene	Propane Butene Butane

Water quality samples were collected in the sample bottles provided by the laboratory, with the appropriate preservation when required. Table 3.4 details the sample bottles used. Samples undergoing dissolved metal analysis were filtered through 0.45 µm filters in the field prior to collection.

Table 3.4 Sample bottles

Category	Sample bottle
Major cations/anions	1 x 1 L plastic, unpreserved
Dissolved metals	1 x 60 mL plastic, preserved
Nutrients	1 x 125 mL plastic, preserved
TOC	1 x 40 mL amber glass, preserved
Phenols/PAH/TPH (C10-C36)	1 x 500 mL amber glass, unpreserved
TPH (C6-C9)/BTEX	2 x 40 ml amber glass, preserved
Methane	2 x 40 ml amber glass, preserved

Samples were sent to the Australian Laboratory Service (ALS) Environmental Pty Ltd, Smithfield, Sydney, a NATA certified laboratory, under appropriate chain-of-custody protocols.

In addition isotope sampling was undertaken in November 2011 to enhance the hydrogeological conceptual model (Parsons Brinckerhoff, 2012).

4. Groundwater monitoring

4.1 Groundwater levels

Groundwater levels monitored over the medium to long term (over several years) allow for seasonal and long term trends to be established. Groundwater levels are discussed generally, and identification and analysis of seasonal or longer term trends is only briefly considered in this report due to the relatively short period (19 months) of monitoring data.

Groundwater level hydrographs for each monitoring bore are plotted with daily rainfall recorded by the Bureau of Meteorology for the Ingleburn rain gauge located near to the CGP (BoM site: 066190) (Figures 4.1–4.3).

To calibrate the level recorded by the dataloggers, manual groundwater level measurements are recorded every three months using an electronic dip meter. Manual groundwater measurements used to verify the logger data are presented in Table 4.1. The groundwater levels were observed to be deeper in the Ashfield Shale (~80 mbgl) then in the upper and lower Hawkesbury Sandstone (~40 mbgl) (Figure 4.1).

Table 4.1 Manual groundwater measurements

Date	RMB01		RMB02		RMB03	
	mbtoc	mAHD	mbtoc	mAHD	mbtoc	mAHD
01/11/2011	81.23	-8.29	41.33	32.01	41.25	32.29
30/11/2011	83.50	-10.56	41.00	32.34	41.74	31.81
06/03/2012	81.44	-8.50	40.87	32.47	41.01	32.53
09/03/2012	81.39	-8.45	40.75	32.59	40.97	32.57
29/05/2012	80.87	-7.93	40.87	32.48	40.96	32.58
09/09/2012	na	na	40.60	32.75	40.73	32.81
06/12/2012	79.62	-6.68	40.80	32.54	40.74	32.80
13/03/2013	78.96	-6.03	40.70	32.64	40.83	32.71
05/06/2013	83.28	-10.34	40.78	32.56	41.44	32.11

na = no dip available

4.1.1 Ashfield Shale

The hydrograph for RMB01 screened in the Wianamatta Group of the Ashfield Shale is shown in Figure 4.2.

Groundwater levels in the Ashfield Shale ranged from -10.35 mAHD to -5.60 mAHD since monitoring began. A gradual increase in the groundwater level of ~4.75 m can be observed between November 2011 and May 2013, after which a sudden fall in the groundwater level (~4.45 m) is visible. This sudden fall in groundwater level is the result of purging during the sampling event at the end of May 2013. The slow recovery from purging (~0.01 m in 15 days) suggests that the area of the Ashfield Shale being monitored (at the depth of the screened section of the bore) has very low permeability.

No response to rainfall events is visible, indicating that no direct rainfall recharge is taking place in this part of the Ashfield shale.

4.1.2 Upper Hawkesbury Sandstone

The hydrograph for RMB02 screened in the upper Hawkesbury Sandstone is shown in Figure 4.3Figure 4.3.

The groundwater level in the upper Hawkesbury Sandstone ranged from 32.37 mAHD to 32.74 mAHD since monitoring began. The water level remained fairly constant, with fluctuations of less than ~0.5 m throughout the monitoring period. There were no responses to individual rainfall events, indicating that no direct rainfall recharge is taking place in the upper Hawkesbury Sandstone.

4.1.3 Lower Hawkesbury sandstone

The hydrograph for RMB03 screened in the lower Hawkesbury Sandstone is shown in Figure 4.4

The groundwater level in the lower Hawkesbury Sandstone ranged from 28.56 mAHD to 32.79 mAHD since monitoring began. An increase of ~0.9 m was observed between November 2011 and March 2012. This increase is likely to reflect the recharge occurring after the November 2011 sampling event. Between March 2012 and May 2013 the groundwater level slowly increased by approximately 0.5 m. A sudden fall in the groundwater level (~4.14 m) and subsequent partial recovery is visible at the end May 2013, as a result of purging during water quality sampling. The relatively slow recovery from purging suggests that the screened section of the lower Hawkesbury Sandstone has low permeability.

As in the upper Hawkesbury Sandstone, no response to individual rainfall events is visible in the lower Hawkesbury Sandstone.

