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Barangaroo
Lend Lease (Millers Point) Pty Limited
3 November 2010

Groundwater Discharge Study

Stage 1 Barangaroo Development

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Prepared for

Lend Lease (Millers Point) Pty Limited

Prepared by

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Executive Summary

AECOM Australia Pty Ltd was engaged by Lend Lease (Millers Point) Pty Ltd (LL) to undertake a Human Health and Ecological Risk Assessment of reported contamination associated with the Site, located at Hickson Road, Darling Harbour, New South Wales.

In order to support the risk assessment, a key pathway and receptor that needed to be considered was the interaction of contaminated groundwater with Darling Harbour. A primary objective of the study was to inform the risk assessment with respect to likely attenuation factors for contaminant mass flux due to mixing of seawater prior to discharge.

AECOM installed a transect of multilevel piezometers, comprising two arrays of three piezometers each, as well as a stilling well in Darling Harbour, immediately adjacent to the multilevel piezometer transect. Instantaneous hydraulic head measurements, groundwater and surface samples and hydraulic head time series data (hydrographs) were collected from these installations during the investigation.

Hydraulic data indicate the existence of two distinct, but related mechanisms for groundwater / surface water interaction at the Site. The first occurs by rapid inundation and drainage of the porous fill material immediately adjacent to the harbour, through a highly efficient hydraulic connection that exists between the harbour and the fill, facilitated by an apparently permeable caisson structure. This response is instant at the temporal scale of the hydrographs, implying that this portion of the aquifer (up to 45 m from the harbour margin) behaves more like an open water system than a typical porous media. The second mechanism, evident within the marine sediments at depth, is a typical aquifer – surface water response, where the potential for discharge and infiltration develops in response to tide-induced hydraulic gradients.

The highly cyclic (diurnal) nature of the infiltration and discharge observed in both mechanisms results in the development of a tidal exchange prism within the fill and marine sediments aquifers immediately adjacent to the harbour, whereby, despite a net discharge occurring, which is controlled by the regional hydraulic gradient, much of the water which discharges during each low water period is comprised largely of seawater which infiltrated during the preceding high water period. This mechanism has significant implications for the mass flux of dissolved phase contaminants to the harbour.

Relative to that occurring from the fill sequence, groundwater discharge volumes and therefore contaminant mass flux from the marine sediments is considered to be negligible from a hydrogeological perspective. While the risk posed from this process will need to be evaluated, it is likely to be commensurate with the relatively low estimates of groundwater discharge volume. Groundwater discharge occurring via the basal Hawkesbury Sandstone is not considered significant in the context of contaminant flux due to very low values of permeability reported for this formation in the literature.

A model to estimate net groundwater/contaminant migration rates based on connate water displacement indicates that migration rates are approximately one tenth of estimated linear groundwater velocities. This discrepancy is due to tidally-induced oscillation of water and particles, which, in this instance can be simply visualised as a process whereby an individual particle migrates 10 steps eastward during the rising tide and 11 steps westward on the falling tide.

This analysis indicates that of the total flux towards the harbour in any given ebb tide, approximately 10% represents water from up gradient, which equates to a groundwater (including connate seawater) to seawater mixing ratio of approximately 1:10. However, given potential uncertainty regarding the original shoreline location and dates for the commencement of reclamation activities, attenuation factors for groundwater up gradient of the tidal exchange prism are conservatively estimated as a factor of 5. Contamination which has migrated into, or is otherwise present within the tidal exchange prism, is not expected to undergo further attenuation prior to discharging to the harbour.

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1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was engaged by Lend Lease (Millers Point) Pty Ltd (LL) to undertake the Human Health and Ecological Risk Assessments (HHERAs) of reported contamination associated with the Barangaroo Stage 1 Development Precinct (now known as Barangaroo South) and the NSW Department of Environment, Climate Change and Water (DECCW) Declaration Area 21122 (as issued by the NSW Environment Protection Authority and gazetted on 15 May 2010), located at Hickson Road, Millers Point, New South Wales (The Site).

In order to support the risk assessments, a key pathway and receptor that needed to be considered was the interaction of groundwater contamination with Darling Harbour.

1.1 Objectives

The primary objective of the groundwater discharge study was to inform the risk assessment process with respect to the nature and extent of contaminant discharge from the Site to Darling Harbour including likely contaminant concentrations at the point of discharge and an indication of overall contaminant mass flux. Specifically, the following objectives were identified:

- To provide more detailed data on the vertical distribution of contaminants and other parameters in the terrestrial groundwater environment;
- To assess the degree of exchange (recharge and discharge) between Darling Harbour and the aquifer system due to tidal movements;
- To assess the impact of this tidal exchange on the fate and transport of dissolved phase groundwater contaminants;
- To attempt to quantify the amount of groundwater discharge, and contaminant mass flux, from the site to Darling Harbour;
- To attempt to quantify the degree of contaminant attenuation by seawater mixing prior to discharge; and
- To provide an updated conceptual hydrogeological model for the harbour margin.

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2.0 Scope of Work and Methodology

The scope of work for characterisation of the terrestrial groundwater interaction with Darling Harbour at the Site was undertaken in addition to the terrestrial groundwater investigations undertaken for the Site. The scope undertaken was as follows:

- Concrete, air knife and hollow stem auger drilling of two boreholes as follows (both boreholes were 75mm in diameter):
  - One borehole located close to Darling Harbour within the proposed Public Domain Area, north of the proposed Southern Cove; and
  - One borehole approximately 50 m landward of Darling Harbour.
- Installation of two sets of nested multilevel piezometers, utilising hollow flight auger drilling methods, in the boreholes as follows:
  - Three 25 mm diameter uPVC piezometers with 1 m screens in each borehole at the following intervals:
    - Immediately below the water table;
    - Immediately below the base of the fill (upper marine sediments); and
    - Intermediate between the two above.
  - Individual gravel packs and bentonite seals for each screen in each nested well. Lithological information and piezometer construction details are enclosed in Appendix A.
  - The locations of the nested multilevel piezometers were selected on the basis of the following:
    - Proximately to the harbour margin where it was anticipated that tidal influence and groundwater – surface water interaction would be at a maximum (i.e. IT1) and to assess the spatial (horizontal and vertical) attenuation of these processes with distance (i.e. IT2).
    - Down gradient of a known source area to allow for an assessment of contaminant distributions, which may not have been present elsewhere.
- Installation of a stilling well in Darling Harbour near the piezometers.
- Sampling and analysis of groundwater and surface water collected from the piezometers and stilling well at low tide. Sampling from the multilevel wells was conducted using dedicated narrow diameter disposable bailers. Where possible, these piezometers were purged of at least 3 bore volumes of groundwater prior to sampling.
- Surveying of all piezometers and the stilling well;
- Deployment of data loggers in all multilevel piezometers and the stilling well for a period of at least 48 hours;
- Analysis of all samples for the following analytical suite:
  - Metals (M13) (As, Ba, Be, Bd, Cr, Co, Cu, Mn, Hg, Ni, Pb, V and Zn);
  - Volatile Organic Compounds (VOCs) (including Benzene, Toluene, Ethylbenzene and Xylenes [BTEX]);
  - Semi Volatile Organic Compounds (SVOCs) (selected samples with ultra trace detection limits);
  - Total Petroleum Hydrocarbons (TPH);
  - Polycyclic Aromatic Hydrocarbons (PAHs) / Phenols;
  - free and Weak Acid Dissociable (WAD) cyanide;
  - Total sulphur;
  - Ammonia;
  - A suite of natural attenuation parameters (major cations, anions, minor anions, iron and total organic carbon);
  - Total Dissolved Solids (TDS); and
  - General water quality parameters (temperature, pH, dissolved oxygen, electrical conductivity and redox potential) were also measured at the time of sampling.
- Preparation of this report including the following:
  - A comprehensive summary of key findings from similar studies performed elsewhere;
  - Presentation of all data logger hydrographs;

- Vertical flow nets of the Site showing the hydraulic heads and groundwater flow direction at both high and low tide;
- The distribution of key contaminants and TDS at low tide;
- An assessment of the impacts of existing subsurface structures (e.g. caisson walls etc.); and
- A discussion of the results including:
    - An assessment of the discharge characteristics and concentration; and
    - An estimate of the mass flux of contaminants to Darling Harbour.

3.0 Groundwater Discharge to Marine Environments

In order assess the potential impacts of contamination in the terrestrial aquifer and in particular the fill material, it is necessary to understand the basic interaction and mechanisms between the groundwater derived from a terrestrial aquifer with the marine environment.

The broad dynamics of groundwater discharge to a marine environment have been well understood for a considerable period of time (over 100 years) and is often simplistically conceptualised by the Ghyben-Herzberg principle, where groundwater in a coastal system discharges to the marine system via a freshwater/saltwater interface (**Figure 1**).

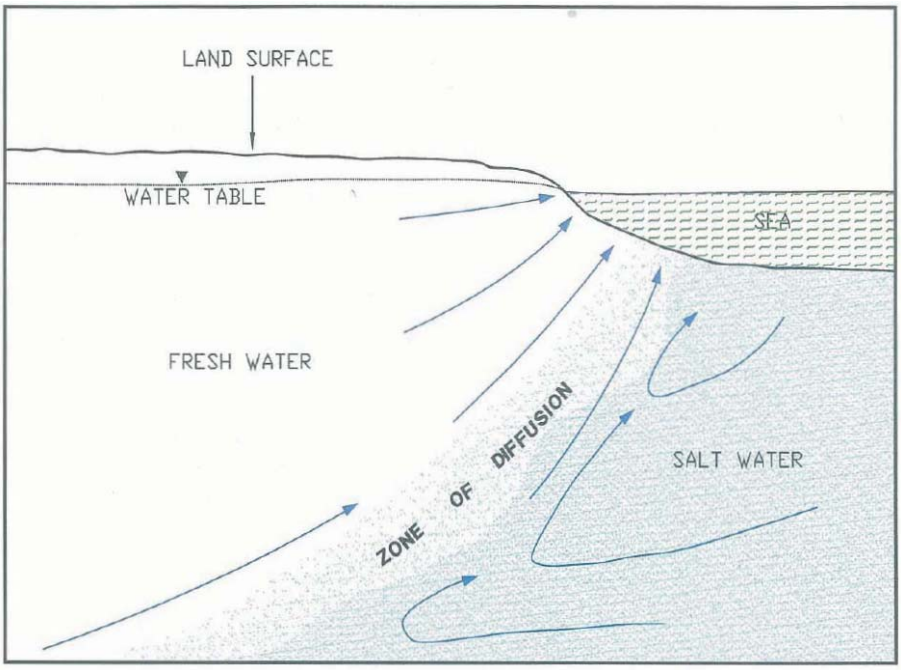
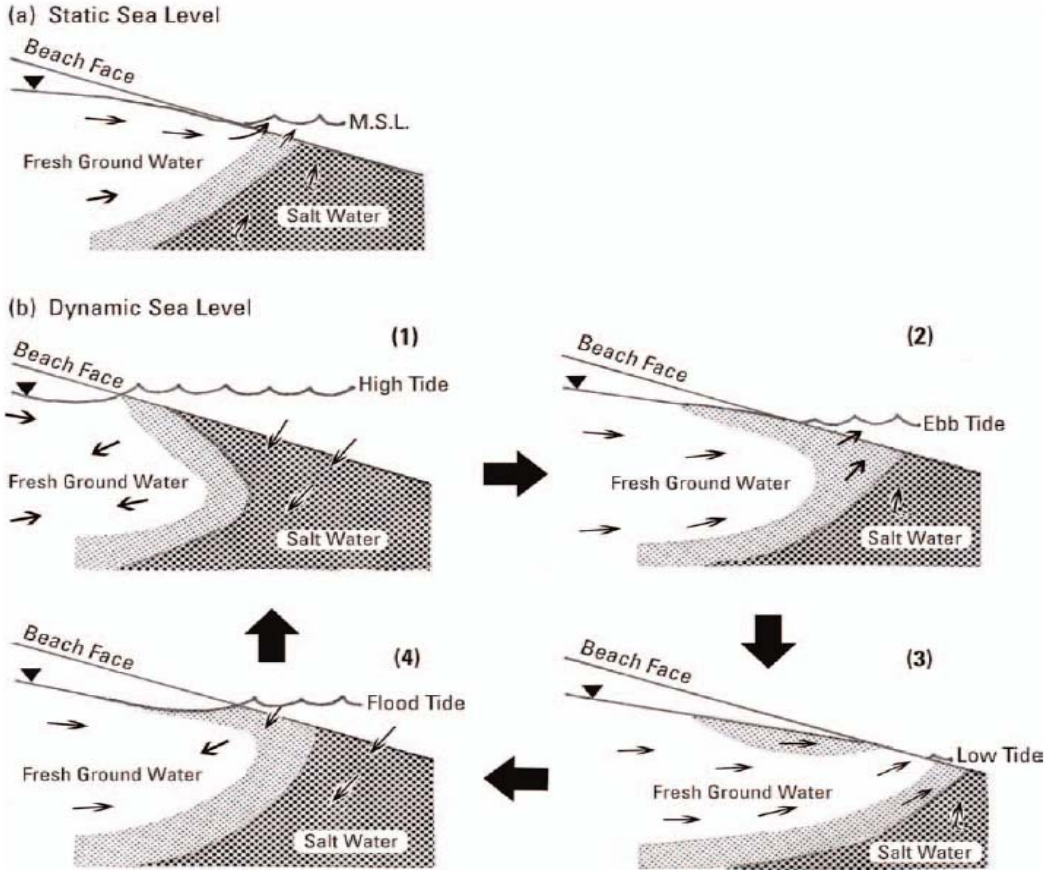


Figure 1: Groundwater Discharge to Sea – Ghyben-Herzberg Static Model (modified after Cooper, 1964)

This interface occurs due to the density difference between freshwater (1000 kg/m^3) and seawater (1025 kg/m^3). As noted by Urish and McKenna (2004), this conceptual model does not discretely characterise the discharge zone, treating the interface as a fixed sharp line in time and space. Urish and McKenna (2004) conceptually show the difference of groundwater discharge between a static and dynamic system (**Figure 2**).



(a) is the discharge for static sea level and (b) is the discharge and infiltration for a dynamic tidal cycle during (1) high tide, (2) ebb tide, (3) low tide, (4) flood tide. The arrows indicate the general direction and pattern of flow. Source: Urish and McKenna (2004).

Figure 2: Beach Groundwater Discharge and Infiltration Concept – Dynamic Model

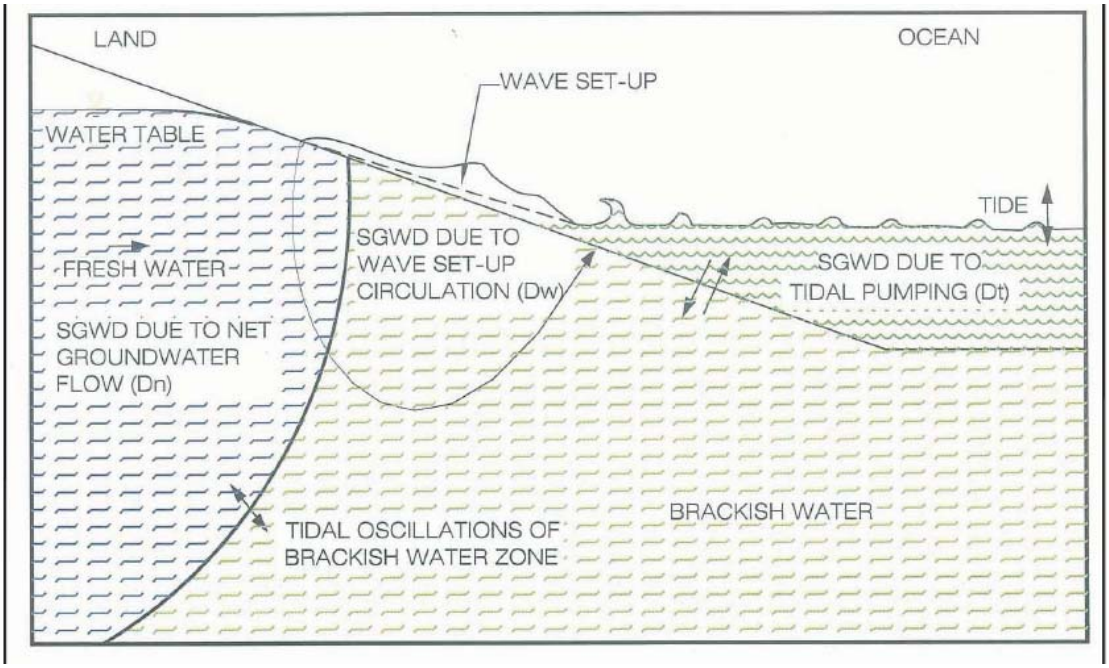
In reality, the mechanisms of groundwater discharge to a marine environment are more complex and are influenced by a number of factors, which have only been researched in more detail over the last decade; principally due to the threat of anthropogenic groundwater contamination on coastal and estuarine systems.

Robinson *et al*., (1998) reported that groundwater discharge from unconfined aquifers to coastal and marine waters can involve complex hydrodynamic mechanisms characterised by fluctuating water table due to tidal activity, density dependent flow along the freshwater/saltwater transition zone and a dynamic groundwater discharge zone within the intertidal zone. Tidally induced fluctuations in the water table elevation can result in the movement (relative to fresh groundwater discharge) back and forth across the sediment-water interface.

Li *et al*., (1999) presented a detailed conceptual and analytical model of groundwater discharge to a coastal sea. A schematic of the processes affecting groundwater discharge in a coastal aquifer is shown on **Figure 3**. The groundwater discharge to the ocean is comprised of three principal components defined by:

$$D_{total} = D_n + D_w + D_t;$$

Where D_n = *net groundwater discharge;*
D_w = *discharge due to wave setup induced groundwater circulation; and*
D_t = *discharge due to tidal oscillations.*



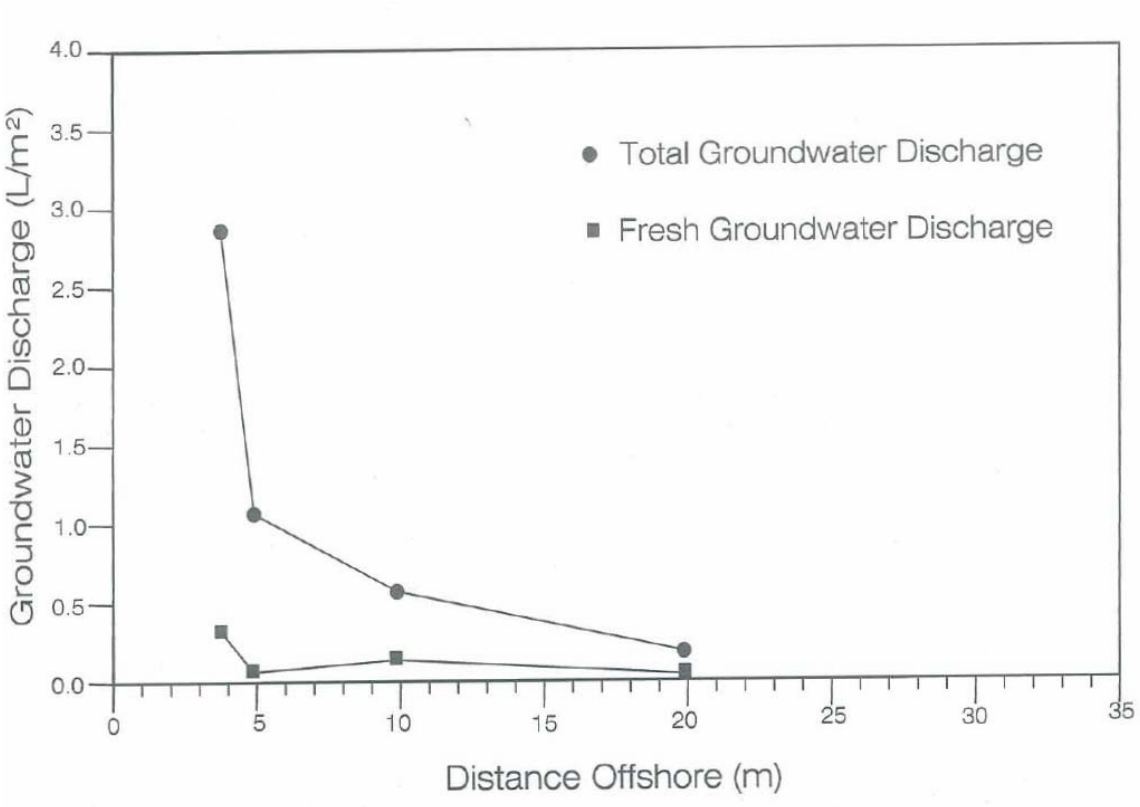
Source: Li *et al.*, 1999

Figure 3: Processes Affecting Groundwater Discharge in a Coastal Aquifer

Li *et al.* (1999) referred to the groundwater discharge as Submarine Ground Water Discharge (SGWD) and noted that the definition of SGWD in the literature is often ambiguous and has been defined as the direct pore water outflow across the ocean-land interface and includes all three components noted above.

The net groundwater discharge (D_n) consists of freshwater and is equivalent to the aquifer recharge, and reported by Li *et al.* (1999) to comprise only 4% of the SGWD in the South Atlantic Bight, with the remaining volume due to wave setup (D_w) and tidal oscillations (D_t). Whilst the groundwater discharge to a coastal sea by wave setup and tidal oscillations are significant, the seepage water is primarily of marine origin (i.e., infiltrated into the intertidal sediments during high tide) and, as noted by Li *et al.* (1999), conclusions cannot be drawn on the relative importance of the two mechanisms in transferring land-derived contamination to the ocean.

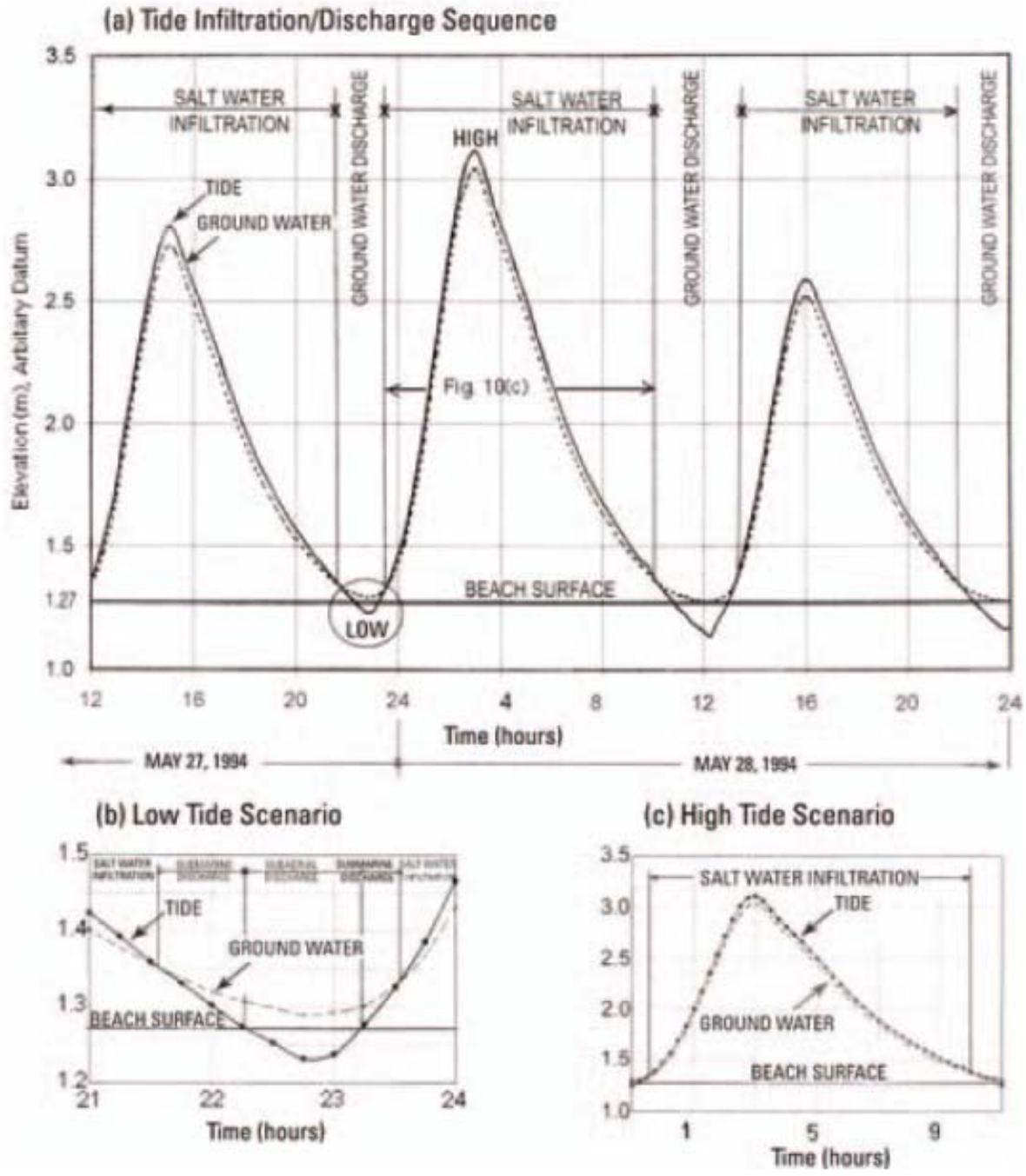
A study of the groundwater discharge to an estuarine environment in Chesapeake Bay by Robinson *et al.* (1998) confirmed that only a small proportion of the seepage measured in the intertidal zone was freshwater (14 %) with both the total and freshwater discharge decreasing with distance offshore (**Figure 4**). This confirmed the earlier work of Bokuniewicz (1980) at Long Island, New York, who reported a decreasing groundwater discharge exponentially perpendicular to, and away from, the shoreline. Robinson *et al.* (1998) also identified that the groundwater discharge was inversely correlated with the tidal elevation (i.e., maximum discharge occurred at low tide and minimum discharge occurred at high tide). The authors also identified a complex transition and mixing in the intertidal discharge zone.