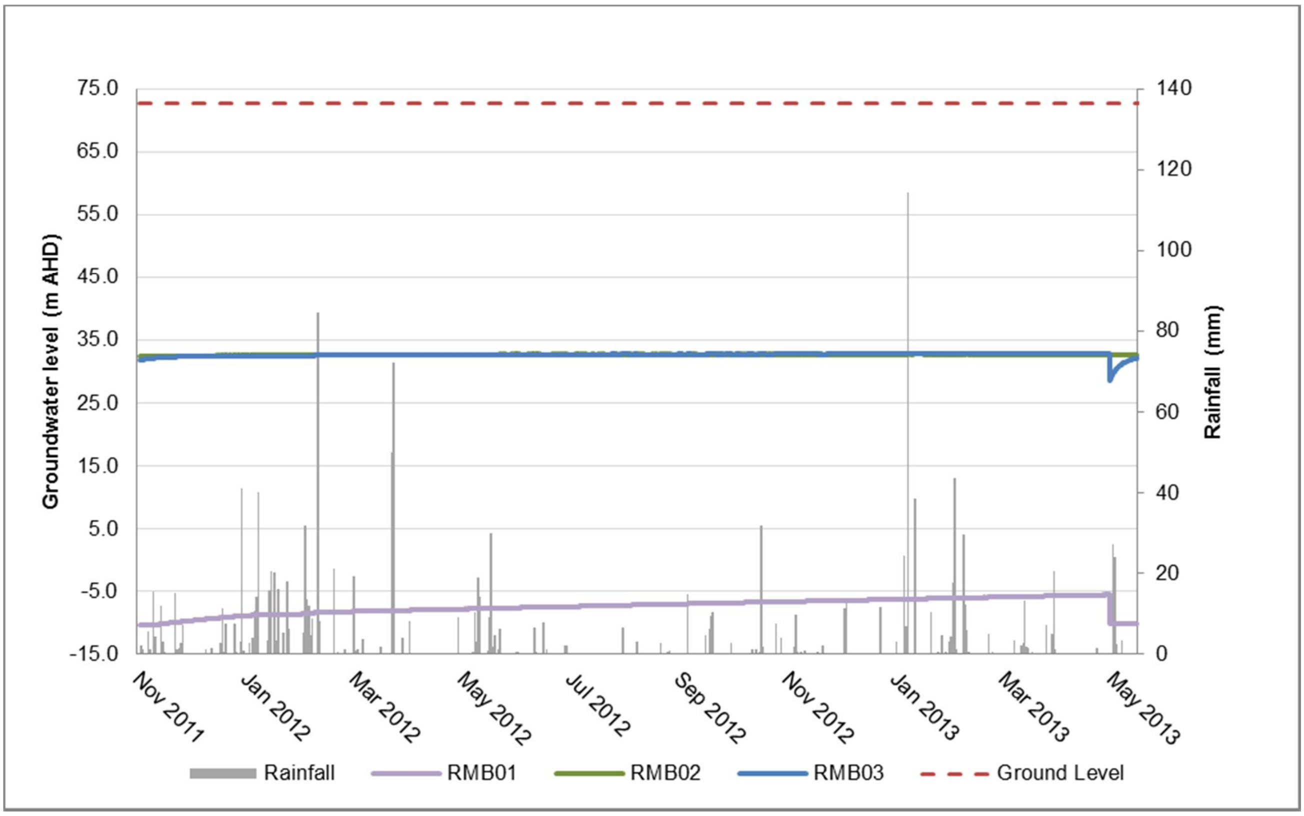

Figure 4.1 Groundwater levels at Denham Court site compared to rainfall

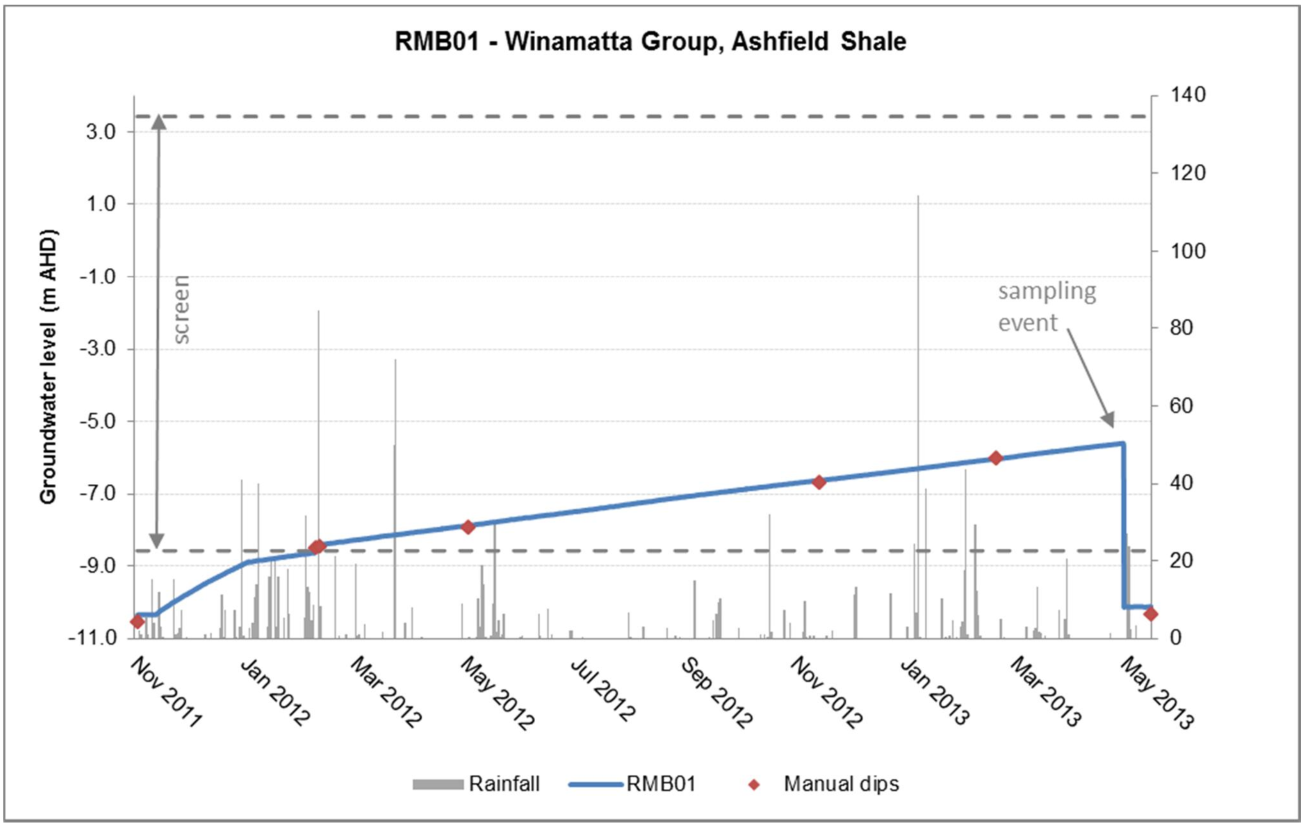

Figure 4.2 Groundwater levels and rainfall RMB01

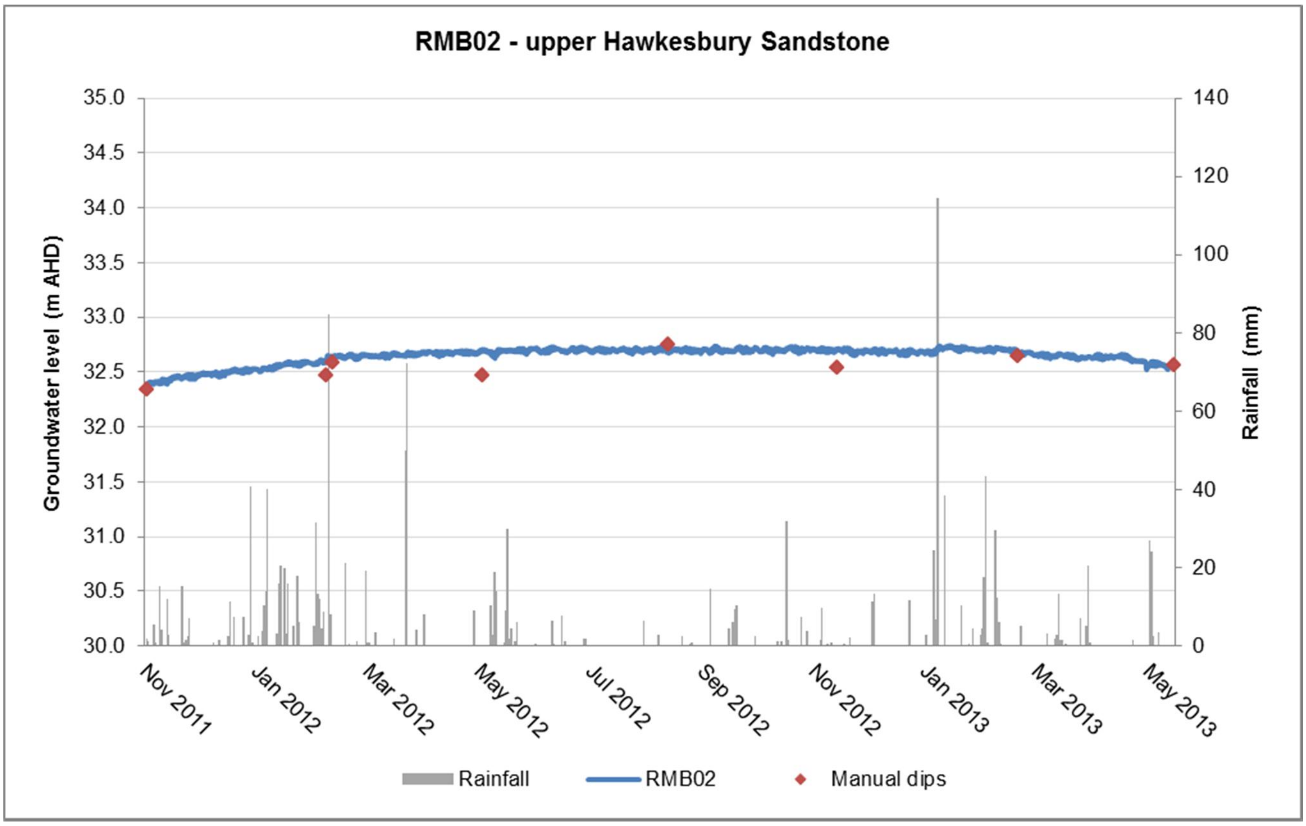

Figure 4.3 Groundwater levels and rainfall RMB02

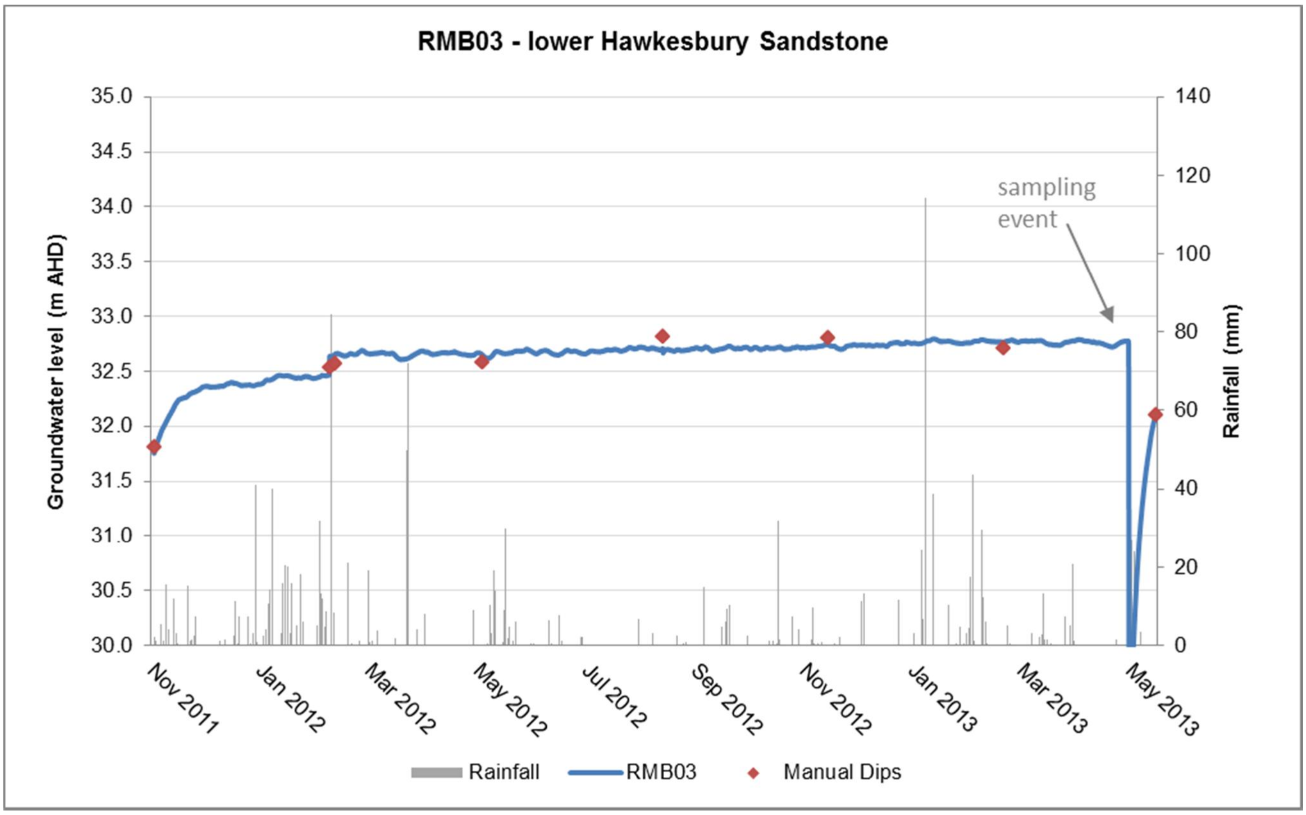

Figure 4.4 Groundwater levels and rainfall RMB03

4.2 Groundwater quality

Water quality results for the May 2013 sampling event are presented and compared to the ANZECC (2000) guidelines for freshwater ecosystems (south-east Australia – lowland rivers) in Table 4.2. A full set of chemical results for the November 2011 and May 2013 sampling events is provided in Appendix A.