Source: Robinson *et al.*, 1998

Figure 4: Total and Fresh Groundwater Discharge, Chesapeake Bay

Urish and McKenna (2004) reported on the detailed study of shoreline discharge from an unconfined aquifer at two sites in an embayment on the Cape Cod, Massachusetts coastline, which provided insight into the highly dynamic spatial and temporal nature of discharge along sandy beaches affected by the tide. The constantly moving tidal boundary over a sloping beach results in a discharge zone of 10 m to 20 m perpendicular to the shoreline, with 35 % to 55 % of the discharge being submarine. The authors reported that the distribution of fresh groundwater through a beach face varies greatly, and is dependent primarily on the tidal cycle and range, the heterogeneous characteristics of the beach sediments and the beach geometry. The estimated relative volume of discharge varies temporally with tidal fluctuations, with the greatest discharge occurring during early to mid ebbing tide and the location of greatest estimated discharge moving seaward during the ebbing tide (**Figure 5**). The salinity of the discharge varies temporally from near freshwater values (1,000 mg/L) to near coastal saltwater values of 30,000 mg/L, being saltiest at the start of discharge as the tide ebbs and freshest during a low tide period of approximately 2 hours. Urish and McKenna confirmed similar findings to those noted above by Robinson *et al.* (1998) and Li *et al.* (1999), that of the total discharge volume approximately 65 % to 85 % is estimated to be from saltwater that infiltrates during the high tide episode (i.e., only 15 % to 35 % is derived from fresh water).



(a) water table elevation (dashed line) and tide level (solid line) during salt water infiltration and ground water discharge periods at site D (monitoring well E) during tidal cycles, (b) occurrence of ground water discharge in low tide scenario, and (c) occurrence of salt water infiltration in high tide scenario. Source: Urish and McKenna, 2004.

Figure 5: Groundwater Discharge Analysis, Cap Cod, Massachusetts

Due to the complex hydrodynamics (including mixing and dilution) which occur within the intertidal zone, the use of terrestrial groundwater concentrations to evaluate potential impacts to a marine environment may be highly misleading and provide a significant overestimate of likely impacts However, it is noted that in terms of the regulatory framework (i.e. EPA, 2002), Maintenance of Ecosystems beneficial use guidelines apply to terrestrial groundwater immediately prior to the point of discharge.

3.1 Previous Case Studies

AECOM personnel have undertaken a number of investigations for intertidal groundwater discharge processes, and include:

- Orica Botany Penrhyn Estuary Groundwater Discharge Study (URS, 2004);
- West Metro Groundwater Discharge Investigation (HLA, 2007);
- Characterisation and discharge of a groundwater contaminant plume to Port Phillip Bay (Edwards and Duran, 2008).

The key findings of these case studies/reports are briefly discussed below.

3.1.1 Orica Botany Penrhyn Estuary Groundwater Discharge Study

One of the key findings of the investigation was that the electrical conductivity (EC) of the pore water in the upper 0.5 m beneath the intertidal mudflats generally exceeded 40,000 µS/cm (approximately 25,000 mg/L TDS) at both high tide and low tide, which largely reflected water of marine origin. Pore water of lower salinity was encountered in deeper sample ports, with the lowest EC recorded (14,000 µS/cm – approximately 8,750 mg/L TDS) at the piezometer nearest to the high tide elevation (BP42 – see **Figure 6** below). A similar trend was observed in the pH of the pore water with lower pH (ph<6) indicative of a greater freshwater influence and higher pH (pH>7) indicative of water of marine origin.

These data indicate that the relatively fresh groundwater (i.e. low salinity) does not discharge directly into Penrhyn Estuary within the intertidal zone. Rather, discharge dynamics are essentially controlled by tidal pumping, with a mixing zone occurring beneath the intertidal zone. The mixing zone represents a mixture of seawater that infiltrates into the underlying sediments during the rising tide, and fresher groundwater derived from a terrestrial source.

In many respects, the findings from the Penrhyn Estuary study are consistent with those reported by Urish and McKenna (2004) noted above, with the exception that freshwater does not emerge in the sediment-water interface at low tide. At the Penrhyn Estuary it was postulated that this was due to the low hydraulic head within the terrestrial aquifer near the coast, which is insufficient to overcome the buoyancy effects of the seawater infiltration into the sediments during the rising tide. As noted by Li *et al.* (1999), groundwater discharge is not only significantly influenced by tidal dynamics but also includes density dependent flow and is a function of the water table elevation in the terrestrial aquifer as well as the geomorphology of the discharge zone.

The presence of the mixing zone was further confirmed by the trend in the concentrations of the volatile chlorinated hydrocarbons (CHCs), which showed a significant decrease in concentration in a seaward and upward direction from the shoreline. The decrease in concentration could not be attributed to degradation alone, since the kinetics (reaction half-lives) are too slow to have caused the reduced concentrations.

Not only was there a clearly defined trend in the EC and the distribution of contaminants, but other field parameters such as pH also showed a distinct trend, which enabled the delineation of distinct hydrogeochemical facies within and adjoining the intertidal discharge zone. **Figure 6** shows a schematic across the study area showing four distinct zones, which from the terrestrial to seaward direction include:

- Freshwater (terrestrial groundwater);
- Zone of diffusion;
- Mixing zone; and
- Seawater.

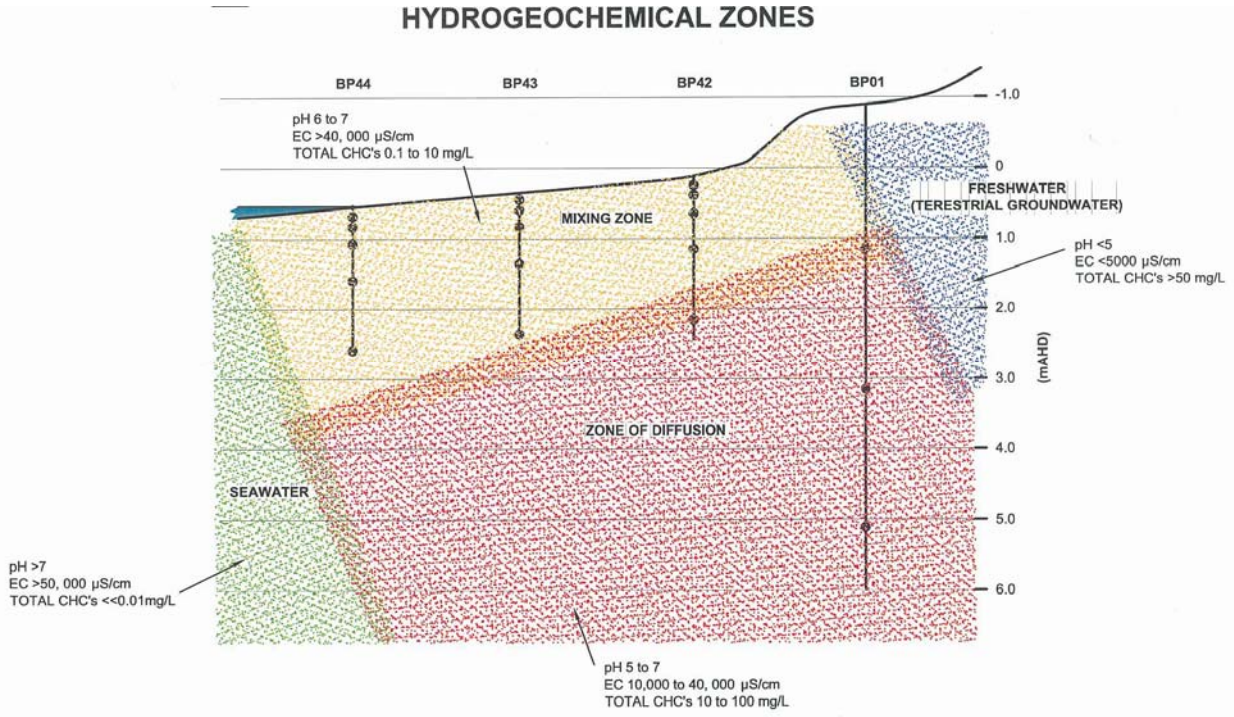


Figure 6: Penrhyn Estuary Groundwater Discharge Study - Hydrogeochemical Zones. Source: URS (2004)

At the Penrhyn Estuary the freshwater terrestrial aquifer was not well defined within the intertidal zone and the adjoining saltmarsh area (i.e. BP01). The freshwater terrestrial aquifer is represented in up gradient areas and generally has a low salinity (<3,000 mg/L), low pH (<5 pH units) and very high concentrations of volatile CHCs (>250 mg/L). The EC data for BP01 suggested that this bundle piezometer was located within the zone of diffusion, although it is strongly influenced by the groundwater of terrestrial origin as evident by the relatively low pH and high concentrations of contaminants.

3.1.2 Groundwater Discharge Investigation, West Metro Site

This study found that the vertical distribution of contaminants within the intertidal sediments showed the lower part of the sediment profile had concentrations higher of one to two orders of magnitude (**Figure 7**). A similar trend was noted for electrical conductivity which showed a decreasing concentration in an offshore and upwards direction. The contaminant concentrations within the clay layer underlying the sandy sediments also appear to decrease with depth.

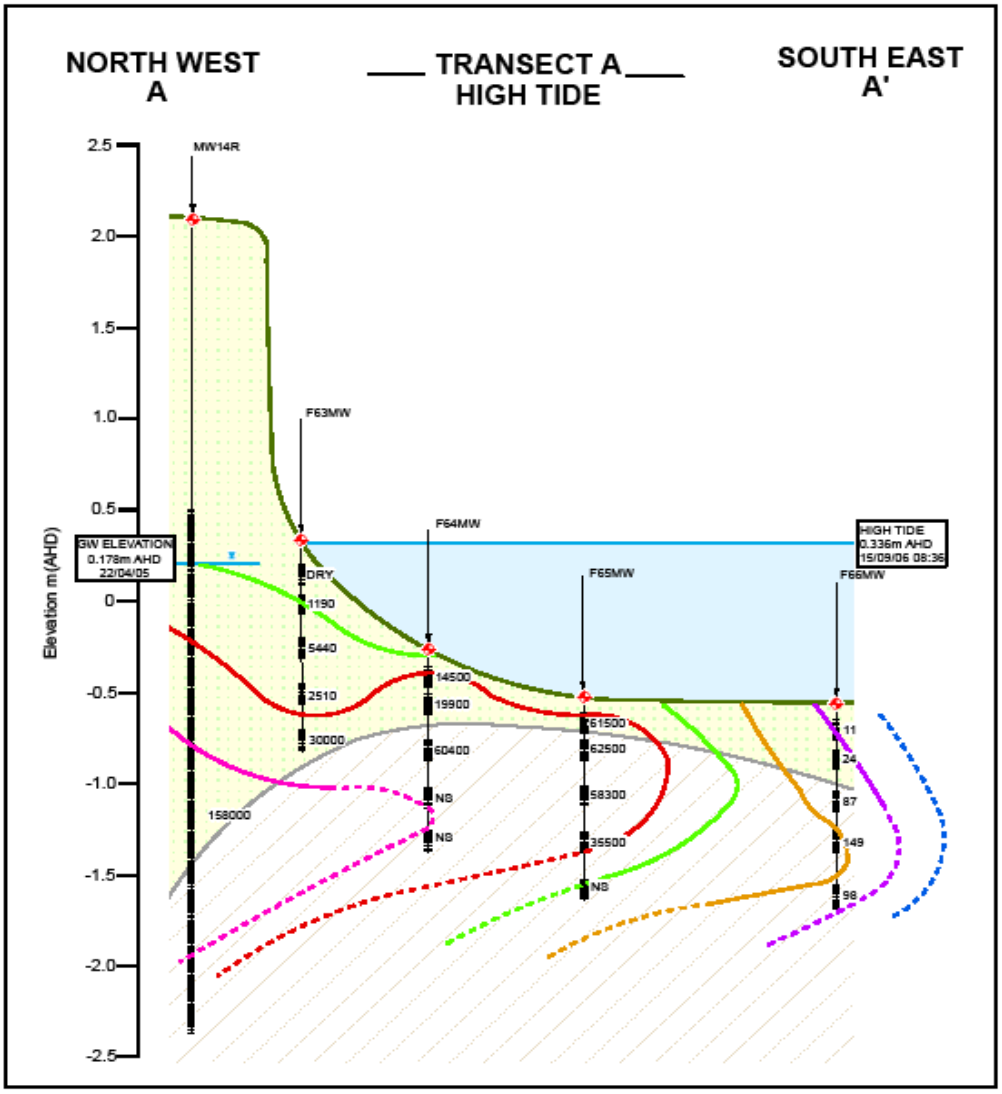


Figure 7: Distribution of 1,2-Dicholoroethane, Intertidal Zone, West Metro Site. Source: HLA (2007)

A notable feature of the distribution within the intertidal zone was that the contaminant concentrations in the near shore piezometers were lower than those recorded further offshore. The locations of these near shore piezometers lie approximately at the high tide and low tide boundary and the lower concentrations likely reflect seawater infiltration into the sediments on the rising tide and by wave set-up near the steep sloping beach face. This mechanism of wave-setup is shown in **Figure 3** (Li *et al.* 1999).

3.1.3 Intertidal Contaminant Transport and Discharge Study Port Phillip Bay

Edwards and Duran (2008) reported on a contaminant groundwater discharge study within the intertidal segment of Port Phillip Bay. The objectives of the study were to identify the various hydrodynamic processes operating within the intertidal zone and its effect on the distribution of petroleum contaminants derived from an LNAPL source located within the up gradient terrestrial aquifer. The study used a number of different characterisation methods for assessing the groundwater discharge mechanisms and included:

- Several transects of multilevel piezometers extending from the terrestrial aquifer to beyond the low tide mark;
- Instantaneous and continuous (data loggers) measurements of hydraulic heads;
- Seepage meters; and
- A broad range of geochemical analyses including stable isotopes.

Figure 8 presents the potentiometric surface for one of the transects which shows discharge of groundwater occurring in the intertidal zone, and beyond the intertidal zone into the submarine environment. Continuous water level measurements showed that the Intertidal pore water pressures are largely controlled by diurnal variations in tidal elevation, but typically lag behind tidal maxima and minima by between 2 and 6 hours. At the low tide elevation, hydraulic heads remain above the sediment – seawater interface throughout the tidal cycle and are also above the head of seawater during low tide. The potential for discharge is greatest during lower low water.

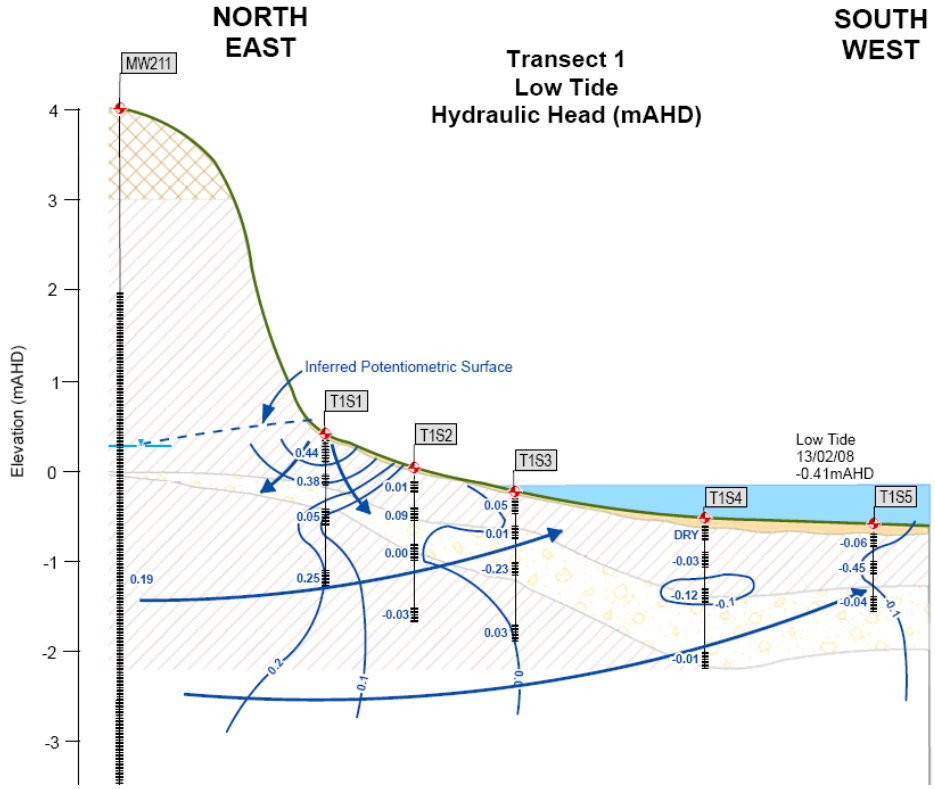


Figure 8: Potentiometric Surface - Port Phillip Bay Intertidal Groundwater Discharge Study. Source: Edwards and Duran (2008).

A downward hydraulic gradient prevails at the high tide mark, consistent with the distribution of TDS (**Figure 9**) and stable isotopes (**Figure 10**), indicating seawater infiltration.

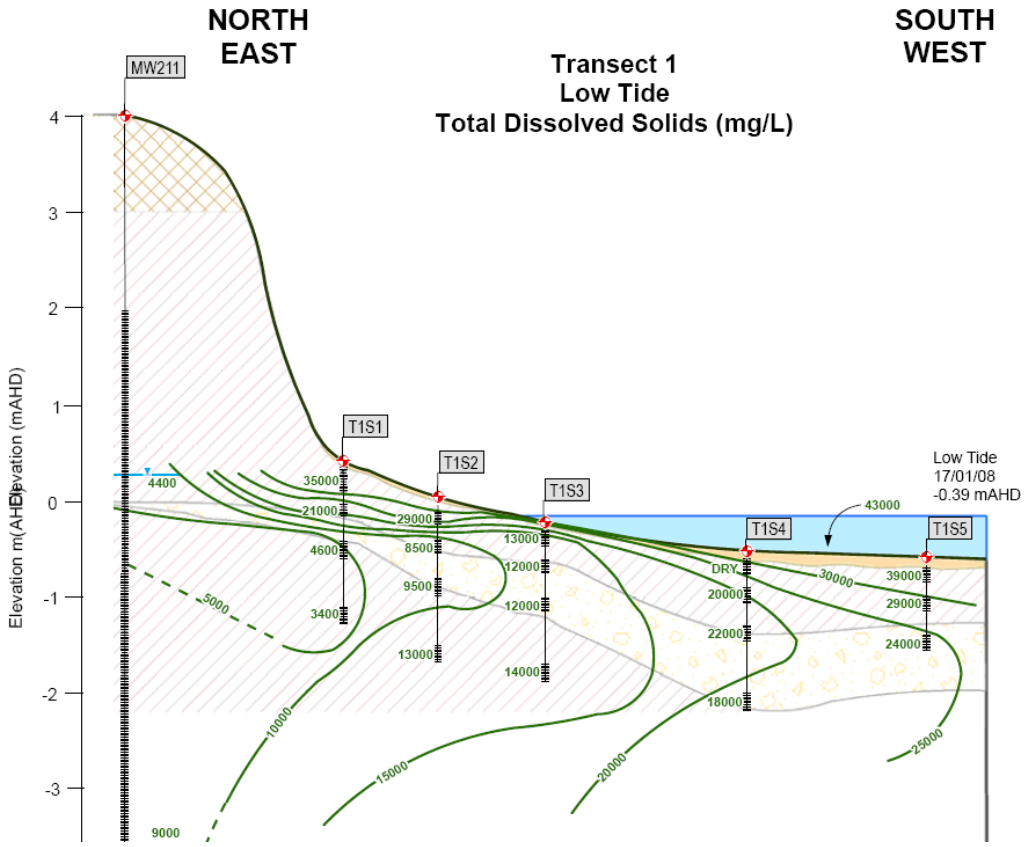


Figure 9: TDS Contours - Port Phillip Bay Intertidal Groundwater Discharge Study. Source: Edwards and Duran (2008).

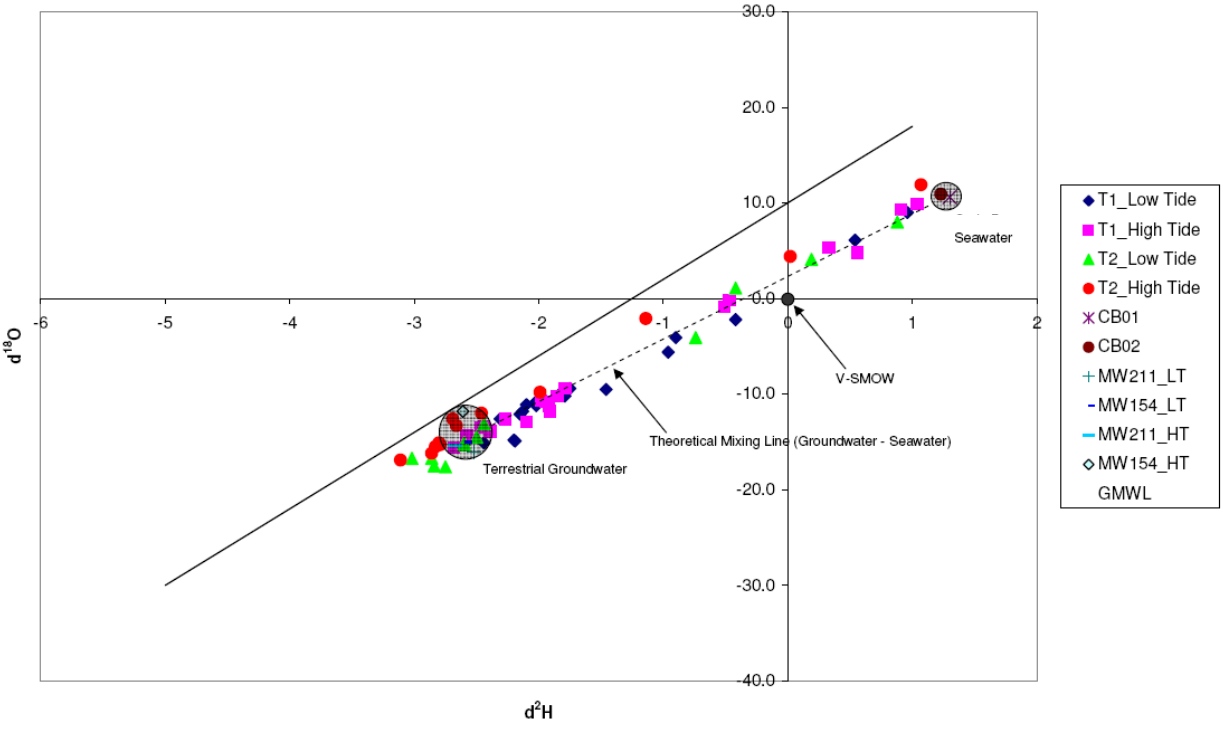


Figure 10: Stable Isotope Mixing Line - Port Phillip Bay Intertidal Groundwater Discharge Study. Source: Edwards and Duran (2008).

Seepage measurements indicate that discharge is variable with a range of 0.1 to 1.2 L/m^2/day during this investigation, but has been shown to be as high as 3.0 L/m^2/day during previous phases. Seepage data confirms that a component of terrestrial groundwater discharges to Port Phillip Bay in the study area. The mixing model indicates that contaminants will become increasingly diluted (water of marine origin) with proximity to the sediment-seawater interface (**Figure 11**).

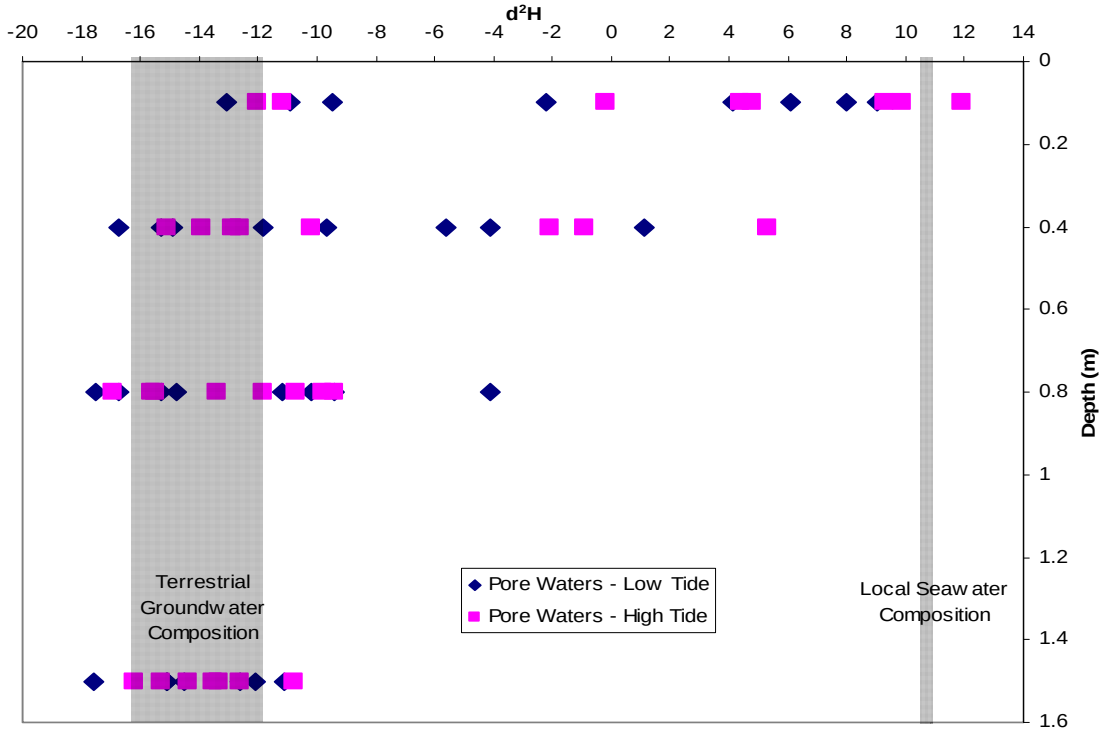


Figure 11: Stable Isotope Mixing Model. Source: Edwards and Duran (2008).