All results have been compared against the ANZECC (2000) guidelines for freshwater ecosystems (south-east Australia – lowland rivers) because the rivers are the ultimate receiving waters for both surface water runoff and groundwater discharge. However, these water guidelines are often naturally exceeded in catchments with rocks deposited in marine environments, hence they are only guidelines and not strict criteria that should be used to evaluate individual water quality results.

A piper diagram is a graphical representation of the chemistry of a water sample and can be used to graphically show the relative concentrations of major ions (Ca^{2+}, Mg^{2+}, Na^{2+}, K^{+}, Cl^{-}, HCO_3^{-}, and SO_4^{2}). Major ion chemistry for the groundwater samples is shown on the piper diagram in Figure 4.5.

Field parameters

The groundwater within the Hawkesbury Sandstone is characterised as moderately saline (<10,800 µS/cm), with sodium and chloride the dominant ions (Figure 4.5). The pH at RMB02 was moderately acidic and the pH at RMB03 was basic, both bores exceeded the ANZECC (2000) guideline values. Reducing redox conditions were encountered in both bores.

Dissolved metals

The major findings of dissolved metal analysis are as follows:

- Manganese concentrations were detected at both monitoring bores, and were below the ANZECC (2000) guideline value (1.9 mg/L).
- Zinc concentrations were detected at RMB02 (0.002 mg/L) and RMB03 (0.602 mg/L) and exceeded the ANZECC (2000) guideline value (0.008 mg/L) at RMB03 only.
- Barium, strontium, iron and bromide concentrations were detected at both bores.
- Arsenic, molybdenum, lead and boron concentrations were detected at RMB03 only, and were below the ANZECC (2000) guideline values.
- Nickel concentrations were detected at RMB02 and were below the ANZECC (2000) guideline value (0.002 mg/L).
- Aluminium, beryllium, cadmium, cobalt, copper, selenium, uranium and vanadium concentrations were all below the laboratory LOR.

The dissolved metal concentrations are considered natural and not unusual for these types of sedimentary rock.

Nutrients

Ammonia concentrations were elevated at RMB02 (4.50 mg/L) and RMB03 (3.82 mg/L), and exceed the ANZECC (2000) guideline value (0.02 mg/L) at both locations. Nitrite and nitrate were below the laboratory LOR at both locations.

Total phosphorus was detected at RMB02 (0.13 mg/L) and RMB03 (0.02 mg/L), and only exceeded the ANZECC (2000) guideline value (0.05 mg/L) at RMB02. Reactive phosphorus was also detected at both bores, with RMB02 (0.10 mg/L) exceeding the ANZECC (2000) guideline value (0.02 mg/L).

Total organic carbon concentrations were variable with 3 mg/L at RMB02 and 18 mg/L at RMB03.

Hydrocarbons

Total petroleum hydrocarbons (TPH) were detected at RMB02 (C_{15}-C_{28} fraction was 210 µg/L) and at RMB03 (C_{10}-C_{14} fraction was 100 µg/L, C_{15}-C_{28} fraction was 410 µg/L and C_{29}-C_{36} fraction was 150 µg/L).

Polycyclic aromatic hydrocarbons were not detected in the two monitoring bores. Phenolic compounds were not detected, except at RMB03, where 3- and 4-Methylphenol concentrations were 2.9 µg/L. BTEX concentrations were below the laboratory LOR, except at RMB03 where Toluene concentrations were 8 µg/L.

Dissolved gases

Dissolve methane was detected at RMB02 (7650 µg/L) and at RMB03 (13100 µg/L).

Table 4.2 Groundwater quality May 2013

Parameters	Units	ANZECC (2000) guidelines[a]	RMB02	RMB03
General parameters				
pH	pH units	6.5 – 8.0[b]	**6.35**	**9.50**
Conductivity	µS/cm	125-2200[b]	**10003**	**7794**
Temperature	0C	–	21.72	18.86
Dissolved oxygen	% sat	80-110[b]	**10.6**	**5.6**
Total Dissolved Solids	mg/L	–	6515	5070
Suspended Solids	mg/L	–	18	80
Redox	mg/L	–	-175	-127
Water type[c]			NaCl	NaCl
Laboratory analytes				
Calcium	mg/L	–	307	7
Magnesium	mg/L	–	83	18
Sodium	mg/L	–	1820	1810
Potassium	mg/L	–	35	21
Chloride	mg/L	–	2800	2280
Sulphate	mg/L	–	<10	10
Total alkalinity as CaCO3	mg/L	–	836	488
Silica	mg/L	–	10.6	6.85
Total cyanide	mg/L	0.007	<0.004	<0.004
Fluoride	mg/L	–	0.2	0.3
Dissolved metals				
Aluminium	mg/L	0.055	<0.01	<0.01
Antimony	mg/L	-	<0.001	<0.001
Arsenic	mg/L	0.013	<0.001	0.002
Beryllium	mg/L	ID	<0.001	<0.001
Barium	mg/L	–	35.1	6.35
Cadmium	mg/L	0.37	<0.0001	<0.0001
Cobalt	mg/L	ID	<0.001	<0.001
Copper	mg/L	0.0014	<0.001	<0.001
Lead	mg/L	0.0034	<0.001	0.001
Manganese	mg/L	1.9	0.052	0.002
Molybdenum	mg/L	ID	<0.001	0.006
Nickel	mg/L	0.011	0.004	<0.001

Parameters	Units	ANZECC (2000) guidelines[a]	RMB02	RMB03
Selenium	mg/L	0.011	<0.01	<0.01
Strontium	mg/L	-	8.00	1.82
Uranium	mg/L	ID	<0.001	<0.001
Vanadium	mg/L	ID	<0.01	<0.01
Zinc	mg/L	0.008	0.020	**0.602**
Boron	mg/L	0.37	<0.05	0.16
Iron	mg/L	ID	5.89	<0.05
Bromine	mg/L	ID	7.3	5.9
Nutrients				
Ammonia as N	mg/L	0.02[b]	**4.50**	**3.82**
Nitrite as N	mg/L	0.02[b]	<0.01	<0.01
Nitrate as N	mg/L	0.7	<0.01	<0.01
Total Phosphorus	mg/L	0.05[b]	**0.13**	0.02
Reactive phosphorus	mg/L	0.02[b]	**0.10**	0.02
Total Organic Carbon	mg/L	–	3	18
Gases				
Methane	µg/L	–	7650	13100
Phenolic compounds				
3-&4-Methylphenol	µg/L	–	<2.0	2.9
Polycyclic aromatic compounds	µg/L		<LORs	<LORs
BTEX compounds				
Toluene	µg/L	–	<2	8
Total petroleum hydrocarbons				
C_6-C_9	µg/L	–	<20	<20
C_{10}-C_{14}	µg/L	–	<50	100
C_{15}-C_{28}	µg/L	–	<100	400
C_{29}-C_{36}	µg/L	–	<50	150

a) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: 95% protection levels (trigger values).

b) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: trigger values for lowland rivers in south-east Australia.

c) Calculated using AQUACHEM

Bold indicates exceedance of guideline value.

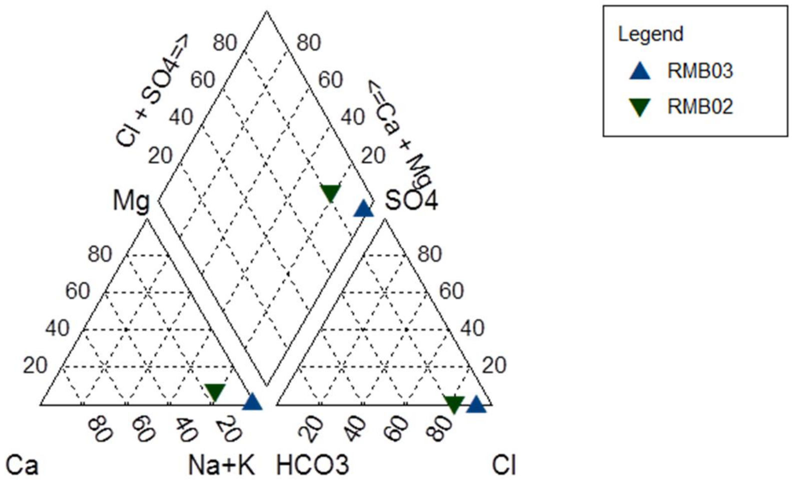

Figure 4.5 Piper plot displaying May 2013 water quality results

5. Conclusions and recommendations

5.1 Conclusions

This report presents the groundwater level and quality data for the July 2012 to June 2013 monitoring period. The following conclusions are made:

Groundwater monitoring

- The groundwater level monitoring network, consisting of three groundwater monitoring bores located 12 km northeast of the CGP, was fully operational and returned consistent results.
- Dataloggers recorded groundwater levels in the three monitoring bores at six hourly intervals.

Groundwater levels

- The groundwater levels in all aquifers are deep (at least 40 m below ground level) and there does not appear to be interaction with the surface environment.
- The groundwater level in the Ashfield Shale showed a gradual increasing trend throughout the monitoring period. The water level was strongly affected by purging during water quality sampling, suggesting that the monitored section of the Ashfield Shale has a very low permeability.
- The groundwater level in the upper Hawkesbury Sandstone has remained fairly constant throughout the monitoring period.
- The groundwater level in the lower Hawkesbury Sandstone increased between November 2011 and March 2012, after which water levels continued to increase, but at a more gradual rate. The water level in this section of the lower Hawkesbury Sandstone is affected by purging during water quality sampling, suggesting that the screened section of this aquifer has a low permeability.

Groundwater quality

- Groundwater in the upper and lower Hawkesbury Sandstone is brackish, with sodium and chloride the dominant ions. The upper sandstone aquifer has slightly acidic conditions, while slightly alkaline conditions were encountered in the lower sandstone aquifer.
- Groundwater in the upper and lower Hawkesbury Sandstone has low concentrations of dissolved metals and only zinc was detected above ANZECC (2000) guideline values at RMB03. Concentrations of dissolved metals above the freshwater ANZECC (2000) guidelines are common in natural brackish to saline groundwater within the Sydney Basin.
- Ammonia, total phosphorus and reactive phosphorous concentrations were higher in the upper Hawkesbury Sandstone and exceeded the ANZECC (2000) guideline values.
- Minor detections of naturally occurring TPH and toluene occurred at the two monitoring sites. Dissolved methane concentrations were detected in both the upper and lower Hawkesbury Sandstone.

5.2 Recommendations

The following recommendations are made regarding the ongoing CGP groundwater monitoring:

- Groundwater level monitoring should continue at the current six hourly intervals to continue to provide a baseline characterisation of the natural groundwater systems at the site.
- Groundwater quality monitoring should be undertaken at quarterly intervals for the 2013-2014 monitoring period to provide a more definitive baseline characterisation of the natural groundwater systems at the site.
- New monitoring bores constructed and operational in early 2013-14 be incorporated into next year's annual monitoring report.

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 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.

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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.