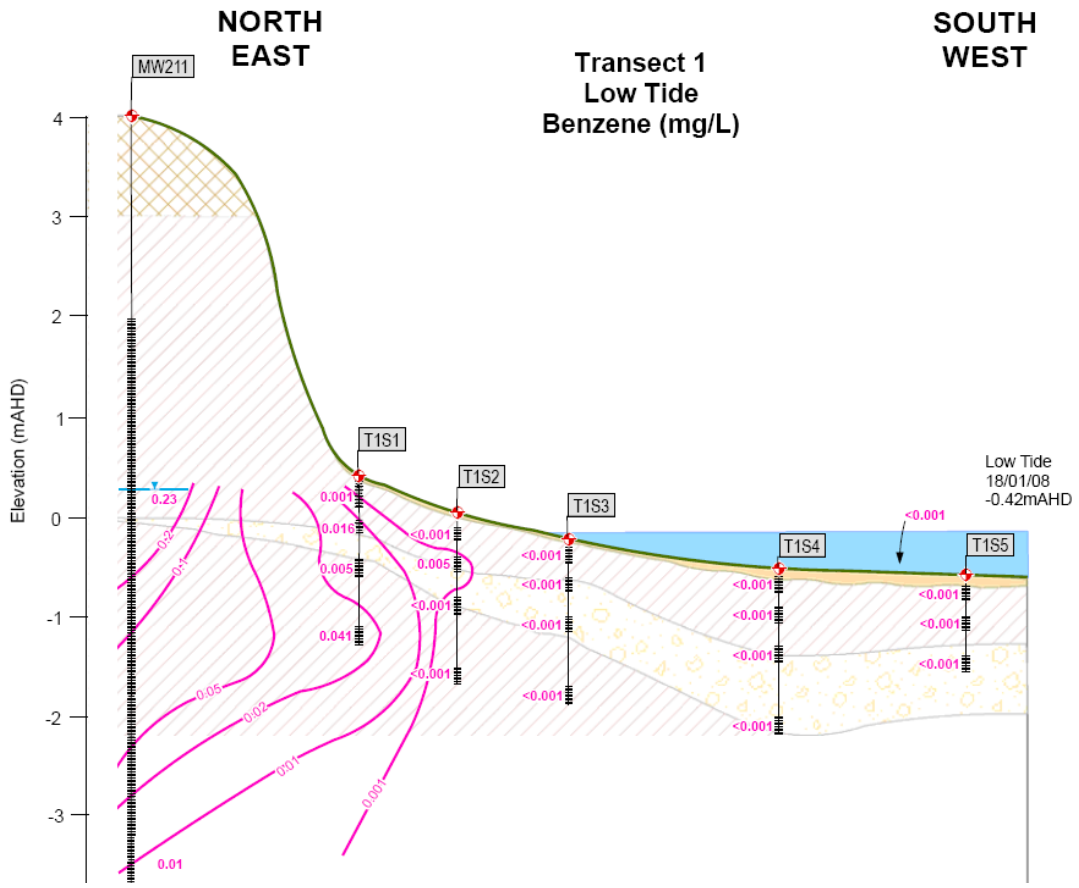


Figure 12: Benzene Contours - Port Phillip Bay Intertidal Groundwater Discharge Study. Source: Edwards and Duran (2008).

3.2 Case Studies Summary

There are a number of findings that are common to all three cases studies that are of relevance to the current investigation, given the tidal nature of the receiving environment, including:

- Shallow aquifer systems adjacent to marine or estuarine (i.e. tidal) environments are typically dominated hydraulically by diurnal movement of the tides.
- Interactions between groundwater and surface water systems in these settings are highly dynamic. While there tends to be a net discharge of groundwater over long time periods, which is controlled by regional terrestrial hydraulic gradients, discharge of groundwater does not occur constantly; rather, discharge is cyclic, typically occurring during ebb to low tide periods, with recharge (seawater ingress) occurring during flood to high tide periods. This process is controlled by the relative hydraulic head between the two systems.
- The constant cycling of recharge and discharge results in the formation of a mixed zone within the adjacent/subjacent terrestrial/intertidal groundwater environment.
- As a result of the presence of this mixed zone, much of the water that discharges from the groundwater system during low tide periods is comprised largely of seawater that entered the aquifer during the preceding high tide/s.
- This results in significant dilution of terrestrial groundwater contaminant concentrations within the aquifer, such that discharging groundwater generally has much lower contaminant concentrations than terrestrial groundwater immediately up hydraulic gradient.

4.0 Results

4.1 Physical Hydrogeology

4.1.1 Hydraulic Head Distribution

Hydraulic head data were collected from all dedicated multilevel piezometers and a number of up gradient monitoring wells (MW40 and MW45) under both high and low tide scenarios. These data are summarised in **Table 1**. A Site plan showing the locations of the relevant monitoring bores and reference cross section B – B' is given in **Figure F1**.

Table 1: Hydraulic Head Data Summary

Piezometer ID	Standpipe Elevation (mAHD)	Date	Tidal Elevation (mAHD)	SWL (m btoc)	RWL (mAHD)
IT1_2.5	2.47	14/04/2010	-0.49	dry	-
		15/04/2010	0.54	2.040	0.43
IT1_9.0	2.47	14/04/2010	-0.49	2.941	-0.47
		15/04/2010	0.54	1.964	0.51
IT1_18.0	2.43	14/04/2010	-0.49	2.555	-0.13
		15/04/2010	0.54	2.325	0.11
IT2_2.5	2.62	14/04/2010	-0.49	3.044	-0.42
		15/04/2010	0.54	2.123	0.50
IT2_9.0	2.59	14/04/2010	-0.49	2.890	-0.3
		15/04/2010	0.54	2.053	0.54
IT2_18.0	2.56	14/04/2010	-0.49	2.631	-0.07
		15/04/2010	0.54	2.457	0.10
IT3	2.08	14/04/2010	-0.49	2.565	-0.49
		15/04/2010	0.54	1.540	0.54
MW40	2.05	14/04/2010	-0.49	2.242	-0.19
		15/04/2010	0.54	1.615	0.44
MW45	2.06	14/04/2010	-0.49	2.316	-0.26
		15/04/2010	0.54	1.475	0.59

A strong tidal response is evident in the instantaneous head measurements, particularly in the shallow multilevel piezometers (e.g. IT1_2.5, IT1_9.0, IT2_2.5 and IT2_9.0), where the amplitudes observed are analogous to that observed in Darling Harbour (IT3). Amplitudes are observed to decline with distance from the harbour margin (e.g. MW40 and MW45), consistent with trends observed in similar environments elsewhere (**Section 3.1)**.

Time series hydraulic head measurements (hydrographs) confirm the cyclic nature of the tidal response in the multilevel piezometer arrays IT1 and IT2 (**Figure 13 and Figure 14,** respectively).

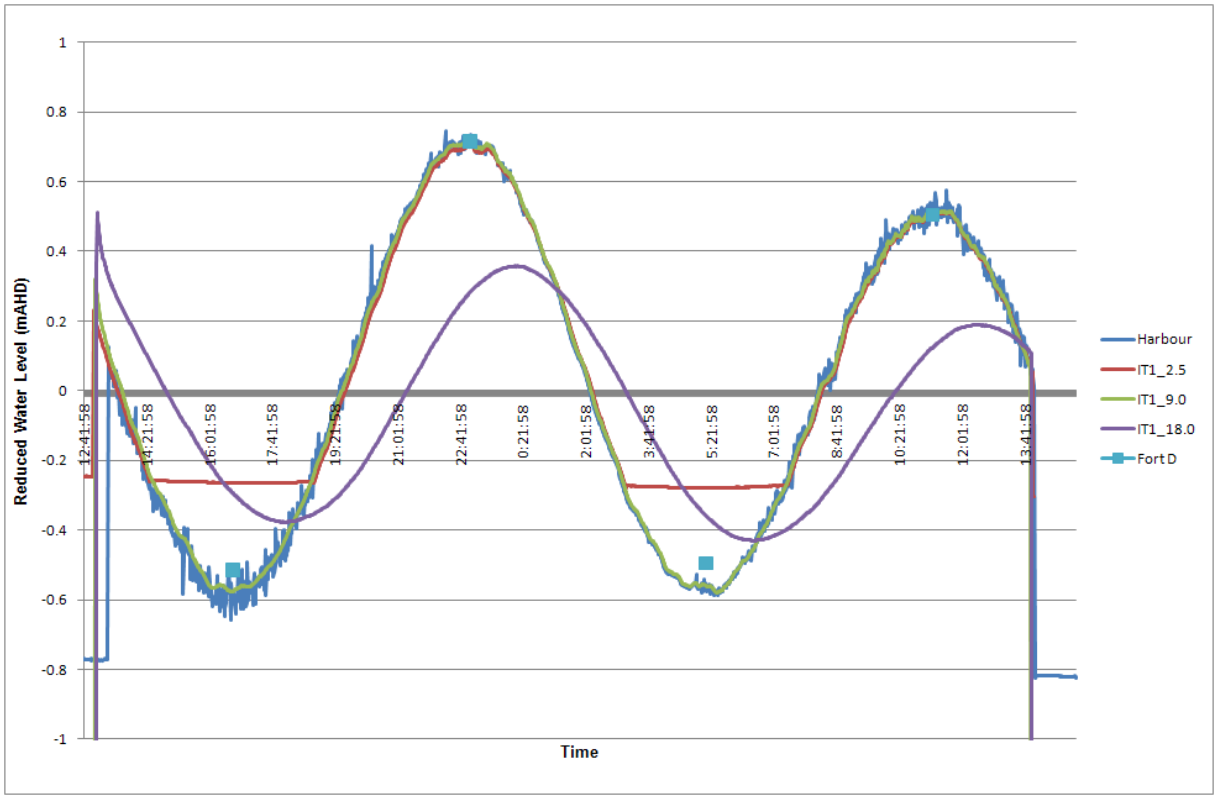


Figure 13: Time series hydraulic head data at piezometer array IT1

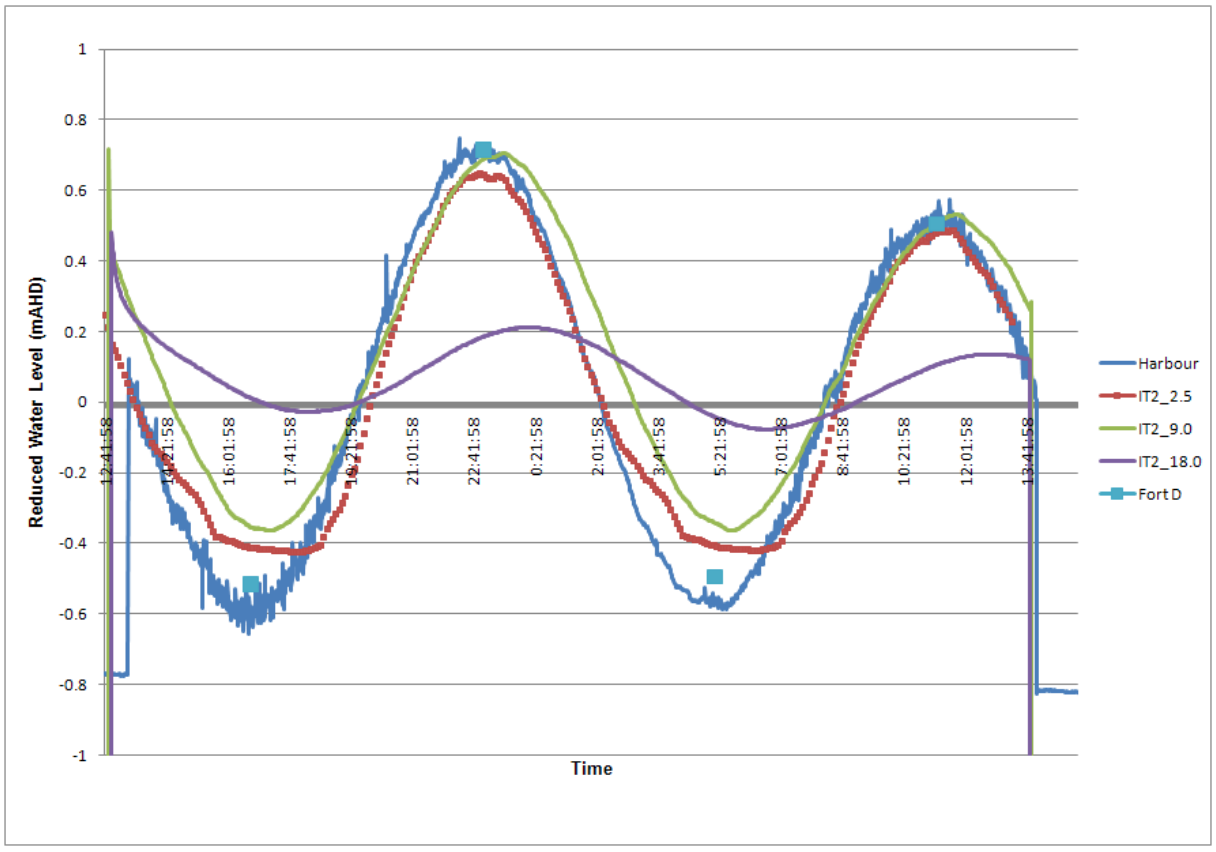


Figure 14: Time series hydraulic head data at piezometer array IT2

4.1.2 Visual Observations

During drilling and groundwater sampling in the vicinity of the harbour margin in the west of the site, the shallow fill aquifer was observed in places to respond rapidly to tidal movements, with groundwater being observed moving with the tide via voids beneath the hardstand. This is corroborated by the very efficient hydraulic connection between the shallow piezometers at IT1 and Darling Harbour, as observed in **Figure 13**.

4.2 Hydrochemistry

4.2.1 Field Parameters

Field parameters were measured on samples from each intertidal piezometer at low tide only (during the collection of groundwater samples). A sample of Darling Harbour seawater was also collected and measured during the low tide at IT3. These data are summarised in **Table 2**.

Table 2: Field Parameter Data Summary

Sample ID	Date	Tide Elevation	pH	EC (mS/cm)	Temp (C)	DO (mg/L)	Redox (mV)^
IT1_2.5	24/03/2010	Low	6.78	44.9	23.0	8.14	227
IT1_9.0	24/03/2010	Low	7.93	48.4	22.4	1.12	-162
IT1_18.0	24/03/2010	Low	6.41	31.3	26.9	4.20	-33
IT2_2.5	24/03/2010	Low	6.77	41.0	26.8	1.01	-37
IT2_9.0	24/03/2010	Low	8.2	41.1	22.6	0.51	-200
IT2_18.0	24/03/2010	Low	6.19	25.2	23.7	6.36	6
IT3 (Darling Harbour)	24/03/2010	Low	8.05	51.1	23.7	8.70	44

^ Field redox measurements given relative to platinum electrode (i.e. as measured)

The field parameter data for the multilevel piezometers is highly variable; however, an affinity with Darling Harbour seawater is exhibited in many cases, particularly in the shallow piezometers at the IT1 array (e.g. EC data). High levels of dissolved oxygen, particularly at IT1_2.5, is consistent with the rapid infiltration and mixing of seawater evident from the hydraulic and anecdotal data.

4.2.2 Salinity

The groundwater and surface water salinities were measured as TDS by the analytical laboratory on samples collected at low tide on 24 March 2010. The laboratory data is summarised in Table T1 and laboratory reports are enclosed in Appendix B. Salinity data from the multilevel piezometers and Darling Harbour is summarised in **Table 3**.

Table 3: Salinity Data Summary

Sample ID	Date	Tide Elevation	TDS (mg/L)
IT1_2.5	24/03/2010	Low	35,700
IT1_9.0	24/03/2010	Low	38,200
IT1_18.0	24/03/2010	Low	29,600
IT2_2.5	24/03/2010	Low	35,600
IT2_9.0	24/03/2010	Low	36,700
IT2_18.0	24/03/2010	Low	23,400
IT3 (Darling Harbour)	24/03/2010	Low	40,200

Consistent with the field EC data (**Table 2**), the TDS data supports a relatively high degree of mixing in the fill adjacent to the harbour (e.g. IT1_2.5 and IT1_9.0), with the influence of seawater declining with distance inland and particularly with depth.

4.2.3 Contaminants of Concern

Groundwater from all multilevel piezometers, and a seawater sample from the stilling well (IT3), were analysed for a broad suite of contaminants. The results of the analyses are summarised in Table T1 and the laboratory certificate of analysis and associated chain of custody documentation is enclosed in Appendix B.

A number of contaminants are present in groundwater adjacent to the harbour at concentrations that exceed ANZECC (2000) Marine Ecosystems (95%) guidelines. These include Ammonia, Naphthalene, Benzene, Toluene, total Xylenes and a variety of metals including Lead, Cobalt and Zinc.

In most cases, contaminants typically associated with gasworks waste (PAHs, benzene, ammonia and cyanide) exhibit an increasing trend with depth and to the east, consistent with a contaminant source lying either at depth or up gradient (e.g. **Figure F5**). At the near harbour location IT1, total PAH concentrations are below detection limit (<0.9 µg/L) in the shallow fill (IT1_2.5), but increase to 393 µg/L at the deepest piezometer (IT1_18.0) (Table T1).

The distribution of metals indicates a more heterogeneous distribution of source material throughout the fill. In the case of lead, the highest concentration recorded among the nested piezometers is at IT1_2.5, in shallow fill adjacent to the harbour margin (Table T1).

The distribution, transport and fate of the primary contaminants of concern are discussed further in the **Section 5.0.**

4.2.4 Data Validation

A validation process of the data utilised in this study was undertaken and is included in the Other Remediation Works (North) Data Gap Investigation Report (AECOM, 2010). The data validation procedure determined that the data were reliable and of suitable quality for interpretive use.

5.0 Conceptual Hydrogeological Model

5.1 Hydraulic Head

The hydraulic head distribution observed within the aquifer system adjacent to Darling Harbour is highly dynamic, particularly within fill material, with a strong cyclic response controlled by tidal fluctuations in the harbour. Time series hydraulic head data collected at one minute intervals from dedicated multilevel piezometes, indicate that a very efficient connection exists between terrestrial groundwater in the fill and Darling Harbour, with the responses in shallow and intermediate depth piezometers closely resembling the tidal elevation observed in the stilling well. At piezometer array IT1 (closest to the harbour margin) the timing and amplitude of the hydraulic response in piezometers IT1_2.5 and IT1_9.0 is virtually identical to that observed in the harbour, indicating that the transmission of head to and from the aquifer system is all but immediate. The absence of a time lag or attenuation of the tidal signal at these locations results in no observable hydraulic gradient developing between the aquifer and the harbour, implying no advective water movement; however, the observed rise in the watertable is evidence that water movement does occur and that the portion of the aquifer adjacent to the caisson (i.e. within ~45 m of the harbour) is immediately inundated on the rising tide and drained on the falling tide, with no apparent resistance to water movement either in the caisson structure or this portion of the fill material in the study area. This process is supported by anecdotal evidence noted during previous drilling investigations near the harbour margin, whereby water could be observed moving in and out of the fill with the tide.

Attenuation (decreased amplitude) and temporal lag of the tidal response does occur with depth, as the stratigraphy underlying the fill grades into less permeable marine sediments, and with distance from the harbour margin, as the permeability of the fill begins to constrain the response over greater distances. Both lag and degree of attenuation are shown to increase with distance from the harbour margin, consistent with studies conducted in similar environments elsewhere (**Section 3.0**). In the near harbour piezometer IT1_18, installed within the marine sediments, the tidal response has a reduced amplitude and a temporal lag of approximately 1.5 hours (**Figure 13**). This results in an upward hydraulic gradient developing between the marine sediments and the harbour during much of the falling limb (ebb tide) and part of the rising limb of the tidal cycle, such that the potential for groundwater discharge from these sediments to the harbour exists during these periods in the tidal cycle. As the tide rises the hydraulic gradient reverses, such that a downward hydraulic gradient and potential for seawater ingress into the aquifer exists (**Figure 13**).

At the IT2 piezometer array, located approximately 55 m from the harbour, the tidal response in the fill and marine sediments is attenuated and delayed relative to the harbour to varying degrees. All exhibit a greater influence of the regional hydraulic gradient, which can be observed at low tide where all piezometers have hydraulic heads above that in the harbour, indicating groundwater flow in a westerly direction. At high tide the head in the fill and the harbour all but equilibrate, resulting in a very flat hydraulic gradient during these periods (**Figure 14**).

Instantaneous measurement of hydraulic head during tidal minima and maxima confirm that the dominant control on groundwater levels, at least in the western portion of the site, is the changing tidal elevation in Darling Harbour. During tidal minima and maxima the harbour forms the low and high head boundary, respectively, for the western portion of the site. During tidal minima, hydraulic head throughout the terrestrial system is higher than that recorded in Darling Harbour, such that the potential for discharge exists across all measured depths of the aquifer – harbour boundary (**Figure F2**). Due to rapid drainage of the upper fill near the harbour margin, the gradient is observed to be very flat within 20 m of the caisson, but steadily rises to the east in response to the more intermediate (rather than local) scale hydraulic gradient. Time series data from IT2 indicates that a hydraulic distribution conducive to groundwater discharge to the harbour may develop up to 5 hours prior and persist for up to three hours following tidal minima (**Figure 14**).

During the rising tide, hydraulic head in the fill immediately adjacent to the harbour rises in constant equilibrium through infiltration of the caisson by seawater such that the shallow pore space adjacent to the harbour is inundated as the watertable rises. This results in a localised reversal of the hydraulic gradient between the aquifer and harbour (**Figure F3**), such that groundwater discharge to the harbour ceases and the potential continues to exist for the infiltration of seawater through the caisson into the eastern portion of the aquifer and downwards into the underlying marine sediments. This results in the establishment of a temporary groundwater divide, where groundwater moving east under the influence of elevated head in the harbour opposes groundwater flowing west under the more intermediate or regional scale hydraulic gradient. Hydrograph data from IT2 indicate that this scenario may develop up to 4 hours prior and persist for up to 2 hours after the peak of high water **Figure 14**. This results in groundwater oscillating backwards and forwards within this area of the aquifer, which creates a

relatively “stagnant zone” where net groundwater movement towards the harbour occurs at a very low velocity. The oscillation of particles in these zones has been confirmed by numerical modelling at other sites (e.g. AECOM, 2009).

There appears to be two distinct, but related mechanisms for groundwater / surface water interaction at the Site, based on the hydraulic data. The first occurs by rapid inundation and drainage of the porous fill material immediately adjacent to the harbour, through a highly efficient hydraulic connection which exists between the harbour and the fill, facilitated by the highly permeable caisson structure. This response is instant at the temporal scale of the hydrographs, implying that this portion of the aquifer (up to 45 m from the harbour margin) behaves more like an open water system than a typical porous media. The second mechanism, evident within the marine sediments at depth, is a typical aquifer – surface water response, where the potential for discharge and infiltration develops in response to tide-induced hydraulic gradients.

The process of inundation into the fill along the harbour margin during the rising tide will result in the development of a prism of seawater within the fill behind the caisson structure, which assuming uniform fill and caisson permeability, would develop along the entire length and depth of the caisson. This tidal exchange prism is subsequently drained via the same pathway as the tide recedes, carrying with it any dissolved and/or particulate contaminants which have either leached into the seawater, become mixed through interaction with other pore water, or have become physically entrained (in the case of particulates) during the tidal movement. In this case, pore water discharge volumes are equivalent to the effective porosity of the fill within the prism area, with the prism volume being equivalent to the change in storage observed during the rise of the water table.

The highly cyclic (diurnal) nature of the discharge and infiltration observed in both mechanisms will result in the development of a mixing zone within the aquifer, whereby despite a net discharge occurring (which is controlled by the regional hydraulic gradient), much of the water which discharges during each low water period is likely to be comprised largely of seawater which infiltrated during the preceding high water period. This phenomenon has been observed in numerous other studies in similar environments (refer **Section 3.0)**. This mechanism is likely to have significant implications for the mass flux of dissolved phase contaminants to the harbour (**Section 5.3**).

5.2 Solute Distribution

5.2.1 Salinity

Based on the salinity distribution a number of groundwater zones are able to be inferred, and from a seaward to landward direction include:

- Seawater (TDS>40,000 mg/L);
- “Connate” water (TDS 30,000 to 40,000 mg/L;
- Zone of diffusion (TDS 14,000 to 30,000 mg/L); and
- Terrestrial groundwater (TDS<14,000 mg/L).

The inferred salinity distribution and the inferred hydrogeochemical regimes are illustrated in **Figure F4**.

The groundwater salinity on the upstream face of the caisson (BH212) largely reflects seawater, with the TDS declining with distance from the harbour (**Figure F4**), reflecting the increased content of terrestrial groundwater to the east. .Estimates of linear groundwater flow velocities (1.1 m/year assuming flow only in a westerly direction i.e., constant discharge to Darling Harbour) indicate that it is likely that significant quantities of “connate” seawater, trapped during reclamation of the fill, remains in-situ beneath the Site. In reality the “net groundwater velocity” is significantly lower since groundwater oscillates backwards and forwards as a function of the tidal elevation and is discussed further in **Section 5.4**.

Salinity values representative of background terrestrial groundwater (e.g. BH204D) are largely restricted to the area immediately adjacent to Hickson Road (within approximately 20 m thereof). A steep salinity gradient exists immediately down gradient of this zone extending to BH45, reflecting a zone of diffusion between the terrestrial groundwater and the “connate” seawater.

It is also evident that groundwater salinities in the marine sediments are lower than in the overlying fill, possibly representative of a narrower mixing zone controlled by the lower sediment permeability or representative of upward leakage from the Hawkesbury Sandstone.

5.2.2 Contaminants of Concern

The distribution of dissolved phase groundwater contamination appears to be partly controlled by the heterogeneous nature and distribution of source material within the fill profile, partly by transport from up gradient and partly by attenuation controlled by tidal fluctuations in Darling Harbour (**Section 5.4)**. It should be noted that the multilevel piezometers screen very discrete portions of the aquifer system, and direct comparison of contaminant concentrations with those in longer screened wells are therefore problematic due to the effects of well screen dilution.

The distribution of total PAH concentrations in the multi-level piezometers, and from bores up gradient, exhibit a general trend of increasing concentrations with depth (**Figure F5**). This distribution is likely to be the result of diffusion/advection of PAHs from a source located at depth or up gradient, or a combination of the two. However, seawater mixing is considered to be the dominant process immediately up gradient of the caisson considering the overall data including hydraulic head response and salinity distribution. The presence of a source at depth in the vicinity of the transect is supported by the presence of tar at MW40.

The distribution of ammonia is consistent with transport from a source lying either up gradient or at depth, with concentrations among the nested piezometers being highest at IT2_9.0 and decreasing with proximity to the harbour. Low concentrations of ammonia are present at shallow depths (e.g. IT1_2.5, IT1_9.0 and IT2_2.5; **Figure F6**), and may be a function of proximity of sources, consistent with the these being located at depth in the fill.