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Appendix A

Groundwater quality data

Summary Table A.1 - Water quality data November 2011

Analyte	Units	LOR	ANZECC 2000 Guidelines	Denham Court Groundwater Monitoring Bores	
Monitoring bore				**RMB02**	**RMB03**
Sample date				**3/11/2011**	**7/11/2011**
Formation				**Upper Hawkesbury Sandstone**	**Lower hawkesbury Sandstone**
Aquifer				**Fractured rock**	**Fractured rock**
General Parameters					
pH	pH units	0.01	6.5 - 8.0*	6.52	7.42
Conductivity	µS/cm	1	125 - 2200*	9517	5713
Temperature	0C	0.01	-	27.55	-
Dissolved oxygen	% sat	0.01	80 - 110%*	5.8	5.6
Total Dissolved Solids	mg/L	1	-	6.188	3.759
Redox	mg/L	-	-	-10	-136
Water type #	-	-	-	NaCl	NaCl
Laboratory Analytes					
Hydroxide Alkalinity as CaCO3	mg/L	1	-	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1	-	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1	-	743	606
Total Alkalinity as CaCO3	mg/L	1	-	743	606
Sulfate as SO4 2-	mg/L	1	-	86	39
Chloride	mg/L	1	-	3980	2350
Calcium	mg/L	1	-	385	121
Magnesium	mg/L	1	-	95	40
Sodium	mg/L	1	-	2090	1580
Potassium	mg/L	1	-	35	25
Silica	mg/L	0.1	-	15.6	10
Ions					
Total Anions	meq/L	0.01	-	129	79.2
Total Cations	meq/L	0.01	-	119	79.5
Ionic Balance	%	0.01	-	4.14	0.18
Dissolved Metals					
Aluminium	mg/L	0.01	0.055	<0.01	<0.01
Arsenic	mg/L	0.001	0.013 (As V)	0.009	0.006
Beryllium	mg/L	0.001	ID	<0.001	<0.001
Barium	mg/L	0.001	-	1.18	5.44
Cadmium	mg/L	0.0001	0.0002	<0.001	<0.0001
Cobalt	mg/L	0.001	ID	0.004	0.006
Copper	mg/L	0.001	0.0014	0.003	0.005
Lead	mg/L	0.001	0.0034	<0.001	<0.001
Manganese	mg/L	0.001	1.9	0.116	0.085
Molybdenum	mg/L	0.001	ID	0.001	0.014
Nickel	mg/L	0.001	0.011	0.009	0.018
Selenium	mg/L	0.01	0.011 (total)	<0.01	<0.01
Strontium	mg/L	0.001	-	10.8	5.78
Uranium	mg/L	0.001	ID	0.016	<0.001
Vanadium	mg/L	0.01	ID	<0.01	<0.01
Zinc	mg/L	0.005	0.008	0.624	12
Boron	mg/L	0.05	0.37	0.06	0.08
Iron	mg/L	0.05	ID	0.029	0.62
Bromine	mg/L	0.1	ID	7.9	4.9
Nutrients					
Ammonia as N	mg/L	0.01	0.02*	4.51	2.77
Nitrite as N	mg/L	0.01	-	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.7	<0.01	0.02
Total Phosphorous	mg/L	0.01	0.05*	<0.01	<0.01
Reactive Phosphorous	mg/L	0.01	0.02*	<0.01	<0.01
Total Organic Carbon	mg/L	1	-	9	17
Dissolved Gases					
Methane	µg/L	10	-	**10100**	**18200**
Phenolic compounds					
Phenol	µg/L	1	320	<1.0	1.1
2-Chlorophenol	µg/L	1	490	<1.0	<1.0
2-Methylphenol	µg/L	1	-	<1.0	<1.0
3-&4-Methylphenol	µg/L	2	-	<2.0	<2.0
2-Nitrophenol	µg/L	1	ID	<1.0	<1.0
2.4-Dimethylphenol	µg/L	1	ID	<1.0	<1.0
2.4-Dichlorophenol	µg/L	1	160	<1.0	<1.0
2.6-Dichlorophenol	µg/L	1	ID	<1.0	<1.0
4-Chloro-3-Methylphenol	µg/L	1	-	<1.0	<1.0
2.4.6-Trichlorophenol	µg/L	1	20	<1.0	<1.0
2.4.5-Trichlorophenol	µg/L	1	ID	<1.0	<1.0
Pentachlorophenol	µg/L	2	ID	<2.0	<2.0
Polycyclic aromatic hydrocarbons					
Naphthalene	µg/L	1	16	<1.0	<1.0
Acenaphthylene	µg/L	1	-	<1.0	<1.0
Acenaphthene	µg/L	1	-	<1.0	<1.0
Fluorene	µg/L	1	-	<1.0	<1.0
Phenanthrene	µg/L	1	ID	<1.0	<1.0
Anthracene	µg/L	1	ID	<1.0	<1.0
Fluoranthene	µg/L	1	ID	<1.0	<1.0
Pyrene	µg/L	1	-	<1.0	<1.0
Benz(a)anthracene	µg/L	1	-	<1.0	<1.0
Chrysene	µg/L	1	-	<1.0	<1.0
Benzo(b)fluoranthene	µg/L	1	-	<1.0	<1.0
Benzo(k)fluoranthene	µg/L	1	-	<1.0	<1.0
Benzo(a)pyrene	µg/L	0.5	ID	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	µg/L	1	-	<1.0	<1.0
Dibenz(a.h)anthracene	µg/L	1	-	<1.0	<1.0
Benzo(g.h.i)perylene	µg/L	1	-	<1.0	<1.0
Sum of PAHs	µg/L	0.5	-	<0.5	<0.5
Total petroleum hydrocarbons					
C6-C9 Fraction	µg/L	20	ID	<20	<20
C10-C14 Fraction	µg/L	50	ID	<50	<50
C15-C28 Fraction	µg/L	100	ID	**460**	**210**
C29-C36 Fraction	µg/L	50	ID	<50	<50
C10-C36 Fraction (sum)	µg/L	50	-		
Total recoverable hydrocarbons					
C6-C10 Fraction	µg/L	20		<20	<20
C6-C10 Fraction minus BTEX (F1)	µg/L	20		<20	<20
>C10-C16 Fraction	µg/L	100		<100	<100
>C16-C34 Fraction	µg/L	100		420	220
>C34-C40 Fraction	µg/L	100		<100	<100
>C10-C40 Fraction (sum)	µg/L	100		420	220
Aromatic Hydrocarbons					
Benzene	µg/L	1	950	<1	<1
Toluene	µg/L	2	ID	<2	<2
Ethyl Benzene	µg/L	2	ID	<2	<2
m&p-Xylenes	µg/L	2	ID	<2	<2
o-Xylenes	µg/L	2	350	<2	<2
Total xlyenes	µg/L	2	-	<2	<2
Sum of BTEX	µg/L	1	-	<1	<1
Naphthalene	µg/L	5	-	<5	<5
Isotopes					
Oxygen-18	‰	0.01	-	-6.06	-6.03
Deuterium	‰	0.1	-	-36.1	-36.4
Carbon-13	‰	0.1	-	5.4	8.4
Radiocarbon	pMC	0.1	-	1.18±0.05	1.87±0.06
Radiocarbon Age (uncorrected)	yrs BP	1	-	35620±370	31900±240

exceeds guideline limits   ID - Insufficient data   na - not analysed

Guideline values   **Bold -** significant result

ANZECC 2000 - Water Quality Guidelines: 95% protection levels (trigger values) for the protection of freshwater aquatic ecosystems.

* ANZECC 2000 - Water Quality Guidelines: 95% protection levels (trigger values) for the protection of freshwater aquatic ecosystems, South-East Australia, low lying river ecosystems