In general, contaminants typically associated with gasworks waste (e.g. naphthalene, benzene, ammonia and cyanide) all have a distribution consistent with a source lying either up gradient or at depth, most likely a coal tar (DNAPL). Conversely, the distribution of a number of metals, particularly lead (**Figure F7**) have a different distribution, whereby concentrations are often higher in the shallow fill and decrease with depth.

The distribution of lead is most likely related to elevated lead concentrations in the shallow soil observed at nearby bore BH212, and is representative of the heterogeneous nature of the fill placed across the site. The IT1_2.5 piezometer only contains water during the high water periods in the tidal cycle such that groundwater at this location is likely to be leached with ”connate” water that fluctuates due to the tidal elevation. As such, the presence of elevated concentrations of lead in groundwater at IT1_2.5 may indicate that the soil contamination identified at BH212 is leachable, which is broadly consistent with leachability data for lead in soil at the Site. Lead was detected at down gradient bore BH212 at a concentration of 1.5 µg/L and in the Darling Harbour sample collected at the stilling well during low tide at a concentration of 0.4 µg/L. The proximity of BH212 to the harbour, combined with its complete screen coverage of the fill aquifer make it an ideal proxy for the hydraulic conductivity-weighted average of groundwater concentrations migrating into Darling Harbour.

5.3 Discharge Rate and Contaminant Mass Flux

As previously discussed, there appears to be two mechanisms of groundwater discharge and therefore solute mass flux to Darling Harbour. The first occurs by free draining of the tidal exchange prism – a highly permeable portion of the fill located adjacent to the harbour defined by a temporary groundwater divide which manifests within the aquifer during each high tide (**Figure F3**). The second occurs by sub-tidal discharge from the marine sediments driven by the terrestrial hydraulic head, which exceeds the hydraulic head in the harbour during typical tidal minima (**Figure F2**).

Exchange between Darling Harbour and the Hawkesbury Sandstone, which underlies the marine sediments throughout the investigation area, has not been evaluated. The Hawkesbury Sandstone is generally regarded in the literature as a relatively impermeable formation (Lees *et al*., 2005; Hewitt, 2005; Merrick and Knight, 2003) and as such, is not considered a significant component of the Site water balance.

5.3.1 Tidal Exchange Prism

The tidal exchange prism is defined as the highly permeable portion of the fill (both intertidal and sub-tidal) which behaves as an equivalent open water body in complete connection to the harbour, as interpreted from hydrograph data from multi-level piezometer array IT1. It is defined arbitrarily as a rectangular prism occupying the space between the caisson and the temporary groundwater divide which develops in the aquifer in response to high tide in the harbour (**Figure F3**). The latter plane is highly dynamic and will manifest differently depending on the relationship between tidal elevation and prevailing terrestrial hydraulic head. It should be noted that there are two high tides and two low tides in the daily tidal cycle. Of the two high tides there is a higher high water and a lower

high water and with the low tides a higher low and lower low water, with each resulting in a change in aquifer storage of a different magnitude with a corresponding tidal exchange prism with different dimensions.

The volume of groundwater within this portion of the aquifer during typical tidal maxima, which subsequently drains into the harbour at low tide, can be approximated from the change in aquifer storage. Based on the hydraulic data collected during this study, hydraulic head fluctuations vary from the tidal range observed (1.03 m) to effectively zero at Hickson Rd in the east of the Site (a distance of approximately 200 m) giving an elongated triangular cross section with an area of approximately 100 m^2 (200 m x 1.03 m x 0.5). A simplified conceptual diagram (**Figure F8**) illustrates this mechanism. This estimate of volume is considered to be conservative as it disregards the progressive time lag (phase shift) observed in the transmission of head change across the Site. Consideration of this delay would result in a smaller estimated volume; however, as the delay is most evident in hydrographs of small amplitudes, the effect is not considered significant for the purposes of this estimate. Laterally, this volume equates to the tidal exchange prism having an extent of approximately 6 m from the landside edge of the caisson into the aquifer. To account for the anticipated fill heterogeneity, the lateral (i.e. east-west) extent of the tidal exchange prism in plan view is conservatively defined as 10 m.

The hydraulic data indicate that the portion of the aquifer adjacent to the harbour where the infiltration through the caisson occurs has a very high permeability, including the possible presence of voids that have been encountered in drill holes throughout this western portion of the Site. To account for this, a relatively high effective porosity of 0.25 is estimated and assigned to the fill material as a whole. As such, the groundwater volume (flux) within the tidal exchange prism (needed to raise the watertable as observed) is estimated at approximately 25 m^3 per linear meter of harbour frontage. Given this drainage occurs twice in any tidal day (approximately a 24 hour period), the volumetric groundwater discharge rate for this portion of the aquifer - harbour margin is estimated at 50 m^3/m/day (i.e. 50 m^3/day per linear meter of harbour frontage).

Estimates of current contaminant mass flux (a function of the groundwater discharge volume and the contaminant concentration) for the tidal exchange prism are constrained by the inherent heterogeneity of the fill material. It should be noted that, due to the nature of the tidal exchange described above, that contamination present within the tidal exchange prism is not expected to undergo further attenuation prior to discharge. Based on data from BH212, where concentrations of ammonia, PAHs and BTEX are below detection limits, the mass flux of these contaminants from drainage of the tidal exchange prism may be negligible for this portion of the Site. This is probably due largely to the absence of a leachable source of these compounds within this portion of the aquifer, which may or may not be representative of the remainder of the harbour margin, and the heavy seawater mixing evident in the salinity data. Conversely, where metal contaminants (e.g. lead) are detected in BH212, it is likely that on drainage of the tidal exchange prism, these contaminants are discharged to harbour. In this case, the mass flux is the integration of the discharge rate (50 m^3/m/day) and contaminant concentration (1.5 µg/L), such that the mass flux for lead may be of the order of 75 mg/m/day where such lead concentrations exist along the harbour margin. While the mass flux of lead in this case may be substantial when integrated over long time periods or extensive areas, it is noted that a concentration of 1.5 µg/L is below the relevant ANZECC Marine Ecosystem guideline.

5.3.2 Exchange via Marine Sediments

The sub-tidal exchange occurring between the marine sediments and the harbour is governed by Darcy's Law, where the discharge rate is a function of the hydraulic conductivity, the hydraulic gradient and the cross-sectional area through which the groundwater can migrate. In this case only the hydraulic conductivity and cross-sectional area can be assumed to be constant; the hydraulic gradient is in a constant state of change. Due to data constraints, only the upper marine sediments are considered in this analysis, sub-tidal discharge from the Hawkesbury Sandstone or other geological units is considered beyond the scope of this investigation.

The cross sectional area of marine sediment – harbour interface across which groundwater discharge/seawater infiltration occurs is unknown, therefore the analysis must be simplified. Any terrestrial groundwater which discharges from the marine sediments must pass through a cross sectional area defined as the area from the base of the caisson to the boundary with the Hawkesbury Sandstone. Based on cross section B – B', this equates to an area of ~20 m^2 per linear meter of harbour frontage, or a total of ~20,000 m^2.

Hydraulic conductivity data for this formation is limited. Based on data from bore MW56, interpreted to be screened across an interval of the marine sediments, the hydraulic conductivity of the formation is estimated to be 0.063 m/day (AECOM, 2010). The horizontal hydraulic gradient calculated from the vertical flow net at low tide (**Figure F2**), within the western portion of the aquifer is estimated at 0.0025. This value is only representative of the gradient at low tide and is significantly lower during other periods in the cycle. Indeed, the gradient reverses completely during high water periods (**Figure F3**). Conservatively assuming this gradient exists for 12 hours a

day, the discharge volume of pore water across the modelled cross section is of the order of 0.0016 m^3/day per metre of harbour frontage, or a total of 1.6 m^3/day for the site as a whole.

This analysis indicates, that relative to the volumes of discharge occurring via the tidal prism throughout the fill material adjacent to the harbour, the volumes of exchange (discharge and recharge) occurring via the marine sediments is likely to be negligible. In addition to the low volumes, the likely mixing dynamics, as observed in this and other studies, will dictate that a high proportion of this ~1.6 m^3/day is seawater that infiltrated the shallow pore space during the preceding high tide (**Section 4.1.1)**.

5.4 Theoretical Connate Water Displacement Mixing Model

By comparing groundwater chloride (Cl^-) compositions (an inert tracer) to that of the terrestrial and oceanic end members, it is possible to estimate the proportion of seawater in any given groundwater sample. However, given the nature of the fill and the history of its formation by reclamation of a shallow marine environment, the background Cl^- concentration for groundwater in this material is highly uncertain. For the purposes of this analysis it is assumed that an unmixed terrestrial groundwater sample from the fill has a Cl^- concentration of 7,000 mg/L, based on a review of the available data for this formation. Based on analytical results from the stilling well, the Cl^- concentration of seawater in Darling Harbour is 23,400 mg/L.

These two end members are joined by a mixing line with the following formula:

$$Y = 0.0061X – 42.683$$

Where Y is equal to the percentage seawater and X is equal to the groundwater Cl^- concentration.

Figure F9 shows the distribution of available Cl^- concentration data in the fill with the equivalent percentage seawater contoured. While the dataset is limited, it indicates that much of the groundwater within fill contains a significant component of seawater, with a clear trend of increasing seawater content towards the harbour margin. There is some evidence for an increased seawater component landward of the proposed Southern Cove area, where the seawall structure is located further inland allowing increased transgression of the seawater in that direction.

This basic analysis indicates that the water lying within the fill adjacent to harbour is between 80% and 100% seawater, such that the terrestrial groundwater component of any given discharge volume is likely to be less than 20%. This is broadly consistent with other studies from similar environments elsewhere (**Section 3.1)**.

However, this theoretical mixing relationship becomes confounded when the seawater identified within the aquifer is considered to, at least partly, represent seawater entrained with the backfill during land reclamation (i.e. “connate” water). In this case the elevated Cl^- concentrations cannot be attributed solely to an advective tidal mixing process, complicating mixing relationships based on Cl^-.

To address this complexity the estimated displacement of the connate seawater by migration of terrestrial groundwater has been used as a proxy for net groundwater migration, and therefore discharge to the marine environment. As previously described, due to the tidally-driven oscillation of particles in the aquifer, net discharge occurs slowly, with the majority of discharge volume comprised of seawater which infiltrated on the rising tide. The net movement of groundwater from the reclaimed fill since formation can be approximately equated to the displacement of the connate – terrestrial groundwater interface from the original harbour shoreline.

Reclamation of Darling Harbour is estimated to have commenced approximately 150 years ago (including the area underlying the former gas works). In that time it is estimated (from **Figure F9**) that the connate – terrestrial interface has migrated approximately 20 m – a net migration rate of 0.13 m/year, or approximately one tenth of the linear groundwater velocity (estimated based on Darcy’s Law at 1.1 m/year). The discrepancy between the net migration rate and the linear groundwater flow velocity is due the alternation of the hydraulic gradient, which causes water and particles to oscillate rather than move constantly in a single direction (as assumed by the linear groundwater velocity equation). In this instance the oscillation and resultant net migration of contaminant particles can be simply visualised as a process whereby an individual particle migrates 10 steps eastward during the rising tide and 11 steps westward on the falling tide (i.e. net migration and therefore net discharge occurs at a rate of one tenth of the estimated linear groundwater flow velocity).

This analysis indicates that of the total flux towards the harbour in any given ebb tide, approximately 10% represents water from up gradient, which equates to a groundwater (including connate seawater) to seawater mixing ratio of approximately 1:10. However, given potential uncertainty regarding the original shoreline location and dates for the commencement of reclamation activities, attenuation factors for groundwater up gradient of the

tidal exchange prism are conservatively estimated as a factor of 5. As previously stated, contamination which has migrated into, or is otherwise present within the tidal exchange prism, is not expected to undergo further attenuation prior to discharging to the harbour.

5.5 Implications for the HHERA Process

The conceptual hydrogeological model indicates that the terrestrial groundwater component of the discharge that occurs to Darling Harbour from the permeable fill material is likely to be a maximum of 20% of the total volume, with the mixing model estimating closer to 10% of the total volume, with the remainder comprising seawater which inundated during the previous high tide. As such, at least a five-fold attenuation factor can be anticipated for any given dissolved-phase groundwater contaminant migrating from a source zone and discharging to Darling Harbour. This attenuation factor would also apply to the leachable concentrations from residual soil contamination. This does not apply to contamination present within the tidal exchange prism defined (based on volume estimates) to be a zone at least six metres wide(on average) along the landside of the caisson. This will vary to some extent based on permeability of the fill profile.

Based on this conservative level of mixing, it should be possible to develop Site-specific ecological screening criteria (SSESC) for groundwater and for leachable concentrations from soil. The adopted SSESC for groundwater and leachable concentration data at the Site could therefore be reasonably approximated as the ANZECC (2000) trigger values multiplied by a factor of five.

Relative to that occurring from the fill sequence, groundwater discharge volumes and therefore contaminant mass flux from the marine sediments is considered to be negligible from a hydrogeological perspective. While the risk posed from this process will need to be evaluated, it is likely to be commensurate with the relatively low estimates of groundwater discharge volume. As previously discussed, groundwater discharge occurring via the basal Hawkesbury Sandstone is not considered significant in this context (**Section 5.3**).

6.0 Conclusions

The following conclusions are drawn from the assessment of the data collected during the current investigation:

- Drilling at IT1 and IT2 has confirmed that a thick sequence of fill material (up to 15 m) is present adjacent to the harbour in the west of the site. This is underlain by natural clayey marine sediments of variable thickness. The fill profile elsewhere on site has been reported up 23 m in thickness.
- A very efficient hydraulic connection exists between the harbour and the fill aquifer immediately adjacent, with head in this portion of the aquifer responding instantly to changes in the tide; the caisson structure is therefore considered to be highly permeable.
- Significant changes in water level in the unconfined fill aquifer (>1.0 m in some cases) suggest significant quantities of water are exchanged across the aquifer – harbour interface. The volume of water discharged to the harbour during a typical ebb tide across the approximate 500 m frontage of the Site (from Block 1 through Block 5) is estimated at 12.5 ML (25 ML/day or 50 m^3/day per linear meter of harbour frontage).
- By comparison to the fill aquifer, exchange occurring via the underlying marine sediments is almost negligible, with a discharge component estimated at 1.6 m^3/day, due to the very low hydraulic conductivity and gradient. Furthermore, groundwater discharge occurring via the basal Hawkesbury Sandstone is not considered significant in the context of site-derived contaminant flux to Darling Harbour.
- The proportion of groundwater to seawater (mixing model) discharging during the low tide cycle to Darling Harbour has been derived from a connate water displacement model. The estimate proportion of groundwater (which in this instance is connate water) is similar to studies elsewhere, suggests that much of the water discharged during ebb tides is comprised of seawater which infiltrated during the previous flood tide. The mixing analysis indicates that the groundwater component of any discharge is likely to be 10-20% of the total, broadly consistent with similar studies conducted elsewhere.
- Contaminant mass flux is difficult to estimate on a site wide basis due to the heterogeneity of the fill, but mass flux is likely to be strongly limited by attenuation occurring up gradient of the tidal exchange prism. Where leachable source material is present within the tidal exchange prism, any resultant groundwater contamination is expected to discharge largely without further attenuation.
- Based on a five-fold attenuation of dissolved phase contamination migrating from an up-gradient source zone into Darling Harbour, SSESC for groundwater and leachable concentration data at the Site could be reasonably approximated as the ANZECC (2000) trigger values multiplied by a factor of five.

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7.0 Limitations Statement

This document was prepared by AECOM Australia Pty Ltd (AECOM) for the sole use of Lend Lease (Millers Point) Pty Ltd, the only intended beneficiary of our work. Any advice, opinions or recommendations contained in this document should be read and relied upon only in the context of the document as a whole and are considered current to the date of this document. Any other party should satisfy themselves that the scope of work conducted and reported herein meets their specific needs before relying on this document. AECOM cannot be held liable for any third party reliance on this document, as AECOM is not aware of the specific needs of the third party. No other party should rely on the document without the prior written consent of AECOM, and AECOM undertakes no duty to, nor accepts any responsibility to, any third party who may rely upon this document.

This document was prepared for the specific purpose described in our proposal dated 16 April 2010 and as agreed to by Lend Lease (Millers Point) Pty Ltd. From a technical perspective, the subsurface environment at any site may present substantial uncertainty. It is a heterogeneous, complex environment, in which small subsurface features or changes in geologic conditions can have substantial impacts on water and chemical movement. Uncertainties may also affect source characterisation assessment of chemical fate and transport in the environment, assessment of exposure risks and health effects, and remedial action performance.

AECOM's professional opinions are based upon its professional judgement, experience, and training. These opinions are also based upon data derived from the testing and analysis described in this document and other referred AECOM document. These opinions are also based on data derived by others as provided by Lend Lease (Millers Point) Pty Ltd and the Barangaroo Delivery Authority. It is possible that additional testing and analysis might produce different results and/or different opinions. AECOM has limited its investigation to the scope agreed upon with Lend Lease (Millers Point Pty) Ltd. AECOM believes that its opinions are reasonably supported by the testing and analysis that have been done, and that those opinions have been developed according to the professional standard of care for the environmental consulting profession in this area at the date of this document. That standard of care may change and new methods and practices of investigation, testing, analysis and remediation may develop in the future, which might produce different results. AECOM's professional opinions contained in this document are subject to modification if additional information is obtained, through further investigation, observations, or validation testing and analysis during remedial activities.

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8.0 References

AECOM, 2009. Conceptual Site Model Report. 221 Whitehall Street, Yarraville. Former Pivot Site. Final. Report No: M4086508, 6 November 2009.

AECOM, 2010. Data Gap Investigation, Other Remediation Works (North) Area, Hickson Road, Millers Point, NSW – DRAFT. 3 June 2010.

ANZECC, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environmental and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, National Water Quality Management Strategy 2000.

Bokuniewicz, H. (1980). *Ground Water Seepage into Great South Bay, New York*. Estuarine and Coastal Marine Science 10, No 4., pp 437-444.

Cooper, Jr., H.H. (1964) U.S. Geological Survey Circular 1613-C.

Edwards, M., and J. Duran, 2008. The Use of Isotopic Tracers and Chloride to Characterise the Discharge of a Groundwater Contaminant Plume to a Marine Environment, Port Phillip Bay, Victoria, Australia. Western Pacific Meeting, American Geophysical Union. 29-31 July 2008, Cairns, Australia.

Environmental Protection Authority Victoria, 2002. The Clean Up and Management of Polluted Groundwater. Publication 840. Environmental Protection Authority Victoria. April 2002.

Hem, J. D., (1985) *Study and Interpretation of the Chemical Characteristics of Natural Water, 3rd Ed*. USGS Water Supply Paper 2254.

Hewitt, P. (2005) Groundwater Control for Sydney Rock Tunnels. AGS AUCTA Mini-Symposium: Geotechnical Aspects of Tunneling for Infrastructure Projects. October 2005.

HLA-Envirosciences (2007). Groundwater Discharge Mechanisms Report, [Confidential West Metro Site], 21 June 2007

Lee, D.R. (1977). A Device for Measuring Seepage Flux in Lakes and Estuaries. Journal of Limnology and Oceanography, Vol. 22, pp140-147.

Lees, D., Edwards, D. and Grant, B. (2005). Recent Experiences in Grouting Sydney Sandstone. AGS AUCTA Mini-Symposium: Geotechnical Aspects of Tunneling for Infrastructure Projects. October 2005.

Li, L., D. A. Barry, F. Stagnitti, and J. Y. Parlange (1999*). Submarine Groundwater Discharge and Associated Chemical input to a Coastal Sea*. Water Resources Research, Vol 35, No 11, pp 3253-3259, November 1999.

Merrick, N.P. and Knight, M.J. (2003). Groundwater Assessment for the Proposed Port Botany Expansion. Report for Sydney Ports Corporation. AccessUTS Consultants, March 2003.

Robinson, M., D. Gallagher, and W. Reay (1998). Field Observations of Tidal and Seasonal Variations in Ground Water Discharge to Tidal Estuarine Surface Water. Ground Water Monitoring and Remediation, pp 83-92, Winter 1998.

Urish, D. W. and T. E. McKenna (2004). Tidal Effects on Ground Water Discharge through a Sandy Marine Beach. Ground Water – Oceans Issue 2004, Vol 42, No 7, pp 971-982.

URS (2004). Orica Botany Environmental Survey, Stage 4 – Remediation. Penrhyn Estuary Baseline Survey – Surface Water and Groundwater Discharge. Document Number R009_A, 13 February 2004.

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9.0 Glossary

Abiotic - Not involving biological activity. A term used to describe chemical degradation process.

Absorption - Chemical assimilation or incorporation of liquids in solids or gases in liquids.

Accuracy - Degree of agreement between a measured value and a true or expected value.

Acidify -Add acid to lower pH.

Adsorption -The attraction and adhesion of a layer of ions from an aqueous solution to the solid surface with which it is in contact.

Advection -The process by which solutes are transported by the motion of flowing groundwater.

Aerobic - Environment where oxygen is present.

AHD - Australian **H**eight **D**atum - a standard reference point for the elevation of a location.

Aliquot - A predetermined weight of a sample which is used for analysis.

Anaerobic - Reducing environment or without oxygen.

Aqueous Phase - Contaminants dissolved in water

Aquifer - An underground geological formation that contains water and is capable of yielding water to a well or spring; a water bearing formation.

Aquitard - See Confining Layer.

Attenuation - A combination of contaminant transport processes (dispersion, sorption, mixing and degradation) which results in a decreasing concentration of a dissolved phase contaminant with distance from the source.

Biodegradation - The breaking down of compounds by biological processes including microorganism activity.

Biota - Biological samples.

Biotic - Involving biological activity.

Biofouling - Clogging of monitoring well screens by insitu bacteria.

Bioremediation - Removal of in situ organic contamination by utilising naturally occurring or specifically engineered or introduced bacteria.

Biotransformation - Structural alteration of a chemical by an organism. In regard to organic compounds , it refers primarily to their decomposition by microorganisms.

BOD - Biochemical **O**xygen **D**emand - A measurement of how much oxygen will be directly consumed by a particular sample.

Bore/Borehole - An uncased well drill hole.

Bore Log - See - Geological Log

BP - See Bundle Piezometer

BTEX - BTEX is an acronym for benzene, toluene, ethylbenzene, and xylene

Bundle Piezometer - A cluster of narrow diameter piezometers with very short screens at different depths in the same hole.

Casing - Steel or plastic tubing that is welded or screwed together to line a borehole.

Chain-of-Custody - Procedure to ensure that samples are traceable from the sample collection through to laboratory analysis and reporting.

Chart Datum - The datum or the plane of reference to which all charted depths are related (but not other heights and elevations). It is a level so low that the tide will not frequently fall below it. Chart datum is not a horizontal surface but may be considered as such over a limited local area.

CHC – Chlorinated Hydrocarbons

Chemical Reduction - Degradation of chemicals in an oxygen deficient environment.

COD - Chemical **O**xygen **D**emand - A measure of the amount of chemical oxidiser required to oxidise the organic matter contained in a water sample.

Connate Water – Water (usually seawater) trapped in a sediment or fill during formation.

Cone of Depression - A cone shaped depression that is formed in a water table where groundwater is removed.

Confidence Level (Confidence Limit, 95 percent) - A level of data reliability achieved by setting a percent confidence limit. A 95 percent confidence limit is the limit of the range of analytical values within which a single analysis will be included 95 percent of the time.

Confined Aquifer - An aquifer whose upper and/or lower boundaries are confined by an impermeable geologic formation, e.g. clay layer; an aquifer in which groundwater is under pressure, e.g. artesian conditions.

Confining Layer - An aquitard or impermeable layer that confines the limits of an aquifer.

Core Sample - A soil or sediment sample obtained relatively undisturbed from the subsurface.

CTC - Tetrachloromethane (Carbon Tetrachloride)

Decontamination - Remove contamination from an item of equipment or from an area of land or body of water.

Dehalogenation - Selective removal of halogen (fluorine, chlorine, bromine and iodine) molecules

Density - The mass or quantity of a substance per unit volume.

Desorption - Reverse of Adsorption, (ion movement from solid phase to aqueous)

Diffusion - The process by which both ionic and molecular species dissolved in water move from areas of higher concentration to areas of lower concentrations.

Dilution - The process of making a substance or substances less concentrated by adding a solvent, such as water.

Dispersion - The phenomenon by which a solute in flowing groundwater is mixed with uncontaminated water and becomes reduced in concentration. Dispersion is caused by both differences in the velocity that the water travels at the pore level and differences in the rate at which it travels through different strata in the flow path.

Dissolution - The process of dissolving DNAPL into the aqueous phase.

Dissolved Phase - See Aqueous Phase

Distribution Coefficient - The slope of a linear isotherm (Freundlich Isotherm). A numerical parameter used to quantify the ability of compounds in solution to be adsorbed onto the surface of solid particles eg soils, organic matter etc.

Diurnal - Having a period or cycle of approximately one tidal day.

DNAPL - Dense **N**on-**A**queous **P**hase **L**iquid - an organic chemical or mixture of organic chemicals which does not readily mix with water and is heavier than water.

DNAPL Source Zones - Zones where residual or free phase DNAPL is present

Drawdown - A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping from wells.

DQOs - Data **Q**uality **O**bjectives

EC – Electrical Conductivity - Electrical Conductivity – A measure of the conductance of water which is general an indication of the salinity – see TDS.

Equipotential - A line in a two-dimensional groundwater flow field such that the total hydraulic heads are equal for all points along the line.

Exposure - Contact with a chemical or physical agent.

Exposure Assessment - The estimation of the magnitude, frequency, duration, route and extent of exposure to a chemical substance or contaminant.

Exposure Pathway - The course a chemical or physical agent takes from a source to an exposed organism. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route.

Exposure Point - The point of contact between a chemical and receptor. If the exposure point differs from the source, a transport/exposure medium or media is involved.

Evaporation - The process by which water passes from the liquid phase to the gas phase.

Evapotranspiration - The sum of evaporation and transpiration.

Extraction Well - A well installed to enable in-situ groundwater remediation by the extraction of groundwater. Extraction wells assist in the control of a migrating plume.

Extraction Pump - Pump associated with extraction well system.

FID - *F*lame ***I***onisation ***D***etector - Detector coupled to a gas chromatograph used to measure the concentrations of organic compounds.

Field Duplicates - These are a set of two discrete samples collected from the one sampling point. The sample is prepared in the field by splitting a field sample, then submitting both to either the same laboratory (inter-laboratory duplicates) or a different laboratory (inter laboratory duplicate) as two independent samples, which are labelled as two discrete locations, the duplicate sample having no reference to the primary sample.

Flow Lines/Flow Path - Direction of groundwater flow.

Flow Net - A set of intersecting equipotential lines and flowlines representing two-dimensional steady state flow through a porous media.

Fracture - A break in the geological formation, e.g. a shear or fault.

Freundlich Isotherm - An empirical equation that describes the amount of solute adsorbed onto a soil surface.

Free Phase DNAPL - DNAPL saturation exceeding the capillary pressure of the soil.

Gamma Tool - A geophysical tool which measures the natural radioactivity of the geological formation

Gauge Board - A temporary or permanent reference point for the measurement of the elevation of a surface water level.

GC/MS - *G*as ***C***hromatograph/***M***ass ***S***pectrometer - Instruments for the measurement of concentrations of organic compounds in soil and water.

Geological Log - A record of the lithology or stratigraphy of the rock or soil encountered in a borehole.

Geophysics - Geological exploration or investigation techniques using principally electrical instruments and applying the method of physics and engineering.

Ghyben-Herzberg Principle - An equation that relates the depth of a salt-water interface in a coastal aquifer to the height of the fresh water table above sea level.

Gradient - The rate of inclination of a slope. The degree of deviation from the horizontal.

Groundwater - Water beneath ground surface.

Hazardous Material - Substances which for reasons of toxicity, corrosivity, etc. are dangerous to humans or other aspects of the environment.

Head Space - The air space at the top of a water or soil sample.

Head Space Analysis - Qualitative or quantitative analysis performed on the air space above a solid or liquid sample in a jar.

Higher High Water - The highest of the high waters of any specified tidal day.

Higher Low Water - The highest of the low waters of any specified tidal day.

Hollow Flight Auger - A drilling method which advances a hole in unconsolidated sediments. Sampling of sediments and installation of monitoring wells can take place through the hollow centre of the auger.

Hydraulic Conductivity - A coefficient of proportionality describing the rate at which water can move through a permeable medium.

Hydraulic Continuity - A connection between two or more geological formations.

Hydraulic Containment - Measures taken to lower the potentiometric surface and/or water table and effect hydraulic capture of the contaminant plume.

Hydraulic Gradient - The change in total head in an aquifer with the change in distance in a given direction.

Hydrocarbon - Organic chemicals such as benzene or tetrachloroethene that contain atoms of carbon and hydrogen.

Hydrogeology - Scientific considerations relating to geological formations, soil, surface water, and especially groundwater.

Hydrophobic Dye Test - A test which involves the introduction of a powder which does not mix with water but has a strong affinity for organic compounds. The powder causes observable staining of soils samples containing DNAPL.

Hydrostratigraphic Unit - A formation, part of a formation, or a group of formations in which there are similar hydrologic characteristics.

Inorganic - A chemical substance that does not contain carbon.

In Situ Pore Fluids - Water occupying the volume between mineral grains in a porous medium.

Intertidal - The intertidal zone is the area that is exposed to the atmosphere at low tide and submerged at high tide.

Intercalations - A layer of different material inserted between layers of similar material.

Isopach - Lines of equal thickness.

Laboratory Control Sample - Samples prepared by the laboratory by spiking an aliquot of appropriate clean matrix reagent with known concentrations of specific analytes. The control sample is then analysed and the results are used to assess the laboratory performance on sample preparation and analysis procedure.

Laboratory Duplicate - These are prepared within the laboratory by dividing a field sample into two samples and analysing separately.

Leachate - Liquid that percolates through soil (or other material) and contains soluble materials derived from soil.

Lithology - The geological (physical) character of a rock or soil.

Lower High Water - The lowest of the high waters of any specified tidal day.

Lower Low Water - The lowest of the low waters of any specified tidal day.

Matrix Spike/Matrix Spike Duplicate - Samples prepared by the laboratory in duplicate by individually spiking two aliquots of a field sample with known concentrations of specific target analytes. The matrix spike and matrix spike duplicate samples were then analysed and subsequently, the results used to assess the effects of the sample matrix on the accuracy and precision of analyses.

Metabolite - A product resulting from the metabolism.

Microgram (ug) - One thousandth part of a milligram (mg) one millionth part of a gram; one billionth part of a kilogram.

Migration - The movement of materials (e.g. water, gas or contaminants in soil) from one location to another.

Mitigation - Reduction or alleviation of a problem. For example, the process of cleaning up a contaminated site in order to return it to an environmentally acceptable state.

Monitoring Well - A well installed to routinely observe groundwater levels or to systematically collect water samples and analyse these for chemical pollution.

Monte Carlo Analysis - A sampling method which randomly selects a value from each input assumption probability distribution. These values are then used to generate an output distribution.

Multilevel Piezometer - See - Bundle Piezometer

NAPL - Non-**A**queous **P**hase **L**iquid - An organic chemical or mixture of organic chemicals that does not readily mix with water.

NH&MRC - National Health and Medical Research Council.

Oil/water Interface Probe - Monitoring instrument used to obtain accurate measurements of product thickness in monitoring wells. Commonly used for LNAPLs and DNAPLs.

Organic Compound - A carbon containing compound.

Palaeochannel - Ancient river or drainage feature which has been infilled by younger sediments.

PCA - Tetrachloroethane (Perchloroethane)

PCE - Tetrachloroethylene (Perchloroethylene)

PDFs - Probability **D**ensity **F**unctions - A distribution of all possible values and their associated probability (likelihood of occurring).

Perched Aquifer - The degree to which a medium such as soil allows another medium such as water to pass through it.

Peristaltic Pump - A pump that can be used for purging and sampling of monitoring wells and bundle piezometers.

Piezometer - A well with a short slotted screen for measuring a potentiometric surface or elevation of the water table.

Piper Trilinear Diagram - A method of graphically plotting the chemical composition of the major anions and cations of a water sample.

Plume - A mass of contaminated water extending outward from the source of the contamination.

Plume Axis - Inferred centre line of a dissolved phase groundwater contamination.

Pore Water - Water occupying the volume between mineral grains in a porous medium.

Porosity - The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

Potentiometric Surface - An imaginary surface representing the total head of groundwater and defined by the level to which water will rise in a well.

Precision - The degree to which a measurement is reproducible.

Pure Phase Solubility - Aqueous solubility of a single organic compound.

Purge (wells) - Pumping out well water to remove drilling debris or impurities; also conducted to bring fresh groundwater up into the casing for sampling collection. The latter is a means of collecting a representative water sample from the aquifer being investigated.

Purge and Trap - A device coupled to a Gas Chromatograph used to analyse volatile compounds.

Push Tubes - Thin walled stainless steel tubes with a cutting edge at the bottom used to collect undisturbed core samples.

Reagent - A substance used in chemistry to detect, measure or produce another substance.

Recharge - Replenishment of an aquifer by a natural process such as addition of water at the ground surface, or by an artificial system such as addition through a well.

Receptor/Receptor Population - An organism, plant or physical structure that receives, may receive or has received environmental exposure to a chemical.

Recovery Test - Hydraulic test performed on a monitoring well which measures the rate at which the water level rises in the well after pumping has ceased.

Remedial Action - Action taken to correct a problem such as fuel contamination of soil and groundwater.

Representative Sample - A sample that is assumed not to be significantly different than the population of samples available. In fuel leak investigation, samples are often selected to be representative of the worst case situation.

Residual Saturation - The term given to DNAPL that is trapped in a pore space by hydrostatic forces. Once the residual saturation has been exceeded it is then termed free phase DNAPL.

Retardation - A general term for the many processes that act to remove the solutes in groundwater which results in the solute front travelling more slowly than the rate of the groundwater flow.

Rinsate Blank - Type of field blank used to check specifically for cross-contamination from reuse of the sampling equipment.

Risk Characterisation - The final component of a risk assessment that involves integration of the chemical and toxicological data for analysis to determine the likelihood that humans may experience an adverse effect from exposure to any of the chemicals being assessed.

Runoff - Overland movement of water, rainfall, a discharge, etc.

Saturated Zone - An underground geologic formation in which the pore spaces or interstitial spaces in the formation are filled with water under pressure equal to or greater than atmospheric pressure.

Screen - Perforation in a well casing and usually located near the bottom of the well or at selected depths to tap perched aquifers.

Semi-volatile Compound - An organic compound which has a low potential to form a vapour at room temperature.

Semiconfined Aquifer - A formation in which the groundwater is partially isolated from the atmosphere by impermeable layers.

Seepage - Pore water that discharges at the ground surface under a driving hydraulic gradient.

Seepage Meter - A device for the collection of seepage and measurement of seepage volume.

Solubility Limits - Maximum concentration at which an organic contaminant will dissolve in the aqueous phase.

Solute Transport Model - A computer-based numerical model which simulates the changes of concentration in the groundwater with time.

Sorption - The attraction and adhesion of a layer of ions from an aqueous solution to the solid surface with which it is in contact.

Specific Yield - The ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil.

SPT - Standard Penetration Test - technique used in cohesive and non-cohesive soils to determine the density or strength of the soils but also as a means of obtaining a relatively undisturbed sample.

Split Spoon Sampler - Sampling tube which is used when conducting an SPT.

Static Headspace - Analytical technique for the measurement of volatile compounds.

Stratigraphy - The study of rock and soil strata, especially their distribution, deposition and age.

Stratigraphic Model - A conceptual model of the relationship of the various stratigraphic layers.

Surrogate Compound - A compound that is introduced into a sample at a known concentration and is used as a system monitoring compound to assess the performance of individual organic analyses.

Surrogate Spike - System monitoring compounds used to assess the performance of the individual analyses. Compounds are spiked into all sample aliquots then undergo normal extraction and analysis procedures. Percent recoveries are calculated for each surrogate, providing an indication of the analytical accuracy.

Target Chemicals (Chemicals of Concern) - Those chemicals which are known or suspected to be present at concentrations which may warrant further investigation or consideration with respect to the potential to be harmful to human health.

TCE - Trichloroethene (Trichloroethylene)

TDS - Total **D**issolved **S**olids - A basic measure of water quality which refers to the amount of solids that remain when a water sample is evaporated to dryness.

Tidal Regression - A relative lowering in the elevation of the tide over a given period.

Tidal Transgression - A relative rise in the elevation of the tide over a given period.

Time Weighted Average (TWA) - The average airborne concentration of a particular substance when calculated over a normal eight hour working day, for a five day working week that is unlikely to cause adverse effects in workers.

Threshold Limit - A chemical concentration above which adverse health or environmental effects may occur.

Trip Blank - Type of field blank used to check if samples have been cross-contaminated with volatile contaminants during handling and transit between the field and laboratory. A trip spike typically comprises a sample of deionised water supplied by the laboratory in a laboratory sample bottle.

TOC - Total **O**rganic **C**arbon.

Topography - The relief and contour of the land surface.

Toxicity - The quality or degree of being poisonous or harmful to plant, animal or human life.

Toxicity Assessment - Consideration of the types of adverse health/environmental effects associated with individual and multiple chemical exposure, the relationship between the magnitude of exposures and adverse effects, and the related uncertainties.

TPH - See Petroleum Hydrocarbons.

Transient Groundwater Flow Model - A computer-based numerical model which simulates the changes in the aquifer heads with time.

Transmissivity - The transmission rate of water (based on a unit width of an aquifer) relative to a hydraulic gradient.

Transpiration - The process by which plants give off water vapour through their leaves.

Unconfined Aquifer - An aquifer whose upper level can extend to ground surface.

Unsaturated Zone - The area between ground surface and the underground water table. Interstitial spaces in this zone contain moisture (water) and air.

uPVC - Unplasticised **P**oly **V**inyl **C**hloride - casing material used for monitoring well construction.

Vapour Pressure - The pressure exerted by a vapour in equilibrium with its liquid or solid phase.

VC - Vinyl Chloride (Chloroethene)

VFAs - Volatile **F**atty **A**cids

VHC - *V*olatile ***H***alogenated ***C***ompound

Viscosity - The property of a fluid describing its resistance to flow.

Volatile Compound - Chemical with sufficiently low vapour pressure to become a gas at room temperature.

VOC Scan - Volatile Organic Compound analytical scan.

Water Level Data Logger - Device for the automatic collection of the water level within a monitoring well.

Water Table - The top of the saturated zone where unconfined groundwater is under atmospheric pressure.

Well Log - A record of installation of a well. It includes construction specifications of the well, depth, owner, location, a description of the soil profile and it is prepared by the well driller, geologist or other appropriately qualified personnel.

Tables

Field_ID					IT1_DEEP	IT1_MID	QC331	QC332	IT1_SHALLOW	IT2_DEEP	IT2_MID	IT2_SHALLOW	MW40	MW45	MW212	MW212	MW56	STILLING WELL(SW)
LocCode					AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT2	AECOM_IT2	AECOM_IT2	AECOM_BH40	AECOM_BH45	MW212	MW212	AECOM_BH56	SW01
WellCode					IT1	IT1	IT1	IT1	IT1	IT2	IT2	IT2	MW40	MW45	MW212	MW212	MW56	SW01
Sampled_Date-Time					24/03/2010	24/03/2010	24/03/2010	24/03/2010	25/03/2010	24/03/2010	24/03/2010	24/03/2010	24/03/2010	19/03/2010	8/05/2008	12/05/2008	17/03/2010	24/03/2010
Area					Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Proposed Southern Cove	VMP & PDA - Proposed Southern Cove	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Proposed Southern Cove
Chem_Group	**ChemName**	**Units**	**EQL**	**ANZECC (2000) Ecosystems Marine Water (95%)**														
	Bicarbonate as CaCO3	mg/L	1		209	105	104	-	153	198	57	289	556	44	-	-	-	94
	N-Nitrosodiphenyl & Diphenylamine	µg/L	1		<20	<2	<2	-	<2	<2	<2	<2	<2	<4	-	-	<2	<2
	Pronamide	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
Amino Aliphatics	N-nitrosodiethylamine	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	N-nitrosodi-n-butylamine	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	N-nitrosodi-n-propylamine	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	N-Nitrosomethylethylamine	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
Amino Aromatics	1-naphthylamine	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	2-naphthylamine	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Diphenylamine	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Anilines	2-nitroaniline	µg/L	1		<10	<1	<1	<4	<1	<1	<1	<1	<1	<4	-	-	<1	<1
	3-nitroaniline	µg/L	1		<10	<1	<1	<4	<1	<1	<1	<1	<1	<4	-	-	<1	<1
	4-chloroaniline	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	4-nitroaniline	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	2-methyl-5-nitroaniline	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Aniline	µg/L	0.5		<10	<1	<1	<2	<0.9	4	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	2-methylaniline	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
BTEX	Benzene	µg/L	1	**700**	113	<1	<1	<5	<1	265	3	2	52	<1	<1	-	378	<1
	Ethylbenzene	µg/L	2		4	<2	<2	<5	<2	7	<2	<2	2	<2	<2	-	20	<2
	Toluene	µg/L	2		22	<5	<5	<5	<5	65	<5	20	46	<5	<5	-	473	<5
	Xylene (m & p)	µg/L	2		22	<2	<2	<10	<2	32	<2	<2	26	<2	<2	-	189	<2
	Xylene (o)	µg/L	2		10	<2	<2	<5	<2	18	<2	<2	12	<2	<2	-	66	<2
	Xylene Total	µg/L			32	<4	<4	<15	<4	50	<4	<4	38	<4	<4	-	255	<4
Chlorinated Hydrocarbons	1,1,1,2-tetrachloroethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,1,1-trichloroethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,1,2,2-tetrachloroethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,1,2-trichloroethane	µg/L	5	**1900**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,1-dichloroethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,1-dichloroethene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,1-dichloropropene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,2,3-trichloropropane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,2-dibromo-3-chloropropane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,2-dichloroethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,2-dichloropropane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,3-dichloropropane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	2,2-dichloropropane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Bromodichloromethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Bromoform	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Carbon tetrachloride	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Chlorodibromomethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Chloroethane	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	Chloroform	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	cis-1,2-dichloroethene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	cis-1,3-dichloropropene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Dibromomethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Hexachlorobutadiene	µg/L	0.5		<5	<1	<2	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Hexachlorocyclopentadiene	µg/L	0.5		<10	<1	<1	<4	<0.9	<1	<1	<1	<0.9	<10	-	-	<0.9	<0.9
	Hexachloroethane	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Trichloroethene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Tetrachloroethene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	trans-1,2-dichloroethene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	trans-1,3-dichloropropene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Vinyl chloride	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50
Explosives	1,3,5-Trinitrobenzene	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	2,4-Dinitrotoluene	µg/L	1		<10	<1	<1	<4	<1	<1	<1	<1	<1	<4	-	-	<1	<1
	2,6-dinitrotoluene	µg/L	1		<10	<1	<1	<4	<1	<1	<1	<1	<1	<4	-	-	<1	<1
	Nitrobenzene	µg/l	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
Field	Alkalinity (total)	mg/L	5		-	-	-	380	-	-	-	-	-	-	-	-	-	-
Halogenated Benzenes	1,2,3-trichlorobenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	1,2,4,5-tetrachlorobenzene	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	1,2,4-trichlorobenzene	µg/L	0.5	**80**	<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	1,2-dichlorobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	1,3-dichlorobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	1,4-dichlorobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	2-chlorotoluene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	4-chlorotoluene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Bromobenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Chlorobenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Hexachlorobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<4	-	-	<0.9	<0.9
	Pentachlorobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
Halogenated Hydrocarbons	1,2-dibromoethane	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Iodomethane	µg/L	5		<5	<5	<5	<5	-	<5	<5	<5	<5	<5	-	-	<5	<5
	Trichlorofluoromethane	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50
Halogenated Phenols	2,3,4,6-tetrachlorophenol	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	2,4,5-trichlorophenol	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.6	<0.9
	2,4,6-trichlorophenol	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.6	<0.9
	2,4-dichlorophenol	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.6	<0.9
	2,6-dichlorophenol	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.6	<0.9
	2-chlorophenol	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.6	<0.9
	Pentachlorophenol	µg/L	0.6	**22**	<20	<2	<2	<4	<2	<2	<2	<2	<2	<4	<2	-	<1	<2
Inorganics	Weak Acid Dissociable Cyanide	µg/L	4		61	85	85	-	7	<4	<4	<4	-	<4	-	-	<4	<4
	Alkalinity (Hydroxide) as CaCO3	µg/L	1000		<1000	<1000	<1000	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-	-	<1000
	Alkalinity (total) as CaCO3	µg/L	1000		209000	105000	104000	-	153000	198000	57000	289000	556000	44000	118000	-	-	94000
	Ammonia as N	µg/L	10		1380	<100	<100	-	<100	5990	9260	<100	9700	<100	-	-	-	<100
	Anions Total	meq/L	0.01		498	614	603	-	647	303	620	589	434	524	691	-	-	728
	Carbonate	µg/L	1000		<1000	<1000	<1000	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-	-	<1000
	Cations Total	meq/L	0.01		533	667	650	-	642	328	575	632	456	556	644	-	-	691
	Chloride	µg/L	500		16300000	20000000	19500000	-	21100000	10100000	21200000	19100000	14500000	17000000	19600000	-	-	23400000
	Cyanide (Free)	µg/L	4		53	37	45	-	<4	<4	<4	<4	<4	<4	<4	-	<4	<4
	Fluoride	µg/L	20		740	1170	1030	-	1320	<20	<20	900	400	-	-	-	1490	
	Ionic Balance	%	0.01		3.35	4.07	3.77	-	0.4	3.96	3.78	3.54	2.4	3.03	3.58	-	-	2.59
	Nitrate (as N)	µg/L	10		-	-	-	-	-	-	-	-	<10	30	-	-	-	
	Nitrite (as N)	µg/L	10		-	-	-	-	-	-	-	-	<10	<10	-	-	-	
	Nitrogen (Total Oxidised)	µg/L	10		-	-	-	-	-	-	-	-	<10	30	-	-	-	
	pH (Lab)	pH_Units	0.01		-	-	-	-	-	-	-	-	-	6.25	-	-	5.06	
	Reactive Phosphorus as P	µg/L	10		-	-	-	-	-	-	-	-	<10	-	-	-	-	
	Sodium (Filtered)	µg/L	1000		9420000	12000000	11700000	-	11600000	6070000	10900000	11400000	7860000	9850000	11500000	-	-	12500000
	Sulphate	µg/L	500		1620000	2360000	2430000	-	2370000	607000	1010000	2180000	687000	2100000	6540000	-	-	3160000
	Sulphur as S	µg/L	1000		603000	853000	901000	-	822000	231000	260000	763000	-	588000	-	-	-	880000
	TDS	mg/L	1		29600	38200	-	-	35700	23400	36700	32600	-	-	-	-	-	40200
	TOC	mg/L	1		96	150	130	80	8	30	60	180	8	3	-	-	9	<1
Lead	Lead (Filtered)	µg/L	0.2	**4.4**	1.1	0.4	1	<1	**12.2**	0.4	0.3	1.6	0.2	0.2	1.5	-	20	0.4
MAH	1,2,4-trimethylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	9	<5	-	-	27	<5
	1,3,5-trimethylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	11	<5
	Isopropylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	n-butylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	n-propylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	p-isopropyltoluene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	sec-butylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Styrene	µg/L	5		<5	<5	<5	<5	<5	10	<5	<5	8	<5	-	-	54	<5
	tert-butylbenzene	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5

Field_ID	IT1_DEEP	IT1_MID	QC331	QC332	IT1_SHALLOW	IT2_DEEP	IT2_MID	IT2_SHALLOW	MW40	MW45	MW212	MW212	MW56	STILLING WELL(SW)
LocCode	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT2	AECOM_IT2	AECOM_IT2	AECOM_BH40	AECOM_BH45	MW212	MW212	AECOM_BH56	SW01
WellCode	IT1	IT1	IT1	IT1	IT1	IT2	IT2	IT2	MW40	MW45	MW212	MW212	MW56	SW01
Sampled_Date-Time	24/03/2010	24/03/2010	24/03/2010	24/03/2010	25/03/2010	24/03/2010	24/03/2010	24/03/2010	20/03/2010	19/03/2010	8/05/2008	12/05/2008	17/03/2010	24/03/2010
Area	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Proposed Southern Cove	VMP & PDA - Proposed Southern Cove	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Proposed Southern Cove