Calculated using Aquachem

PARSONS BRINCKERHOFF

Summary Table A.2 - Water quality data May 2013

Analyte	Units	LOR	ANZECC 2000 Guidelines	Denham Court Groundwater Monitoring Bores	
Monitoring bore				**RMB02**	**RMB03**
Sample date				**21/05/2013**	**21/05/2013**
Formation				**Upper Hawkesbury Sandstone**	**Lower Hawkesbury Sandstone**
Aquifer				**Fractured rock**	**Fractured rock**
General Parameters					
pH	pH units	0.01	6.5 - 8.0*	6.35	9.50
Conductivity	µS/cm	1	125 - 2200*	10003	7794
Temperature	0C	0.01	-	21.72	18.86
Dissolved oxygen	% sat	0.01	80 - 110%*	10.6	5.6
Total Dissolved Solids	mg/L	1	-	6515	5070
Suspended Solids	mg/L	1	-	18	80
Redox	mg/L	-	-	-175	-127
Water type #	-	-	-	NaCl	NaCl
Laboratory Analytes					
Hydroxide Alkalinity as CaCO3	mg/L	1	-	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1	-	<1	260
Bicarbonate Alkalinity as CaCO3	mg/L	1	-	836	228
Total Alkalinity as CaCO3	mg/L	1	-	836	488
Sulfate as SO4 2-	mg/L	1	-	<10	10
Chloride	mg/L	1	-	2800	2280
Calcium	mg/L	1	-	307	7
Magnesium	mg/L	1	-	83	18
Sodium	mg/L	1	-	1820	1810
Potassium	mg/L	1	-	35	21
Silica	mg/L	0.1	-	10.6	6.85
Total Cyanide	mg/L	0.004	0.007	<0.004	<0.004
Fluoride	mg/L	0.1	-	0.2	0.3
Ions					
Total Anions	meq/L	0.01	-	95.7	74.3
Total Cations	meq/L	0.01	-	102	81.1
Ionic Balance	%	0.01	-	3.29	4.36
Dissolved Metals					
Aluminium	mg/L	0.01	0.055	<0.01	<0.01
Antimony	mg/L	0.001	-	<0.001	<0.001
Arsenic	mg/L	0.001	0.013 (As V)	<0.001	0.002
Beryllium	mg/L	0.001	ID	<0.001	<0.001
Barium	mg/L	0.001	-	35.1	6.35
Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001
Chromium	mg/L	0.001	0.001	<0.001	<0.001
Cobalt	mg/L	0.001	ID	<0.001	<0.001
Copper	mg/L	0.001	0.0014	<0.001	<0.001
Lead	mg/L	0.001	0.0034	<0.001	0.001
Manganese	mg/L	0.001	1.9	0.052	0.002
Molybdenum	mg/L	0.001	ID	<0.001	0.006
Nickel	mg/L	0.001	0.011	0.004	<0.001
Selenium	mg/L	0.01	0.011 (total)	<0.01	<0.01
Strontium	mg/L	0.001	-	8.00	1.82
Uranium	mg/L	0.001	ID	<0.001	<0.001
Vanadium	mg/L	0.01	ID	<0.01	<0.01
Zinc	mg/L	0.005	0.008	0.020	0.602
Boron	mg/L	0.05	0.37	<0.05	0.16
Iron	mg/L	0.05	ID	5.89	<0.05
Bromine	mg/L	0.1	ID	7.3	5.9
Nutrients					
Ammonia as N	mg/L	0.01	0.02*	4.50	3.82
Nitrite as N	mg/L	0.01	-	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.7	<0.01	<0.01
Total Phosphorous	mg/L	0.01	0.05*	0.13	0.02
Reactive Phosphorous	mg/L	0.01	0.02*	0.10	0.02
Total Organic Carbon	mg/L	1	-	3	18
Dissolved Gases					
Methane	µg/L	10	-	**7650**	**13100**
Ethene	µg/L	11	-	<10	<10
Ethane	µg/L	12	-	<10	<10
Propene	µg/L	13	-	<10	<10
Propane	µg/L	14	-	<10	<10
Butene	µg/L	15	-	<10	<10
Butane	µg/L	16	-	<10	<10
Phenolic compounds					
Phenol	µg/L	1	320	<1.0	<1.0
2-Chlorophenol	µg/L	1	490	<1.0	<1.0
2-Methylphenol	µg/L	1	-	<1.0	<1.0
3-&4-Methylphenol	µg/L	2	-	<2.0	**2.9**
2-Nitrophenol	µg/L	1	ID	<1.0	<1.0
2.4-Dimethylphenol	µg/L	1	ID	<1.0	<1.0
2.4-Dichlorophenol	µg/L	1	160	<1.0	<1.0
2.6-Dichlorophenol	µg/L	1	ID	<1.0	<1.0
4-Chloro-3-Methylphenol	µg/L	1	-	<1.0	<1.0
2.4.6-Trichlorophenol	µg/L	1	20	<1.0	<1.0
2.4.5-Trichlorophenol	µg/L	1	ID	<1.0	<1.0
Pentachlorophenol	µg/L	2	ID	<2.0	<2.0
Polycyclic aromatic hydrocarbons					
Naphthalene	µg/L	1	16	<1.0	<1.0
Acenaphthylene	µg/L	1	-	<1.0	<1.0
Acenaphthene	µg/L	1	-	<1.0	<1.0
Fluorene	µg/L	1	-	<1.0	<1.0
Phenanthrene	µg/L	1	ID	<1.0	<1.0
Anthracene	µg/L	1	ID	<1.0	<1.0
Fluoranthene	µg/L	1	ID	<1.0	<1.0
Pyrene	µg/L	1	-	<1.0	<1.0
Benz(a)anthracene	µg/L	1	-	<1.0	<1.0
Chrysene	µg/L	1	-	<1.0	<1.0
Benzo(b)fluoranthene	µg/L	1	-	<1.0	<1.0
Benzo(k)fluoranthene	µg/L	1	-	<1.0	<1.0
Benzo(a)pyrene	µg/L	0.5	ID	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	µg/L	1	-	<1.0	<1.0
Dibenz(a.h)anthracene	µg/L	1	-	<1.0	<1.0
Benzo(g.h.i)perylene	µg/L	1	-	<1.0	<1.0
Sum of PAHs	µg/L	0.5	-	<0.5	<0.5
Total petroleum hydrocarbons					
C6-C9 Fraction	µg/L	20	ID	<20	<20
C10-C14 Fraction	µg/L	50	ID	<50	100
C15-C28 Fraction	µg/L	100	ID	210	410
C29-C36 Fraction	µg/L	50	ID	<50	150
C10-C36 Fraction (sum)	µg/L	50	-	<50	660
Total recoverable hydrocarbons					
C6-C10 Fraction	µg/L	20	-	<20	<20
C6-C10 Fraction minus BTEX (F1)	µg/L	20	-	<20	<20
>C10-C16 Fraction	µg/L	100	-	<100	120
>C16-C34 Fraction	µg/L	100	-	220	520
>C34-C40 Fraction	µg/L	100	-	<100	<100
>C10-C40 Fraction (sum)	µg/L	100	-	220	640
Aromatic Hydrocarbons					
Benzene	µg/L	1	950	<1	<1
Toluene	µg/L	2	ID	<2	**8**
Ethyl Benzene	µg/L	2	ID	<2	<2
m&p-Xylenes	µg/L	2	ID	<2	<2
o-Xylenes	µg/L	2	350	<2	<2
Total xlyenes	µg/L	2	-	<2	<2
Sum of BTEX	µg/L	1	-	<1	**8**
Naphthalene	µg/L	5	-	<5	<5

exceeds guideline limits   ID - Insufficient data   na - not analysed

Guideline values   **Bold -** significant result

ANZECC 2000 - Water Quality Guidelines: 95% protection levels (trigger values) for the protection of freshwater aquatic ecosystems.