Chem_Group	ChemName	Units	EQL	ANZECC (2000) Ecosystems Marine Water (95%)														
Metals	Arsenic (Filtered)	µg/L	0.5		1.8	2.7	2.5	<20	0.9	0.6	2	2.1	5.2	1.1	1.2	-	2.5	2.1
	Barium (Filtered)	µg/L	1		128	91	91	103	50	259	767	185	468	62	-	-	464	8
	Beryllium (Filtered)	µg/L	0.1		0.3	<0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	-	-	1.3	<0.1
	Cadmium (Filtered)	µg/L	0.1	5.5	0.4	<0.2	<0.2	0.4	1.3	<0.2	<0.2	<0.2	0.4	11.5	0.2	-	1.7	<0.2
	Calcium (Filtered)	µg/L	1000		662000	675000	644000	-	462000	604000	1410000	713000	540000	588000	418000	-	-	440000
	Chromium (hexavalent)	µg/L	2		<2	<2	<2	-	<2	<2	4	<2	16	<2	-	-	<2	<2
	Chromium (III+VI) (Filtered)	µg/L	0.5	4.4	<0.5	102	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5
	Cobalt (Filtered)	µg/L	0.2	1	51.9	1.6	0.7	3	0.3	18.6	0.5	3.7	1.9	8	-	-	34.2	<0.2
	Copper (Filtered)	µg/L	1	1.3	<1	19	<1	<10	1	<1	<1	<1	4	<1	<1	-	17	4
	Iron (Filtered)	µg/L	50		83500	<500	<500	-	530	4780	<500	<500	14100	187000	-	-	-	<500
	Magnesium (Filtered)	µg/L	1000		1020000	1210000	1170000	-	1250000	344000	265000	1090000	995000	1120000	1340000	-	-	1400000
	Manganese (Filtered)	µg/L	0.5		4340	418	414	356	25.6	466	1090	1090	437	4890	-	-	714	2.6
	Mercury (Filtered)	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	-	0.1	<0.1
	Nickel (Filtered)	µg/L	0.5	70	70	45.9	2.1	5	3.6	5.6	1.8	10.5	19.5	36	<0.5	-	78.1	<0.5
	Potassium (Filtered)	µg/L	1000		252000	446000	438000	-	444000	214000	353000	417000	195000	259000	477000	-	-	473000
	Vanadium (Filtered)	µg/L	0.5	100	<0.5	<0.5	<0.5	<1	1.8	2.3	1.8	1.7	<0.5	1.7	<0.5	-	0.7	1
	Zinc (Filtered)	µg/L	1	15	127	23	6	≤20	35	15	7	17	21	14	16	-	191	13
Nitroaromatics	1,4-dinitrobenzene	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Organochlorine Pesticides	4,4-DDE	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	a-BHC	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Aldrin	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Aldrin + Dieldrin	µg/L			<20	<2	<2	<4	<1.8	<2	<2	<2	<1.8	<4	-	-	<1.2	<1.8
	b-BHC	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Chlordane (cis)	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Chlordane (trans)	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	d-BHC	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	DDD	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	DDT	µg/L	0.6		<10	<1	<1	<4	<0.9	<1	<1	<1	<0.9	<4	-	-	<0.9	<0.9
	DDT+DDE+DDD	µg/L			<30	<3	<3	<8	<2.7	<3	<3	<3	<2.7	<8	-	-	<2.1	<2.7
	Dieldrin	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Endosulfan I	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Endosulfan II	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Endosulfan sulphate	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Endrin	µg/L	0.3	0.008	<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Endrin aldehyde	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Endrin ketone	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	g-BHC (Lindane)	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Heptachlor	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Heptachlor epoxide	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Methoxychlor	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Organophosphorous Pesticides	Azinophos methyl	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Chlorfenvinphos	µg/L	0.3		<11	<1	<1	-	<1	<1	<1	<1	<1	<2	-	-	<0.6	<1
	Chlorpyrifos	µg/L	0.3	0.009	<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Chlorpyrifos-methyl	µg/L	0.3		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Coumaphos	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Demeton-O	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Demeton-S	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Diazinon	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Dichlorvos	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Dimethoate	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Disulfoton	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Ethion	µg/L	0.3		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Ethoprop	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Ethyl methanesulfonate	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Fenitrothion	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Fensulfothion	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Fenthion	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Malathion	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Methyl methanesulfonate	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Methyl parathion	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Mevinphos (Phosdrin)	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Naled (Dibrom)	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Phorate	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Prothiofos	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Ronnel	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Safrole	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Stirophos	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Trichloronate	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
PAH	7,12-dimethylbenz(a)anthracene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	<0.1	<0.9	<0.9
PAH/Phenols	2,4-dimethylphenol	µg/L	0.5		177	<1	1	<2	<0.9	195	10	2	69	<2	<1	-	<0.9	<0.9
	2-chloronaphthalene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	2-methylnaphthalene	µg/L	0.5		<10	4	4	2	<0.9	4	7	<1	36	<2	-	<0.1	<0.9	<0.9
	2-methylphenol	µg/L	0.5		17	<1	<1	<2	<0.9	31	5	1	15	<2	<1	-	<0.9	<0.9
	2-nitrophenol	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.9	<0.9
	3-&4-methylphenol	µg/L	0.5		<20	<2	<2	<4	<2	35	9	20	20	<4	<2	-	<2	<2
	3-methylcholanthrene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	<0.1	<0.9	<0.9
	4-chloro-3-methylphenol	µg/L	0.3		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	-	<0.6	<0.9
	Acenaphthene	µg/L	0.5		<10	6	6	6	<0.9	1	6	1	4	<2	<1	<0.1	<0.9	<0.9
	Acenaphthylene	µg/L	0.5		12	10	11	11	<0.9	2	2	<1	16	<2	<1	<0.1	<0.9	<0.9
	Anthracene	µg/L	0.5		10	6	6	3	<0.9	<1	2	<1	3	<2	<1	<0.1	<0.9	<0.9
	Benz(a)anthracene	µg/L	0.5		21	7	8	<2	<0.9	<1	<1	<1	<0.9	<2	<1	<0.1	<0.9	<0.9
	Benzo(a) pyrene	µg/L	0.3		17	7	6	<2	<0.9	<1	<1	<1	<0.9	<2	<0.5	<0.05	<0.6	<0.9
	Benzo(b)&(k)fluoranthene	µg/L	1		39	12	12	<4	<2	<2	<2	<2	<2	<4	-	-	<2	<2
	Benzo(g,h,i)perylene	µg/L	0.5		10	3	3	<2	<0.9	<1	<1	<1	<0.9	<2	<1	<0.1	<0.9	<0.9
	Chrysene	µg/L	0.5		21	7	8	<2	<0.9	<1	<1	<1	<0.9	<2	<1	<0.1	<0.9	<0.9
	Dibenz(a,h)anthracene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	<1	<0.1	<0.9	<0.9
	Fluoranthene	µg/L	0.5		33	13	15	5	<0.9	<1	2	1	2	<2	<1	<0.1	<0.9	<0.9
	Fluorene	µg/L	0.5		10	11	12	9	<0.9	1	5	<1	12	<2	<1	<0.1	<0.9	<0.9
	Indeno(1,2,3-c,d)pyrene	µg/L	0.5		<10	<1	2	<2	<0.9	<1	<1	<1	<0.9	<2	<1	<0.1	<0.9	<0.9
	Naphthalene	µg/L	0.5	70	153	16	17	<2 - 10	<0.9	159	41	<1	244	8	<1	<0.1	<0.9	<0.9
	PAHs (Sum of total)	µg/L	0.5		369 - 393	122.5 - 134	131.5 - 143	66	<0.9	165 - 169.5	70 - 73	2 - 8	297 - 299.7	8 - 21	<15.5	<1.55	<0.9	<0.9
	Phenanthrene	µg/L	0.5		29	20	22	12	<0.9	2	10	<1	14	<2	<1	<0.1	<0.9	<0.9
	Phenol	µg/L	0.5	400	<10	<1	<1	<2	<0.9	7	2	<1	2	<2	<1	-	<0.9	<0.9
	Pyrene	µg/L	0.5		38	14	15	4	<0.9	<1	2	<1	2	<2	<1	<0.1	<0.9	<0.9
Pesticides	Chlorobenzilate	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Parathion	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Pirimphos-ethyl	µg/L	0.3		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.6	<0.9
	Profenofos	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Sulfotepp	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Phthalates	Bis(2-ethylhexyl) phthalate	µg/L	20		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	-	<20	<20
	Butyl benzyl phthalate	µg/L	2		<10	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	<2	<2
	Diethylphthalate	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Dimethyl phthalate	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Di-n-butyl phthalate	µg/L	2		<10	2	3	<2	<2	4	5	5	<2	<2	-	-	<2	3
	Di-n-octyl phthalate	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
Solvents	Methyl Ethyl Ketone	µg/L	5		<50	<50	<50	<5	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	2-hexanone (MBK)	µg/L	5		<50	<50	<50	<5	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	2-pentanone	µg/L	5		-	-	-	<5	-	-	-	-	-	-	-	-	-	-
	4-Methyl-2-pentanone	µg/L	5		<50	<50	<50	<5	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	Ethyl acetate	µg/L	5		-	-	-	<5	-	-	-	-	-	-	-	-	-	-
	Isophorone	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Methyl Tertiary Butyl Ether	mg/L	0.005		-	-	-	<0.005	-	-	-	-	-	-	-	-	-	-
	Vinyl acetate	µg/L	5		<50	<50	<50	<5	<50	<50	<50	<50	<50	<50	-	-	<50	<50
SVOC	2-(acetylamino) fluorene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	<0.1	<0.9	<0.9
	2-Picoline	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	3,3-Dichlorobenzidine	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	4-(dimethylamino) azobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	4-aminobiphenyl	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	4-bromophenyl phenyl ether	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	4-chlorophenyl phenyl ether	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	4-Nitroquinoline-N-oxide	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Acetophenone	µg/L	0.5		<10	<1	<1	2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Azobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Benzyl alcohol	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Bis(2-chloroethoxy) methane	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Bis(2-chloroethyl)ether	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Bis(2-chloroisopropyl) ether	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Carbazole	µg/L	0.5		10	7	7	7	<0.9	16	11	<1	17	<2	-	-	<0.9	<0.9
	Dibenzofuran	µg/L	0.5		<10	6	7	6	<0.9	1	4	<1	9	<2	-	-	<0.9	<0.9
	EPN	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Hexachloropropene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Isosafrole	µg/L	2		-	-	-	<2	-	-	-	-	-	-	-	-	-	-
	Methapyrilene	µg/L	0.5		<10	<1	<1	-	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	N-nitrosomorpholine	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	N-nitrosopiperidine	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	N-nitrosopyrrolidine	µg/L	1		<10	<1	<1	<4	<1	<1	<1	<1	<1	<4	-	-	<1	<1

Field_ID	IT1_DEEP	IT1_MID	QC331	QC332	IT1_SHALLOW	IT2_DEEP	IT2_MID	IT2_SHALLOW	MW40	MW45	MW212	MW212	MW56	STILLING WELL(SW)
LocCode	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT1	AECOM_IT2	AECOM_IT2	AECOM_IT2	AECOM_BH40	AECOM_BH45	MW212	MW212	AECOM_BH56	SW01
WellCode	IT1	IT1	IT1	IT1	IT1	IT2	IT2	IT2	MW40	MW45	MW212	MW212	MW56	SW01
Sampled_Date-Time	24/03/2010	24/03/2010	24/03/2010	24/03/2010	25/03/2010	24/03/2010	24/03/2010	24/03/2010	20/03/2010	19/03/2010	8/05/2008	12/05/2008	17/03/2010	24/03/2010
Area	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Proposed Southern Cove	VMP & PDA - Proposed Southern Cove	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Public Domain Blocks 4&5	Proposed Southern Cove

Chem_Group	ChemName	Units	EQL	ANZECC (2000) Ecosystems Marine Water (95%)														
	Pentachloronitrobenzene	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
	Phenacetin	µg/L	0.5		<10	<1	<1	<2	<0.9	<1	<1	<1	<0.9	<2	-	-	<0.9	<0.9
TPH	TPH C6 - C9	µg/L	20		210	<20	<20	<50	<20	350	30	40	-	<20	<20	-	1460	<20
	TPH C10 - C14	µg/L	50		1350	100	140	70	<50	1860	210	<50	-	<50	<50	-	440	<50
	TPH C15 - C28	µg/L	100		3050	900	950	<200	<100	2790	3580	240	-	<100	<100	-	920	<100
	TPH C29-C36	µg/L	50		950	450	340	50	<50	200	320	90	-	<50	<50	-	<50	<50
	TPH+C10 - C36 (Sum of total)	µg/L	50		5350	1450	1430	120 - 220	<50	4850	4110	330 - 355	-	<50	<200	-	1360 - 1385	<50
VOC	Bromomethane	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	Carbon disulfide	µg/L	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Chloromethane	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	cis-1,4-Dichloro-2-butene	µg/L	5		<5	<5	<5	-	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	Dichlorodifluoromethane	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	<50	<50
	Pentachloroethane	µg/L	2		<5	<5	<5	<2	<5	<5	<5	<5	<5	<5	-	-	<5	<5
	trans-1,4-Dichloro-2-butene	µg/L	5		<5	<5	<5	-	<5	<5	<5	<5	<5	<5	-	-	<5	<5

Figures

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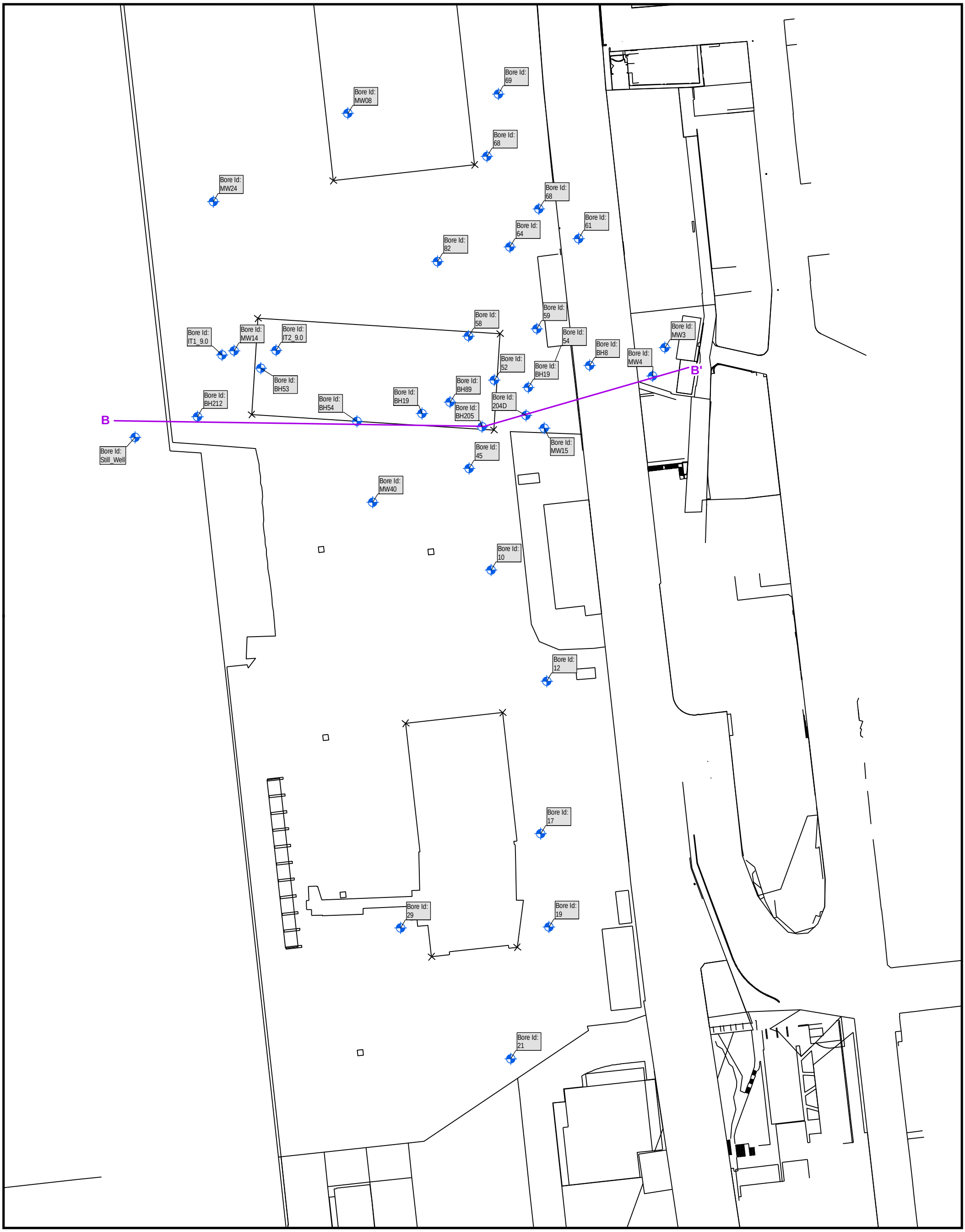

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N

0 18.5 37.5 56 75

metres

Legend

- Borehole
- BoreID: 21 Borehole ID
- B—B' Cross Section Alignment

SELECTED BORE AND CROSS SECTION B-B' PLAN

Lend Lease (Millers Point) Pty Ltd

Barangaroo Groundwater Discharge Study

Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	ART 03 Aug 2010

Figure

F1

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF1_BoreLoc_03Aug10.mxd

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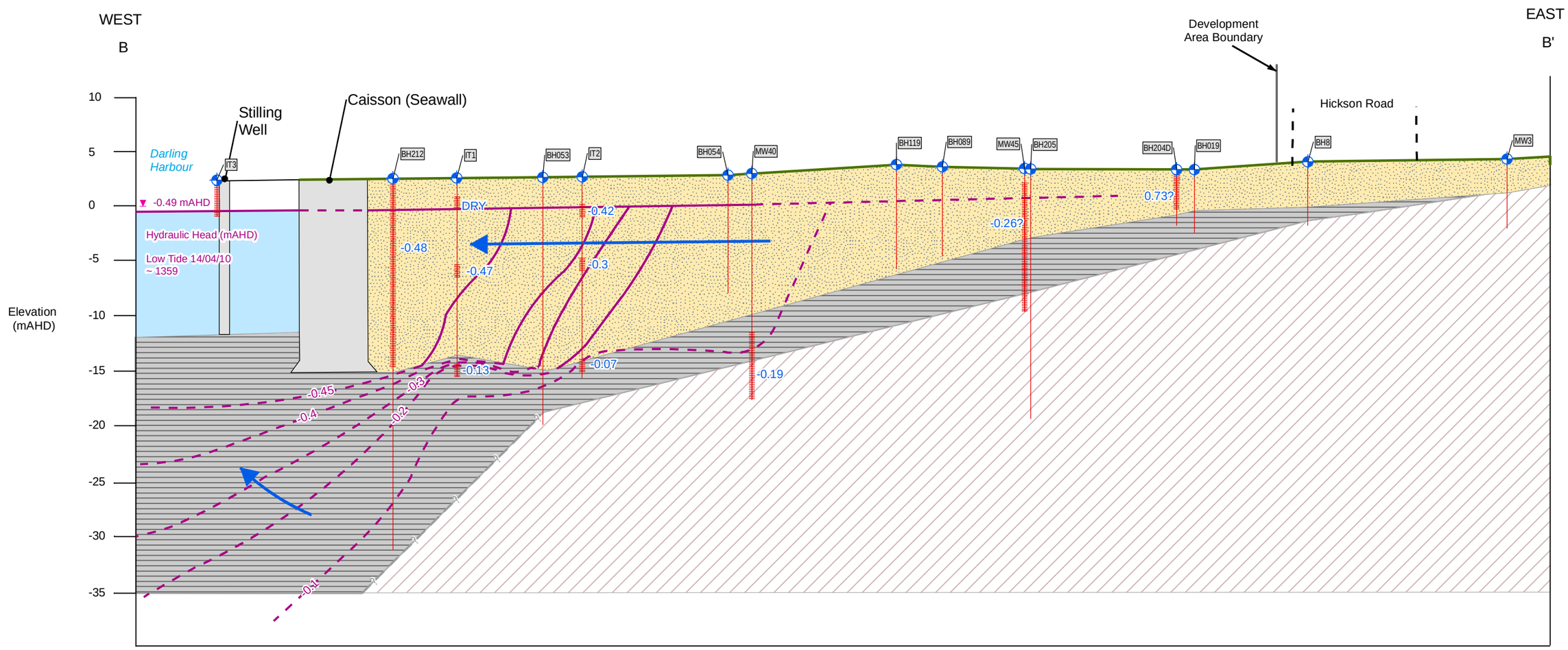

AECOM

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0 25

metres

Horizontal Exagerration

LEGEND

- Monitoring Well
- Borehole
- Screened Interval
- Ground Surface
- Inferred Geological Boundary
- Fill
- Hawkesbury Sandstone
- Marine Sediments
- Temporary Groundwater Divide
- Hydraulic Head Contours (mAHD)
- Inferred Hydraulic Head Contours (mAHD)
- Inferred Groundwater Flow Direction

HYDRAULIC HEAD DISTRIBUTION - LOW TIDE

Lend Lease (Millers Point) Pty Ltd

Barangaroo Groundwater Discharge Study

Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	ART 03 Aug 2010

Figure

F2

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF2_Transect_BB_GWContours_LowTide_03Aug10.mxd

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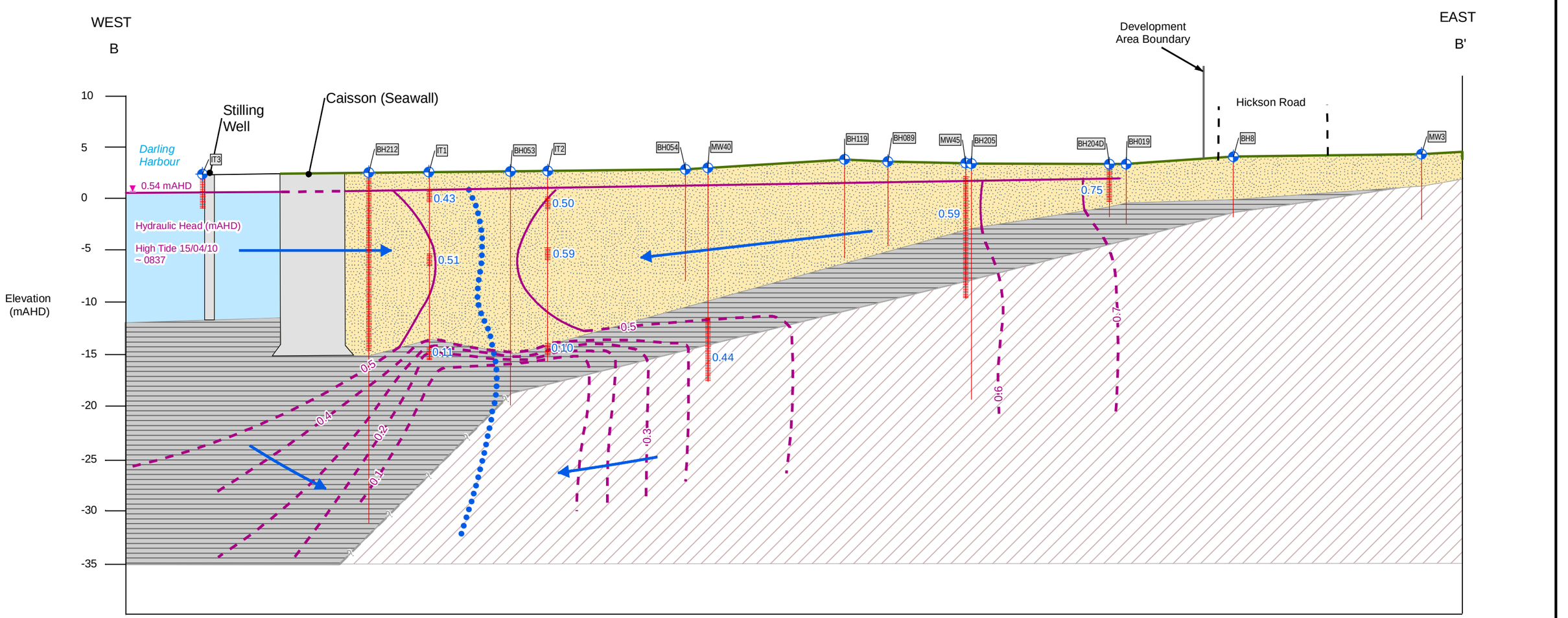

AECOM
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0 25
metres
Horizontal Exagerration

LEGEND

- Monitoring Well
- Borehole
- Screened Interval
- Ground Surface
- Inferred Geological Boundary
- Fill
- Hawkesbury Sandstone
- Marine Sediments
- Temporary Groundwater Divide
- Hydraulic Head Contours (mAHD)
- Inferred Hydraulic Head Contours (mAHD)
- Inferred Groundwater Flow Direction

HYDRAULIC HEAD DISTRIBUTION - HIGH TIDE

Lend Lease (Millers Point) Pty Ltd
Barangaroo Groundwater Discharge Study
Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	ART 03 Aug 2010

Figure
F3

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF3_Transect_BB_GWContours_HighTide_03Aug10.mxd

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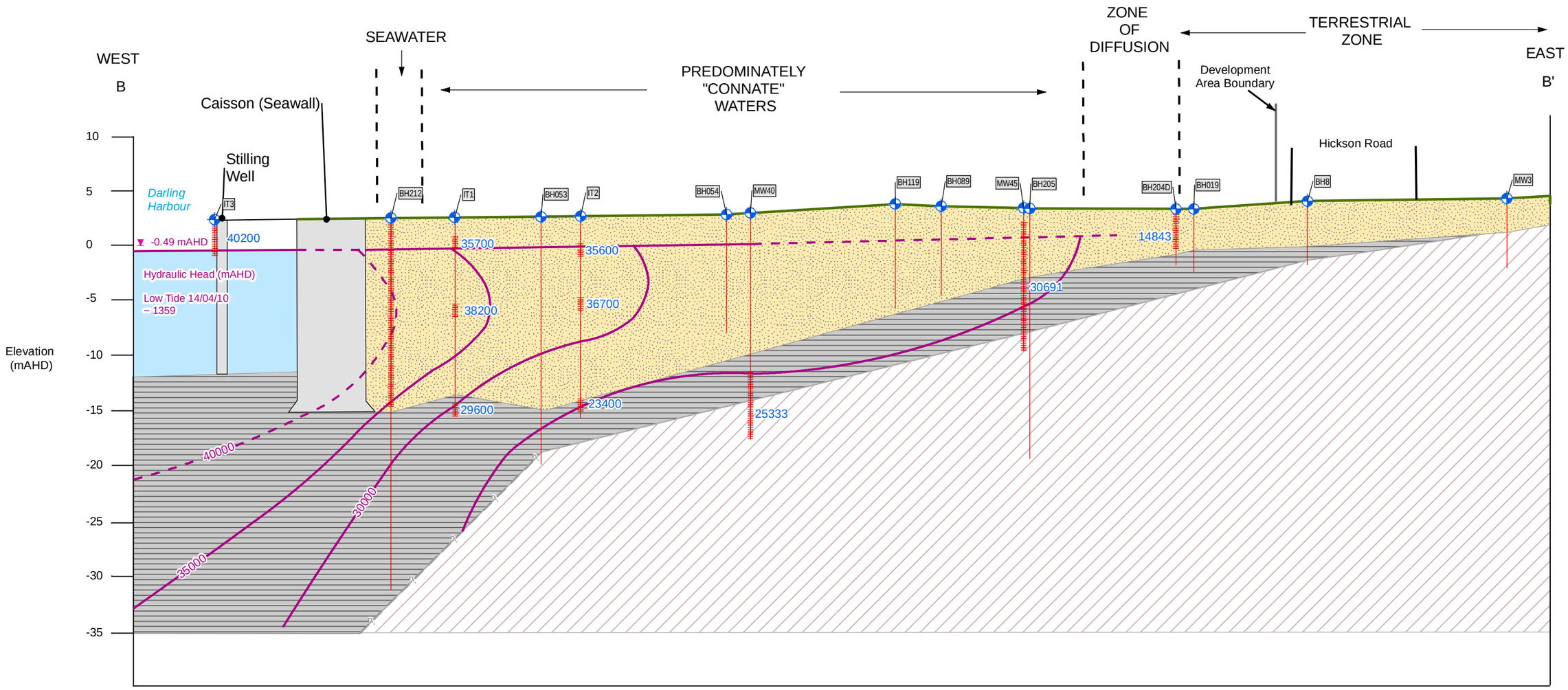

AECOM

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0 25

metres

Horizontal Exagerration

LEGEND

- Monitoring Well
- Borehole
- Screened Interval
- Ground Surface
- Inferred Geological Boundary
- Fill
- Hawkesbury Sandstone
- Marine Sediments
- Temporary Groundwater Divide
- TDS Contours (mg/L)
- Inferred TDS Contours (mg/L)

TDS DISTRIBUTION (mg/L) - LOW TIDE

Lend Lease (Millers Point) Pty Ltd

Barangaroo Groundwater Discharge Study

Hickson Road, Millers Point, NSW

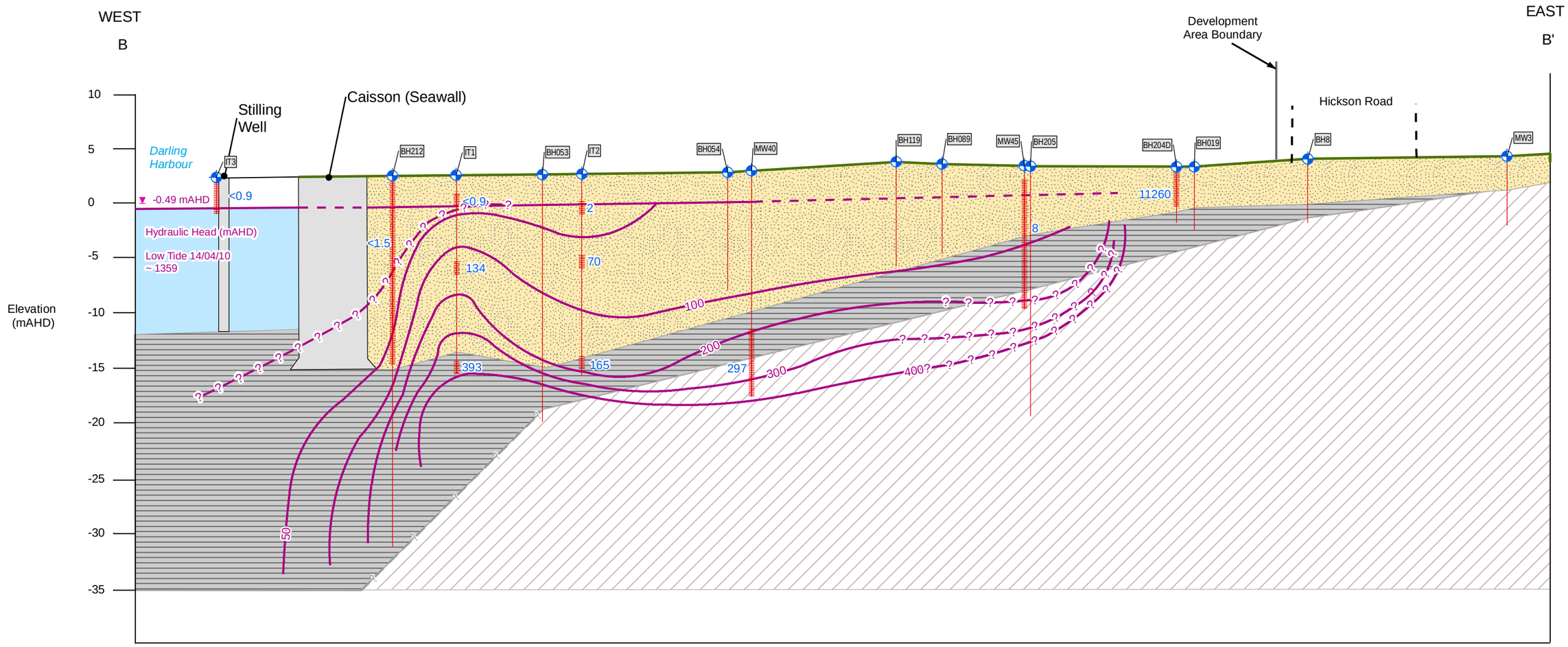
PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	ART 03 Aug 2010

Figure

F4

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF4_Transect_BB_TDS_Contours_LowTide_03Aug10.mxd

A3 size



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0 25

metres

Horizontal Exagerration

LEGEND

- Monitoring Well
- Borehole
- Screened Interval
- Ground Surface
- Inferred Geological Boundary
- Fill
- Hawkesbury Sandstone
- Marine Sediments
- Temporary Groundwater Divide
- Total PAH Contours (µg/L)
- Inferred Total PAH Contours (µg/L)

TOTAL PAHs DISTRIBUTION (µg/L) - LOW TIDE

Lend Lease (Millers Point) Pty Ltd

Barangaroo Groundwater Discharge Study

Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	DJB 03 May 2010

Figure

F5

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF5_Transect_BB_PAHs_Contours_LowTide_03Aug10.mxd

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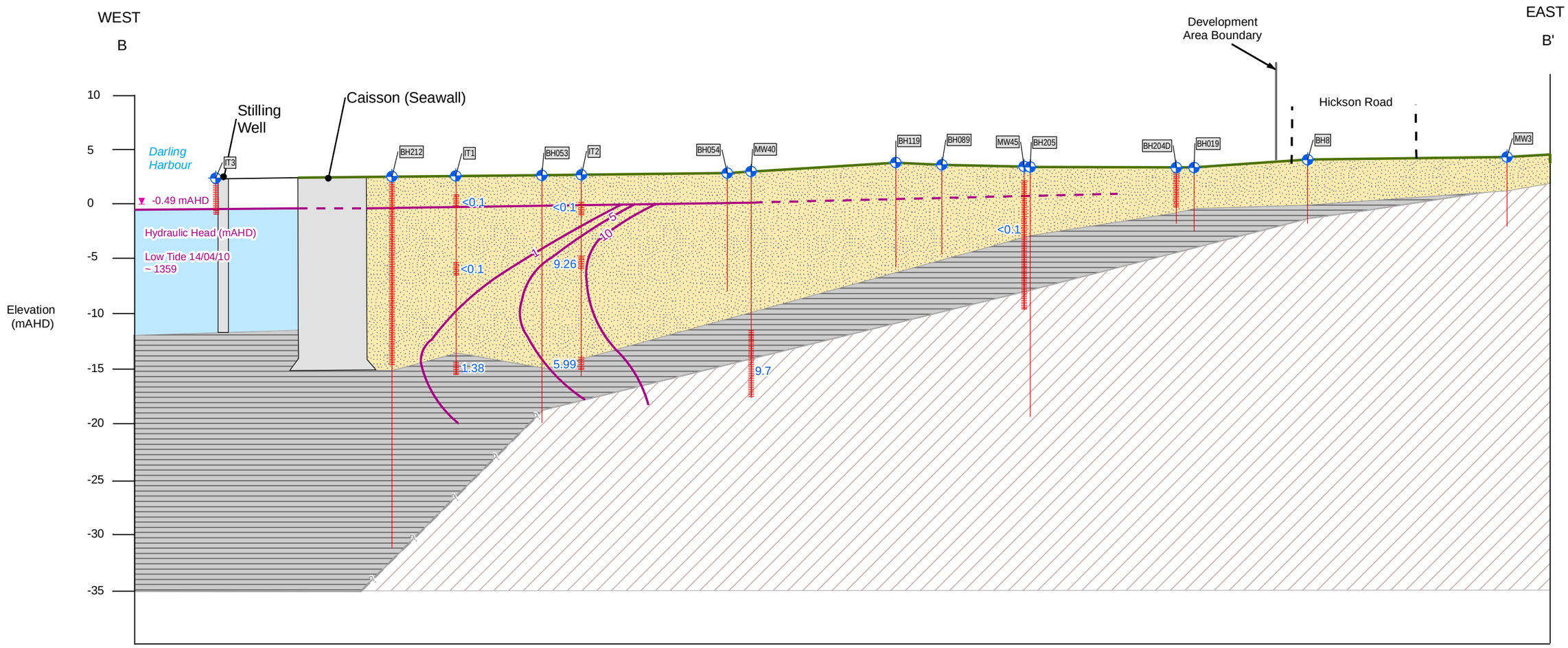

AECOM
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0 25
metres
Horizontal Exagerration

LEGEND

- Monitoring Well
- Borehole
- Screened Interval
- Ground Surface
- Inferred Geological Boundary
- Fill
- Hawkesbury Sandstone
- Marine Sediments
- Temporary Groundwater Divide
- Ammonia Contours (mg/L)

TOTAL AMMONIA DISTRIBUTION (mg/L) - LOW TIDE

Lend Lease (Millers Point) Pty Ltd
Barangaroo Groundwater Discharge Study
Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	ART 03 Aug 2010

Figure
F6

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF6_Transect_BB_Ammonia_Contours_LowTide_03Aug10.mxd

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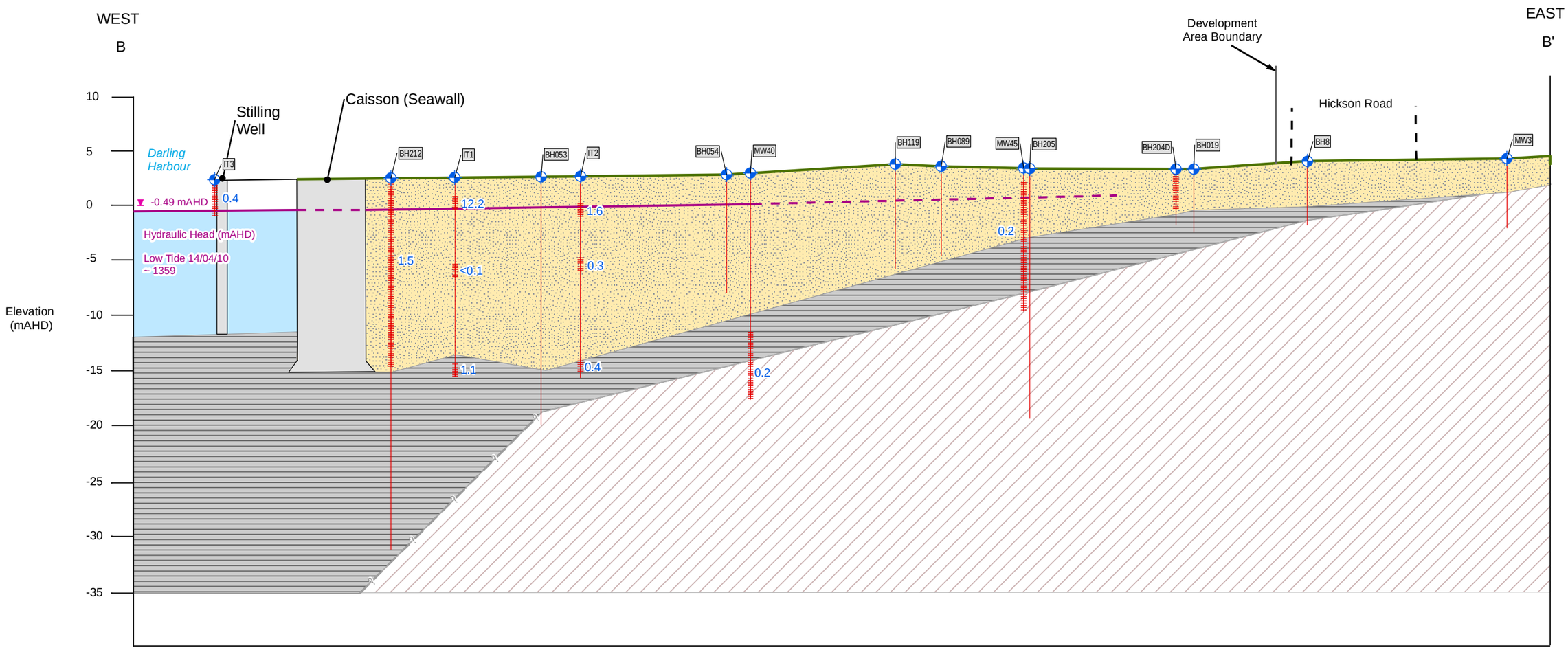

AECOM

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0 25

metres

Horizontal Exagerration

LEGEND

- Monitoring Well
- Borehole
- Screened Interval
- Ground Surface
- Inferred Geological Boundary
- Fill
- Hawkesbury Sandstone
- Marine Sediments
- Temporary Groundwater Divide
- Lead Contours (mg/L)

TOTAL LEAD DISTRIBUTION (mg/L) - LOW TIDE

Lend Lease (Millers Point) Pty Ltd

Barangaroo Groundwater Discharge Study

Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	DJB 03 May 2010

Figure

F7

Map Document: (G:\GISMEL\60153531\01\ArcGIS\60153531_FigFX_Transect_BB_Lead_Contours_LowTide_29Apr10.mxd)

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Barangaroo Development Area

Proportion Seawater Infiltrated On Previous Rising Tides (Schematic)

Proportion Groundwater Discharge (Schematic)

Hickson Road

Caisson (Seawall)

Δs

Darling Harbour

High Tide

Low Tide

Fill

High Tide

Low Tide

Start

Finish

Δs'

Tidal Exchange Prism

Δs = Δs'

Net Particle Migration Conceptual Diagram

Net Migration (net discharge) ~ 10%

HIGH TIDE

LOW TIDE

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LEGEND

Idealised Water Table Elevation

Tidal Exchange Prism

Δs Change in Aquifer Storage

Note:
Volume calculations do not account for phase shift in hydrograph responses and are therefore considered to be conservative

TIDAL EXCHANGE PRISM - SIMPLIFIED CONCEPTUAL DIAGRAM

Lend Lease (Millers Point) Pty Ltd
Barangaroo Groundwater Discharge Study
Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	DJB 03 May 2010

Figure
F8

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BoreID: 69
Seawater: 15
Chloride: 9520

BoreID: MW08
Seawater: 25
Chloride: 11100

BoreID: 68
Seawater: 39
Chloride: 13400

BoreID: MW24
Seawater: 76
Chloride: 19500

BoreID: MW198
Seawater: 0
Chloride: 2030

BoreID: 64
Seawater: 5
Chloride: 7760

BoreID: 61
Seawater: 0
Chloride: 25.2

BoreID: 62
Seawater: 41
Chloride: 13700

BoreID: 58
Seawater: 48
Chloride: 14900

BoreID: 59
Seawater: 0
Chloride: 2090

BoreID: IT1_9.0
Seawater: 79
Chloride: 20000

BoreID: MW14
Seawater: 70
Chloride: 20200

BoreID: 54
Seawater: 0
Chloride: 36.5

BoreID: IT2_9.0
Seawater: 87
Chloride: 21200

BoreID: BH212
Seawater: 77
Chloride: 19600

BoreID: 52
Seawater: 67
Chloride: 17900

BoreID: 204D
Seawater: 0
Chloride: 6670

BoreID: Still_Well
Seawater: 100
Chloride: 23400

BoreID: 45
Seawater: 61
Chloride: 17000

BoreID: MW15
Seawater: 0
Chloride: 519

40
20
0
80
100
60

BoreID: 10
Seawater: 77
Chloride: 19600

BoreID: 12
Seawater: 67
Chloride: 17900

BoreID: 17
Seawater: 56
Chloride: 16200

BoreID: 26
Seawater: 73
Chloride: 18900

BoreID: 19
Seawater: 62
Chloride: 17100

BoreID: 21
Seawater: 42
Chloride: 13900

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N

0 18.5 37.5 56 75
metres

Legend

Borehole

% of Seawater

BoreID: 21
Saltwater: 42
Chloride: 1390

Borehole ID
% of Seawater
Chloride Concentration (mg/L)

ESTIMATED % SEAWATER BASED ON BACKGROUND GROUNDWATER Cl- OF ~ 7000 mg/L IN FILL

Lend Lease (Millers Point) Pty Ltd

Barangaroo Groundwater Discharge Study

Hickson Road, Millers Point, NSW

PROJECT ID	60153531
CREATED BY	DJB
LAST MODIFIED	DJB 06 Sep 2010

Figure

F9

Map Document: \\aumel1fp006\GIS\GISMEL\60153531\01\ArcGIS\60153531_FigF9_SeawaterCont_03Aug10.mxd

A3 size

Appendix A

Borelogs

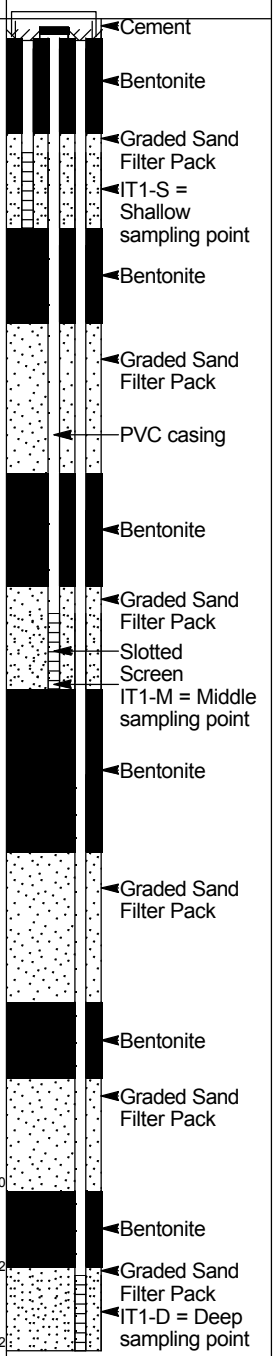
AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

BOREHOLE LOG IT1

PROJECT NUMBER	S41500	**DATE**	10 and 11 March 2010
PROJECT NAME	Barangaroo-Other Remediation Works(North) Area	**BLANK**	0.0-1.77 m bgs, 0.0-7.86 m bgs, 0.0-16.62 m bgs
LOCATION	Hickson Road, Millers Point NSW 2000	**SCREEN**	1.77-2.77 m bgs, 7.86-8.86 m bgs, 16.62-17.62 m bgs
DRILLING METHOD	Core, Air-knife & Hollow Augers	**GRAVEL PACK**	1.5-2.77 m bgs, 7.5-8.86 m bgs, 16.5-17.62 m bgs
SAMPLING METHOD	Well Installation Only	**SANITARY SEAL/BENTONITE**	0.33-1.5 m bgs, 6.0-7.5 m bgs, 15.5-16.5 m bgs
SURFACE ELEVATION	2.550 m AHD		
LOGGED BY	S. Masters	**NORTHING**	333581.58
COMMENTS	Public Domain. IT1 - nested intertidal monitoring well.	**EASTING**	6251642.89

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				0.5		ASPHALT	ASPHALT	0.14
						FILL	Roadbase	0.33
				1.0		FILL	Gravelly Sand (FILL). Brown, slightly moist. No odour, staining or fibre cement material noted.	
				1.5			Becoming light brown and moist from 0.58 m bgs. Contains weathered sandstone fragments. No odour, staining or fibre cement material noted.	
				2.0				
				2.5			Becoming brown from 2.5 m bgs. Contains round marine gravels, weathered sandstone fragments and brick fragments. No odour, staining or fibre cement material noted.	
				3.0				
				3.5				
				4.0				
				4.5				
				5.0		FILL	Sandy Silty Gravel (FILL). Very loose, moist. Contains bricks, coke fragments. Slight tar odour. No staining or fibre cement material noted.	5.00
				5.5			No drill cuttings from 6.0 to 15.5 m bgs. Lithology assumed as above.	
				6.0				
				6.5				
				7.0				
				7.5				
				8.0				
				8.5				
				9.0				
				9.5				
				10.0				
				10.5				
				11.0				
				11.5				
				12.0				
				12.5				
				13.0				
				13.5				
				14.0				
				14.5				
				15.0				
				15.5		CLS	Silty Sandy CLAY. Orange/grey, moist. No odour, staining or fibre cement material noted.	15.50
				16.0				
				16.5		CH	Silty CLAY. Grey/black, moist, high plasticity. Marine sediment. No odour, staining or fibre cement material noted.	16.62
				17.0				
				17.5			Borehole terminated at 17.62; target depth reached. Total Depth: 17.62 m	17.62

WELL DIAGRAM

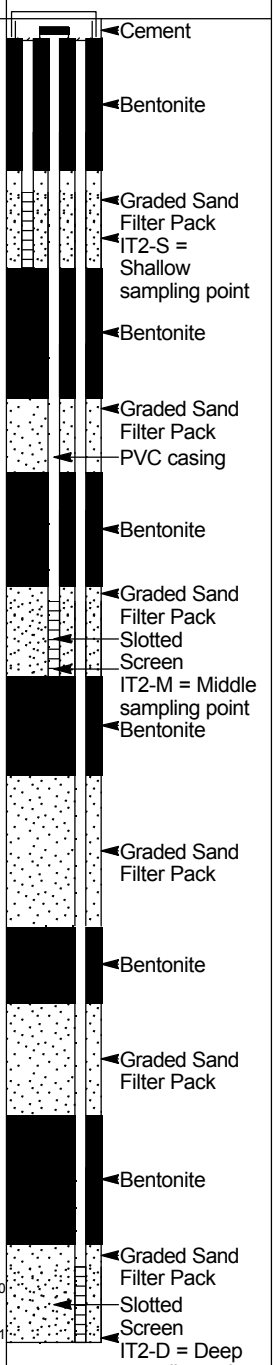


AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

BOREHOLE LOG IT2

PROJECT NUMBER	S41500	**DATE**	10 Mar 10
PROJECT NAME	Barangaroo-Other Remediation Works(North) Area	**BLANK**	0.0-2.295 m bgs, 0.0-7.7 m bgs, 0.0-16.51 m bgs
LOCATION	Hickson Road, Millers Point NSW 2000	**SCREEN**	2.295-3.295 m bgs, 7.7-8.7 m bgs, 16.51-17.51 m bgs
DRILLING METHOD	Core, Air-knife & Hollow Augers	**GRAVEL PACK**	2.0-3.295 m bgs, 7.5-8.7 m bgs, 16.2-17.51 m bgs
SAMPLING METHOD	Well Installation Only	**SANITARY SEAL/BENTONITE**	0.26-2.0 m bgs, 6.0-7.5 m bgs, 14.5-16.2 m bgs
SURFACE ELEVATION	2.680 m AHD		
LOGGED BY	S. Masters	**NORTHING**	333606.37
COMMENTS	Public Domain. IT2 - nested intertidal monitoring well.	**EASTING**	6251644.5

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				0.5		ASPHALT	ASPHALT	0.07
						FILL	Roadbase - compacted.	0.26
				1.0		FILL	Gravelly Sand (FILL). Moist. Contains weathered sandstone fragments and angular gravels. No odour, staining or fibre cement material noted.	0.80
				1.5			Sandy Silt (FILL). Dark brown, moist. No odour, staining or fibre cement material noted.	
				2.0				
				2.5				2.70
				3.0		FILL	Gravelly Silty Sand (FILL). Moist. Contains bricks, rounded gravels, some wood. Slight hydrocarbon odour. No staining or fibre cement material noted.	
				3.5		FILL	Silty Sand (FILL). Very moist. Contains some aggregate. No odour, staining or fibre cement material noted.	3.50
				4.0			Becoming grey and saturated from 4.5 m bgs. No odour, staining or fibre cement material noted.	
				4.5				
				5.0				
				5.5				
				6.0			Sandstone boulder encountered from 5.8 to 5.9 m bgs.	
				6.5				
				7.0			Becoming light grey/brown from 6.8 m bgs.	
				7.5				
				8.0			Sandstone boulder encountered from 7.5 to 7.7 m bgs.	
				8.5			Contains some sandstone cobbles and boulders from 7.7 m bgs. No odour, staining or fibre cement material noted.	
				9.0				
				9.5				
				10.0				
				10.5				
				11.0				
				11.5				
				12.0				
				12.5				
				13.0				
				13.5				
				14.0				
				14.5				
				15.0				
				15.5				
				16.0				
				16.5				
				17.0		SW-SC	Silty Sandy CLAY. Red/brown/yellow/grey, moist. No odour, staining or fibre cement material noted.	16.90
				17.5			Borehole terminated at 17.51 m bgs; target depth reached. Total Depth: 17.51 m	17.51



AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

MONITORING WELL LOG BH40 / MW40

PROJECT NUMBER	S41500	**DATE**	18 and 19 February 2010
PROJECT NAME	Barrangaroo - Other Remediation Works (North)	**BLANK**	0.0 to 14.3 m bgs
LOCATION	Hickson Road, Millers Point NSW 2000	**SCREEN**	14.3 to 20.3 m bgs
DRILLING METHOD	Core, Air-knife & Mud-Rotary	**GRAVEL PACK**	13.5 to 20.3 m bgs
SAMPLING METHOD	SPT	**SANITARY SEAL/BENTONITE**	12.5 to 13.5 m bgs
SURFACE ELEVATION	2.120 m AHD		
LOGGED BY	S. Patel and K. O'Brien	**NORTHING**	333642
COMMENTS	Proposed Southern Cove	**EASTING**	6251571.18

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
				0.5		ASPHALT	ASPHALT	0.06	
				1.0		FILL	Clayey Sand (FILL). Light brown, dry to slightly moist. Contains trace sandstone fragments (<5 %). No odour, staining or fibre cement material noted.		
0.5		BH40_1.0-1.2 QC53	✳	1.5					
				2.0					
				2.5		FILL	Sandstone (FILL). Grey, slightly moist. No odour, staining or fibre cement material noted.	2.50	
0.4		BH40_2.5-2.7		3.0					
				3.5					
				4.0					
				4.5					
				5.0		FILL	Sandy Gravel (FILL). Light brown to grey, coarse grained, moist. No odour, staining or fibre cement material noted.	5.00	
0.3		BH40_5.0-5.2		5.5					
				6.0					
				6.5					Cement
				7.0		FILL	Sand (FILL). Grey/brown, medium to coarse grained, medium dense, saturated. Containssand and minor medium sized weathered sandstone fragments (<5 %). No odour, staining or fibre cement material noted.	7.00	Blank Casing
3.6		BH40_7.0-7.2	✳	7.5					
				8.0					
				8.5					
2.3		BH40_8.5-8.7 QC54	✳ ✳	9.0					
				9.5					
				10.0		FILL	Sandy Gravel (FILL). Grey/brown, medium to coarse grained, medium dense, saturated. Contains coarse sized weathered sandstone fragments (90 %). No odour, staining or fibre cement material noted.	10.00	
1.2		BH40_10.0-10.2		10.5					
				11.0					
				11.5		FILL	Clayey Sand (FILL). Grey, fine to medium grained, loose to medium dense, very moist to saturated. Contains sand (80 %) and soft, low plasticity clay (20 %). No odour, staining or fibre cement material noted.	11.50	
1.6		BH40_11.5-11.7		12.0					
				12.5					
				13.0					Bentonite
1.8		BH40_13.0-13.2	✳	13.5					
				14.0				14.30	
				14.5		SW			

S41500_BORELOGS(VMP&PDA + BLOCKS4&5)_12APR10.GPJ 16/04/10

AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

MONITORING WELL LOG BH40 / MW40

PROJECT NUMBER S41500 **DATE** 18 and 19 February 2010
PROJECT NAME Barrangaroo - Other Remediation Works (North)
LOCATION Hickson Road, Millers Point NSW 2000 **GROUND WATER ELEVATION**