* ANZECC 2000 - Water Quality Guidelines: 95% protection levels (trigger values) for the protection of freshwater aquatic ecosystems, South-East Australia, low lying river ecosystems

Calculated using Aquachem

PARSONS BRINCKERHOFF

Appendix B

ALS laboratory results

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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

☐BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

☐MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 27 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 024423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

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

CLIENT: Parsons Brinckerhoff

OFFICE: Sydney

PROJECT: 214759B

ORDER NUMBER:

PROJECT MANAGER: James Duggleby — CONTACT PH: 9272 5248

SAMPLER: Sean Moran — SAMPLER MOBILE: 0422 395 059

COC emailed to ALS? (YES / NO) — EDD FORMAT (or default):

Email Reports to jduggleby@pb.com.au

Email Invoice to accounts@pb.com.au

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)

☐ Standard TAT (List due date):

☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.:

COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
	David		
DATE/TIME:	DATE/TIME: 23/5 1100	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE | SAMPLE DETAILS MATRIX: SOLID (S) WATER (W) | CONTAINER INFORMATION | ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required). | Additional Information

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	Conductivity, pH, TDS	Cations - Ca,Mg,Na,K	Anions - Cl, SO4, Alkalinity	Anions: Minor - Nitrite as N, Nitrate as N, Fluoride, Reactive Phosphorus	ICP/MS Dissolved metals*:Al, Sb (antimony), As, Ba, Be, B, Br, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Sr, U, V, Zn	Nitrogen - Ammonia as N	Phosphorus - Total as P	W-24 TRH(C6-C40)/BTEXN /PAH/Phenols	Gases C1-C4	Silica reactive	Suspended solids	Total Organic Carbon	Cyanide	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	RMB02	21/05/2013 1230	W			x	x	x	x	x	x	x	x	x	x	x	x	x	48hr holding time
2	RMB03	21/05/2013 1600	W			x	x	x	x	x	x	x	x	x	x	x	x	x	expires 23/05/13
																			@ 1230
					TOTAL														

Environmental Division
Sydney
Work Order
ES1311719

Telephone : +61-2-8784 8555

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

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1311719**	Page	: 1 of 8
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MR JAMES DUGGLEBY	Contact	: Loren Schiavon
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jduggleby@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	: 214759B	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 23-MAY-2013
Sampler	: SM	Issue Date	: 29-MAY-2013
Site	: ----		
		No. of samples received	: 2
Quote number	: EN/008/12	No. of samples analysed	: 2

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

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

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*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics
Phalak Inthaksone	Laboratory Manager - Organics	Sydney Organics
Phalak Inthaksone	Laboratory Manager - Organics	Sydney Organics
Raymond Commodor	Instrument Chemist	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

- **ED041G:LOR raised for Sulfate analysis on sample ID(RMB02) due to sample matrix.**
- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**
- **EK026SF: Spike failed for Total Cyanide analysis due to matrix interferences (confirmed via re-analysis).**
- **EK026SF: Unpreserved natural samples used for Total Cyanide analysis.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	RMB02	RMB03	----	----	----
			Client sampling date / time	21-MAY-2013 12:30	21-MAY-2013 16:00	----	----	----
				ES1311719-001	ES1311719-002	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.24	9.43	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	10700	8320	----	----	----
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	----	10	mg/L	5550	4200	----	----	----
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	18	80	----	----	----
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	260	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	836	228	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	836	488	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<10	10	----	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	2800	2280	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	307	7	----	----	----
Magnesium	7439-95-4	1	mg/L	83	18	----	----	----
Sodium	7440-23-5	1	mg/L	1820	1810	----	----	----
Potassium	7440-09-7	1	mg/L	35	21	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.002	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L	35.1	6.35	----	----	----
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	<0.001	<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	0.051	0.002	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB02	RMB03	----	----	----
			Client sampling date / time	21-MAY-2013 12:30	21-MAY-2013 16:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1311719-001	ES1311719-002	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.006**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.004**	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Strontium	7440-24-6	0.001	mg/L	**8.00**	**1.82**	----	----	----
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	**0.020**	**0.602**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	**0.16**	----	----	----
Iron	7439-89-6	0.05	mg/L	**5.89**	<0.05	----	----	----
Bromine	7726-95-6	0.1	mg/L	**7.3**	**5.9**	----	----	----
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.10	mg/L	**10.6**	**6.85**	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.3**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**4.50**	**3.82**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.13**	**0.02**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.10**	**0.02**	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**95.7**	**74.3**	----	----	----
Total Cations	----	0.01	meq/L	**102**	**81.1**	----	----	----
Ionic Balance	----	0.01	%	**3.29**	**4.36**	----	----	----
EP005: Total Organic Carbon (TOC)								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB02	RMB03	----	----	----
			Client sampling date / time	21-MAY-2013 12:30	21-MAY-2013 16:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1311719-001	ES1311719-002	----	----	----
EP005: Total Organic Carbon (TOC) - Continued								
Total Organic Carbon	----	1	mg/L	**3**	**18**	----	----	----
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	**7650**	**13100**	----	----	----
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	**2.9**	----	----	----
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 Hydrocarbons								
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	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB02	RMB03	----	----	----
			Client sampling date / time	21-MAY-2013 12:30	21-MAY-2013 16:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1311719-001	ES1311719-002	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(b)fluoranthene	205-99-2	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	----	0.5	µg/L	<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (WHO)	----	0.5	µg/L	<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	**100**	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	**410**	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	**150**	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	**660**	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
C6 - C10 Fraction	----	20	µg/L	<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	----	20	µg/L	<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	**120**	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	**520**	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	**640**	----	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	----	----	----
Toluene	108-88-3	2	µg/L	<2	**8**	----	----	----
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	**8**	----	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**41.2**	**41.1**	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**92.7**	**94.3**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB02	RMB03	----	----	----
			Client sampling date / time	21-MAY-2013 12:30	21-MAY-2013 16:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1311719-001	ES1311719-002	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates - Continued								
2.4.6-Tribromophenol	118-79-6	0.1	%	**106**	**116**	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**75.7**	**84.6**	----	----	----
Anthracene-d10	1719-06-8	0.1	%	**105**	**107**	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**106**	**104**	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**84.2**	**77.9**	----	----	----
Toluene-D8	2037-26-5	0.1	%	**111**	**104**	----	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	**98.8**	**96.6**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	44
2-Chlorophenol-D4	93951-73-6	15.9	102
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20.4	112
Anthracene-d10	1719-06-8	29.6	118
4-Terphenyl-d14	1718-51-0	21.5	126
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