- Continued from Previous Page -

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
0.7		BH40_15.2-15.5		15.5		SW (Continued) SC	SAND. White, fine to medium grained, loose, saturated. Contains minor coarse grained sand and crushed shells. No odour, staining or fibre cement material noted. *(Continued)*	15.20	
				16.0			Gravelly Clayey SAND. Dark grey, fine to medium grained, medium dense, saturated. Contains minor angular fine grained gravels and pockets of white sand. No odour, staining or fibre cement material noted.		
53.3		BH40_16.5-16.7	✳	16.5		SC	Chemical odour noted from 16.0 m bgs.	16.50	Graded Sand Filter Pack
				17.0			U50 Sample taken between 16.0 to 16.45 m bgs.		38 mm Slotted Screen
				17.5					
205		BH40_17.8-18.0	✳	18.0			Sandy CLAY. Grey with red/orange mottling, medium stiff, very moist, medium plasticity. Contains fine grained sand (20 %). Black stained veins of tar with sheen noted. Strong chemical odour noted. No fibre cement material noted.		
				18.5					
				19.0			Becoming very stiff to hard with low to medium plasticity and saturated from 19.0 m bgs. Contains fine grained sand (40 %) and weathered fine grained, hard sandstone fragments. Chemical odour noted. No stainig or fibre cement material noted.	19.20	
41.3		BH40_19.0-19.4	✳	19.5		SW-SC			
				20.0		SANDSTONE		20.10	
				20.5			Clayey SAND. Very Light grey/white, fine to medium grained, dense, saturated. Contains sand (90 %) and minor clay (10 %). Chemical odour noted. No staining or fibre cement material noted.	20.50	
							SANDSTONE. Orange/cream, medium grained, hard, saturated. Slightly weathered, moderate strength. No odour, staining or fibre cement material noted.		
							Borehole terminated at 20.5 m bgs; refusal on Sandstone Bedrock. Total Depth: 20.50 m		

S41500_BORELOGS(VMP&PDA + BLOCKS4&5)_12APR10.GPJ 16/04/10

AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

MONITORING WELL LOG BH45 / MW45

PROJECT NUMBER	S41500	**DATE**	23 Feb 10
PROJECT NAME	Barrangaroo - Other Remediation Works (North)	**BLANK**	0.0 to 1.5 m bgs
LOCATION	Hickson Road, Millers Point NSW 2000	**SCREEN**	1.5 to 12.8 m bgs
DRILLING METHOD	Core, Air-knife & Push-tube	**GRAVEL PACK**	1.0 to 12.8 m bgs
SAMPLING METHOD	Grab & Push-tube	**SANITARY SEAL/BENTONITE**	0.5 to 1.0 m bgs
SURFACE ELEVATION	2.160 m AHD		
LOGGED BY	K. Pigram	**NORTHING**	333698.38
COMMENTS	Proposed Southern Cove - VMP & PDA Remediation Works	**EASTING**	6251588.6

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
1.3		BH45_0.08-0.1		0.5		ASPHALT	ASPHALT	0.07	Cement
						FILL	Gravelly Silty Sand (FILL). White, grey/brown and yellow, fine grained,medium dense, dry. Contains roadbase gravels (10-20 mm) (30 %), silt (30 %) and sand (30 %). Contains two pieces of metal (20 mm) and trace ash (<10 %). No odour or fibre cement material noted.		
0.9		BH45_0.8-1.0	✳	1.0		FILL	Gravelly Sand (FILL). Grey/brown, dense, medium to coarse grained, slightly moist. Contains weathered sandstone fragments (10-30 mm)(20 %), sand (50 %), minor silt (10 %), minor roadbase gravels (10-20 mm)(10 %) and minor soft, low plasticity clay (10 %). Slight tar odour. No staining or fibre cement material noted.	1.00	Bentonite Blank Casing
				1.5					
				2.0	▽				
4.3		BH45_2.2-2.4		2.5			Becoming saturated at 2.2 m bgs.		
				3.0					
1.3		BH45_3.2-3.4 QC230	✳ ✳	3.5		FILL	Silty Gravelly Sand (FILL). Light grey/brown, fine to medium grained, dense, saturated. Contains silt (20 %), sand (35 %), minor soft to medium stiff, low plasticity clay (10 %) and weathered sandstone fragments (10-20 mm)(30 %). Slight tar odour. Trace (<5 %) black staining. No fibre cement material noted.	3.20	
				4.0					
0.6		BH45_4.4-4.6		4.5		FILL	Silty Sandy Clayey Gravel (FILL). Light grey/brown, medium dense, saturated. Contains silt (20 %), red/brown, soft, low plasticity clay (30 %), medium to coarse grained sand (20 %) and weathered sandstone fragments (10-30 mm)(30 %). Slight tar odour. No staining or fibre cement material noted.	4.40	
				5.0					
0.8		BH45_5.6-5.8		5.5			Black staining (<10 %) and moderate tar/hydrocarbon odour noted from 5.6 to 5.8 m bgs.	5.80	
				6.0		FILL	Gravelly Sandy Clay (FILL). Grey/brown, soft to medium stiff, saturated, low plasticity. Contains fine to medium grained sand (30 %), clay (50 %) and weathered sandstone fragments (10-20 mm)(20 %). Trace black staining and slight tar odour noted. No fibre cement material noted.		
0.7		BH45_6.3-6.5		6.5					
				7.0					Graded Sand Filter Pack 38 mm Slotted Screen
0.5		BH45_7.2-7.4 QC231 QC232	✳ ✳ ✳	7.5		FILL	Clayey Sandy Gravel (FILL). Grey/brown, dense, saturated. Contains soft, low plasticity clay (20 %), medium grained sand (20 %) and gravels (10-20 mm)(60 %). Very slight tar odour. No staining or fibre cement material noted. Refusal at 8.2 m bgs; using push tube. Switch to solid flight augers.	7.20	
				8.0				8.20	

S41500_BORELOGS(VMP&PDA + BLOCKS4&5)_12APR10.GPJ 16/04/10

AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

MONITORING WELL LOG BH45 / MW45

PROJECT NUMBER S41500 **DATE** 23 Feb 10
PROJECT NAME Barrangaroo - Other Remediation Works (North)
LOCATION Hickson Road, Millers Point NSW 2000 **GROUND WATER ELEVATION**

- Continued from Previous Page -

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
				8.5		SW	SAND. White/light grey, medium grained, very dense. Contains quartz granules (10 %) and crushed sandstone (80 %) and minor weathered sandstone fragments (10-30 mm)(10 %). No odour, staining or fibre cement material noted.		
				9.0			Cave-in using solid flight augers and push-tube to sample at 9.2 m bgs. Sample not indicative of depth and therefore not taken at 9.2 m bgs.		
				9.5					
				10.0					
				10.5		SANDSTONE		10.50	
0.6		BH45_10.5-10.7					SANDSTONE. White/light grey, very dense, saturated. Contains weathered sandstone fragments (10-20 mm)(70 %) and quartz fragments (30 %). Very slight gaseous odour. No staining or fibre cement material noted.		
				11.0					
1.1		BH45_11.2-11.4					Becoming hard from 11.2 m bgs. Contains weathered sandstone gravels (10-30 mm)(90 %) and medium grained sand and quartz (10 %). Very slight tar odour. No staining or fibre cement material noted.		
				11.5					
				12.0					
1.3		BH45_12.2-12.4					Trace (<2%) vein of tar with black staining from 12.15 to 12.2 m bgs.		
				12.5			Very slight tar odour noted from 12.2 m bgs. No staining or fibre cement material noted.		
				13.0					
1.1		BH45_13.2-13.4	✳					13.40	
							Borehole terminated at 13.4 m bgs; refusal on Sandstone Bedrock.		
							Re-drilled with hollow augers on 24/02/2010 for monitoring well installation. Refusal at 12.8 m bgs.		
							Total Depth: 13.40 m		

S41500_BORELOGS(VMP&PDA + BLOCKS4&5)_12APR10.GPJ 16/04/10

AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

MONITORING WELL LOG BH56 / MW56

PROJECT NUMBER	S41500	**DATE**	04 Mar 10
PROJECT NAME	Barrangaroo - Other Remediation Works (North)	**BLANK**	0.0 to 18.0 m bgs and 21.0 to 21.4 m bgs
LOCATION	Hickson Road, Millers Point NSW 2000	**SCREEN**	18.0 to 21.0 m bgs
DRILLING METHOD	Core, Air-knife & Hollow Augers	**GRAVEL PACK**	17.5 to 21.0 m bgs
SAMPLING METHOD	Grab & SPT	**SANITARY SEAL/BENTONITE**	16.75 to 17.5 m bgs and 21.0 to 21.4 m bgs
SURFACE ELEVATION	2.610 m AHD		
LOGGED BY	L. Kontus	**NORTHING**	333615.76
COMMENTS	Public Domain	**EASTING**	6251644.66

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
4.4		BH56_0.06-0.16		0.5		ASPHALT	ASPHALT	0.06	
				1.0		FILL	Gravelly Silty Sand (FILL). Brown, medium grained, loose, slightly moist. Contains roadbase gravels (20 %). No odour, staining or fibre cement material noted.	1.00	
				1.5		FILL	Gravelly Clayey Sand (FILL). Brown, orange and white, loose to medium dense, saturated. Contains weathered sandstone fragments. No odour, staining or fibre cement material noted.		
				2.0					
0.7		BH56_2.5-2.7	✳	2.5 ▽		FILL	Clayey Sandy Gravel (FILL). Brown, low dense, saturated. Contains road base gravels, sandstone fragments and a piece of a terracotta tile. No odour, staining or fibre cement material noted.	2.50	
				3.0					
				3.5					
				4.0					
0.7		BH56_4.25-4.6 QC123	✳	4.5		FILL	Silty Gravelly Sand (FILL). Red brown and dark brown, medium to coarse grained, medium dense, saturated. Contains glass and steel fragments, weathered sandstone fragments, crushed brick and sand. No odour, staining or fibre cement material noted.	4.25	
				5.0					
0.5		BH56_5.5-5.9 QC124		5.5		FILL	Silty Clayey Sand (FILL). Dark and light grey, loose, saturated. Contains silt (30 %), clay (50 %), weathered sandstone fragments and steel fragments. No odour, staining or fibre cement material noted.	5.50	
				6.0					
				6.5					
1.2		BH56_7.0-7.2	✳	7.0			Becoming grey and loose to medium dense from 7.0 m bgs. Contains weathered sandstone and shale fragments and roadbase gravels (10 %). Tar odour noted. No staining or fibre cement material noted.		
				7.5					
				8.0					
0.5		BH56_8.5-8.9		8.5		FILL	Clayey Gravelly Sand (FILL). Grey, loose, saturated. Contains weathered sandstone and shale fragments, roadbase gravels (20 %) and sand (70 %). No odour, staining or fibre cement material noted.	8.50	Cement / Blank Casing
				9.0					
				9.5					
0.7		BH56_10.0-10.2		10.0		FILL	Silty Gravelly Clayey Sand (FILL). Grey, loose, saturated. Contains terracotta tile, roadbase gravels and weathered sandstone fragments. No odour, staining or fibre cement material noted.	10.00	
				10.5					
				11.0					
0.4		BH56_11.5-11.7	✳	11.5		FILL	Silty Sand (FILL). Light brown, dense, saturated. Contains minor clay (<15 %), weathered sandstone fragments and crushed brick. No odour, staining or fibre cement material noted.	11.50	
				12.0					
				12.5				13.00	

S41500_BORELOGS(VMP&PDA + BLOCKS4&5)_12APR10.GPJ 16/04/10

AECOM Australia Pty Ltd
Level 5, 828 Pacific Highway
Gordon NSW 2072

MONITORING WELL LOG BH56 / MW56

PROJECT NUMBER S41500 **DATE** 04 Mar 10
PROJECT NAME Barrangaroo - Other Remediation Works (North)
LOCATION Hickson Road, Millers Point NSW 2000 **GROUND WATER ELEVATION**

- Continued from Previous Page -

PID (ppm)	RECOVERY	SAMPLE NUMBER	ANALYSED	DEPTH (m BGS)	GRAPHIC LOG	USCS CLASS	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
1.5		BH56_13.0-13.2	✳	13.5		FILL	Clayey Sand (FILL). Brown, red and yellow, loose, very moist. Contains sand (80 %), trace weathered sandstone fragments and organic matter (twigs) (<10 %). No odour, staining or fibre cement material noted.		
0.4		BH56_14.5-15.0 QC125 QC126	✳ ✳ ✳	14.0 14.5 15.0 15.5			Becoming grey and light brown and saturated from 14.5 m bgs. Contains sand (80 %), trace crushed brick and weathered sandstone gravels (<10 %). No odour, staining or fibre cement material noted.		
				16.0		FILL	Sandstone (FILL). Grey, very dense, saturated. No odour, staining or fibre cement material noted.	16.00	
0.5		BH56_17.5-17.8	✳	16.5 17.0 17.5		SW	SAND. Grey with red mottling, medium grained, loose, saturated. Contains highly weathered sandstone with minor interspersed stiff, low plasticity clay bands (10 %). No odour, staining or fibre cement material noted.	17.50	Bentonite
16.4		BH56_19.0-19.40 QC127 QC128		18.0 18.5 19.0 19.5			Becoming light grey with orange mottling from 19.0 m bgs. Becoming increasingly denser and consolidated with depth. Moderate tar odour noted. No staining or fibre cement material noted.		Graded Sand Filter Pack 38 mm Slotted Screen
8.3		BH56_20.5-20.9	✳	20.0 20.5 21.0					
1		BH56_21.4-21.6	✳				Borehole terminated at 21.4 m bgs; refusal on Sandstone Bedrock. Total Depth: 21.40 m	21.40	Bentonite Sump

Appendix B

Laboratory Analytical Data and Chain of Custody Documentation

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1005598**	Page	: 1 of 20
Client	: **AECOM Australia Pty Ltd**	Laboratory	: Environmental Division Sydney
Contact	: MR ANTHONY DAVIS	Contact	: Charlie Pierce
Address	: LEVEL 5, 828 PACIFIC HIGHWAY GORDON NSW, AUSTRALIA 2072	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: anthony.davis@aecom.com	E-mail	: charlie.pierce@alsenviro.com
Telephone	: +61 02 8484 8999	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 8484 8989	Facsimile	: +61-2-8784 8500
Project	: S4150014-BARANGAROO	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: 1303951		
C-O-C number	: ----	Date Samples Received	: 25-MAR-2010
Sampler	: KP	Issue Date	: 07-APR-2010
Site	: ----		
		No. of samples received	: 10
Quote number	: SY/259/09 V2	No. of samples analysed	: 10

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

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

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*
Alex Rossi	Organic Chemist	Organics
Ashesh Patel	Inorganic Chemist	Inorganics
Celine Conceicao	Spectroscopist	Inorganics
Sanjeshni Jyoti Mala	Senior Chemist Volatile	Organics
Wisam.Marassa	Metals Coordinator	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 insuffient 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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- **EG020A-F: LOR's for some samples have been raised due to matrix interference (High sample salinity)**
- **EK055G LOR raised for ammonia on the sample ID (IT1_SHALLOW, IT1_MID, IT2_SHALLOW, STILLING WELL(SW), QC331) due to sample matrix.**
- **EP074/EP080: Positive results confirmed by re-analysis.**
- **EP074: Level of Reporting raised for toluene due to ambient background levels in the laboratory.**
- **EP075: Particular samples required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly. Poor surrogate recovery due to sample matrix interferences.**
- **EP075: 'Sum of PAH' is the sum of the USEPA 16 priority PAHs**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW Client sampling date / time: [25-MAR-2010] ES1005598-001	Client sample ID: IT1_MID Client sampling date / time: 24-MAR-2010 15:00 ES1005598-002	Client sample ID: IT1_DEEP Client sampling date / time: 24-MAR-2010 15:00 ES1005598-003	Client sample ID: IT2_SHALLOW Client sampling date / time: 24-MAR-2010 15:00 ES1005598-004	Client sample ID: IT2_MID Client sampling date / time: 24-MAR-2010 15:00 ES1005598-005
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	**35700**	**38200**	**29600**	**32600**	**36700**
ED009: Anions								
Chloride	16887-00-6	0.50	mg/L	**21100**	**20000**	**16300**	**19100**	**21200**
Fluoride	16984-48-8	0.02	mg/L	**1.32**	**1.17**	**0.74**	**0.90**	<0.02
Sulfate	14808-79-8	0.50	mg/L	**2370**	**2360**	**1620**	**2180**	**1010**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**153**	**105**	**209**	**289**	**57**
Total Alkalinity as CaCO3	----	1	mg/L	**153**	**105**	**209**	**289**	**57**
ED040T: Total Major Anions								
^ Sulfur as S	----	1	mg/L	**822**	**853**	**603**	**763**	**260**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**462**	**675**	**662**	**713**	**1410**
Magnesium	7439-95-4	1	mg/L	**1250**	**1210**	**1020**	**1090**	**265**
Sodium	7440-23-5	1	mg/L	**11600**	**12000**	**9420**	**11400**	**10900**
Potassium	7440-09-7	1	mg/L	**444**	**446**	**252**	**417**	**353**
EG020F: Dissolved Metals by ICP-MS								
Iron	7439-89-6	0.05	mg/L	**0.53**	<0.50	**83.5**	<0.50	<0.50
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001
EG050F Low: Dissolved Hexavalent Chromium - Low								
Hexavalent Chromium	18540-29-9	0.002	mg/L	<0.002	<0.002	<0.002	<0.002	**0.004**
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS								
Arsenic	7440-38-2	0.5	µg/L	**0.9**	**2.7**	**1.8**	**2.1**	**2.0**
Barium	7440-39-3	1	µg/L	**50**	**91**	**128**	**185**	**767**
Beryllium	7440-41-7	0.1	µg/L	<0.1	<0.1	**0.3**	<0.1	<0.1
Cadmium	7440-43-9	0.2	µg/L	**1.3**	<0.2	**0.4**	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L	<0.5	**102**	<0.5	<0.5	<0.5
Cobalt	7440-48-4	0.2	µg/L	**0.3**	**1.6**	**51.9**	**3.7**	**0.5**
Copper	7440-50-8	1	µg/L	**1**	**19**	<1	<1	<1
Lead	7439-92-1	0.2	µg/L	**12.2**	**0.4**	**1.1**	**1.6**	**0.3**
Manganese	7439-96-5	0.5	µg/L	**25.6**	**418**	**4340**	**1090**	**154**
Nickel	7440-02-0	0.5	µg/L	**3.6**	**45.9**	**70.0**	**10.5**	**1.8**
Vanadium	7440-62-2	0.5	µg/L	**0.7**	**2.3**	<0.5	<0.5	**1.7**
Zinc	7440-66-6	5	µg/L	**35**	**23**	**127**	**17**	**7**
EK025G: Free cyanide by Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW Client sampling date / time: [25-MAR-2010] ES1005598-001	IT1_MID 24-MAR-2010 15:00 ES1005598-002	IT1_DEEP 24-MAR-2010 15:00 ES1005598-003	IT2_SHALLOW 24-MAR-2010 15:00 ES1005598-004	IT2_MID 24-MAR-2010 15:00 ES1005598-005
EK025G: Free cyanide by Discrete Analyser - Continued								
Free Cyanide	----	0.004	mg/L	<0.004	**0.037**	**0.053**	<0.004	<0.004
EK028G: Weak Acid Dissociable Cyanide By Discrete Analyser								
Weak Acid Dissociable Cyanide	----	0.004	mg/L	**0.007**	**0.085**	**0.061**	<0.004	<0.004
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.10	<0.10	**1.38**	<0.10	**9.26**
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	**647**	**614**	**498**	**589**	**620**
^ Total Cations	----	0.01	meq/L	**642**	**667**	**533**	**632**	**575**
^ Ionic Balance	----	0.01	%	**0.40**	**4.07**	**3.35**	**3.54**	**3.78**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**8**	**150**	**96**	**180**	**60**
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	1	µg/L	<1	<1	**113**	**2**	**3**
Toluene	108-88-3	2	µg/L	<5	<5	**22**	**20**	<5
Ethylbenzene	100-41-4	2	µg/L	<2	<2	**4**	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	**22**	<2	<2
Styrene	100-42-5	5	µg/L	<5	<5	<5	<5	<5
ortho-Xylene	95-47-6	2	µg/L	<2	<2	**10**	<2	<2
Isopropylbenzene	98-82-8	5	µg/L	<5	<5	<5	<5	<5
n-Propylbenzene	103-65-1	5	µg/L	<5	<5	<5	<5	<5
1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	<5	<5	<5	<5
sec-Butylbenzene	135-98-8	5	µg/L	<5	<5	<5	<5	<5
1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	<5	<5	<5	<5
tert-Butylbenzene	98-06-6	5	µg/L	<5	<5	<5	<5	<5
p-Isopropyltoluene	99-87-6	5	µg/L	<5	<5	<5	<5	<5
n-Butylbenzene	104-51-8	5	µg/L	<5	<5	<5	<5	<5
EP074B: Oxygenated Compounds								
Vinyl Acetate	108-05-4	50	µg/L	<50	<50	<50	<50	<50
2-Butanone (MEK)	78-93-3	50	µg/L	<50	<50	<50	<50	<50
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	<50	<50	<50	<50
2-Hexanone (MBK)	591-78-6	50	µg/L	<50	<50	<50	<50	<50
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	5	µg/L	<5	<5	<5	<5	<5
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW Client sampling date / time: [25-MAR-2010] ES1005598-001	IT1_MID 24-MAR-2010 15:00 ES1005598-002	IT1_DEEP 24-MAR-2010 15:00 ES1005598-003	IT2_SHALLOW 24-MAR-2010 15:00 ES1005598-004	IT2_MID 24-MAR-2010 15:00 ES1005598-005
EP074D: Fumigants - Continued								
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	<5	<5	<5
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	<50	<50	<50
Chloromethane	74-87-3	50	µg/L	<50	<50	<50	<50	<50
Vinyl chloride	75-01-4	50	µg/L	<50	<50	<50	<50	<50
Bromomethane	74-83-9	50	µg/L	<50	<50	<50	<50	<50
Chloroethane	75-00-3	50	µg/L	<50	<50	<50	<50	<50
Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	<50	<50	<50
1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	<5	<5	<5
Iodomethane	74-88-4	5	µg/L	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	<5	<5	<5
1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	<5	<5	<5
1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	<5	<5	<5
Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	<5	<5	<5
Trichloroethene	79-01-6	5	µg/L	<5	<5	<5	<5	<5
Dibromomethane	74-95-3	5	µg/L	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	<5	<5	<5
1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	<5	<5	<5
Tetrachloroethene	127-18-4	5	µg/L	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	<5	<5	<5
Pentachloroethane	76-01-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	<5	<5	<5
Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	<5	<5	<5
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	5	µg/L	<5	<5	<5	<5	<5
Bromobenzene	108-86-1	5	µg/L	<5	<5	<5	<5	<5
2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	<5	<5	<5
4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	<5	<5	<5
EP074G: Trihalomethanes								

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW Client sampling date / time: [25-MAR-2010] ES1005598-001	Client sample ID: IT1_MID Client sampling date / time: 24-MAR-2010 15:00 ES1005598-002	Client sample ID: IT1_DEEP Client sampling date / time: 24-MAR-2010 15:00 ES1005598-003	Client sample ID: IT2_SHALLOW Client sampling date / time: 24-MAR-2010 15:00 ES1005598-004	Client sample ID: IT2_MID Client sampling date / time: 24-MAR-2010 15:00 ES1005598-005
EP074G: Trihalomethanes - Continued								
Chloroform	67-66-3	5	µg/L	<5	<5	<5	<5	<5
Bromodichloromethane	75-27-4	5	µg/L	<5	<5	<5	<5	<5
Dibromochloromethane	124-48-1	5	µg/L	<5	<5	<5	<5	<5
Bromoform	75-25-2	5	µg/L	<5	<5	<5	<5	<5
EP075A: Phenolic Compounds								
Phenol	108-95-2	0.5	µg/L	<0.9	<1	<10	<1	**2**
2-Chlorophenol	95-57-8	0.3	µg/L	<0.9	<1	<10	<1	<1
2-Methylphenol	95-48-7	0.5	µg/L	<0.9	<1	**17**	**1**	**5**
3- & 4-Methylphenol	1319-77-3	0.5	µg/L	<2	<2	<20	<2	**9**
2-Nitrophenol	88-75-5	0.5	µg/L	<0.9	<1	<10	<1	<1
2.4-Dimethylphenol	105-67-9	0.5	µg/L	<0.9	<1	**177**	**2**	**10**
2.4-Dichlorophenol	120-83-2	0.3	µg/L	<0.9	<1	<10	<1	<1
2.6-Dichlorophenol	87-65-0	0.3	µg/L	<0.9	<1	<10	<1	<1
4-Chloro-3-Methylphenol	59-50-7	0.3	µg/L	<0.9	<1	<10	<1	<1
2.4.6-Trichlorophenol	88-06-2	0.3	µg/L	<0.9	<1	<10	<1	<1
2.4.5-Trichlorophenol	95-95-4	0.3	µg/L	<0.9	<1	<10	<1	<1
Pentachlorophenol	87-86-5	0.6	µg/L	<2	<2	<20	<2	<2
EP075B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	µg/L	<0.9	**16**	**153**	<1	**41**
2-Methylnaphthalene	91-57-6	0.5	µg/L	<0.9	**4**	<10	<1	**7**
2-Chloronaphthalene	91-58-7	0.5	µg/L	<0.9	<1	<10	<1	<1
Acenaphthylene	208-96-8	0.5	µg/L	<0.9	**10**	**12**	<1	**2**
Acenaphthene	83-32-9	0.5	µg/L	<0.9	**6**	<10	**1**	**6**
Fluorene	86-73-7	0.5	µg/L	<0.9	**11**	**10**	<1	**5**
Phenanthrene	85-01-8	0.5	µg/L	<0.9	**20**	**29**	<1	**10**
Anthracene	120-12-7	0.5	µg/L	<0.9	**6**	**10**	<1	**2**
Fluoranthene	206-44-0	0.5	µg/L	<0.9	**13**	**33**	**1**	**2**
Pyrene	129-00-0	0.5	µg/L	<0.9	**14**	**38**	<1	**2**
N-2-Fluorenyl Acetamide	53-96-3	0.5	µg/L	<0.9	<1	<10	<1	<1
Benz(a)anthracene	56-55-3	0.5	µg/L	<0.9	**7**	**21**	<1	<1
Chrysene	218-01-9	0.5	µg/L	<0.9	**7**	**21**	<1	<1
Benzo(b) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	µg/L	<2	**12**	**39**	<2	<2
7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	µg/L	<0.9	<1	<10	<1	<1
Benzo(a)pyrene	50-32-8	0.3	µg/L	<0.9	**7**	**17**	<1	<1
3-Methylcholanthrene	56-49-5	0.5	µg/L	<0.9	<1	<10	<1	<1
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	µg/L	<0.9	**2**	<10	<1	<1
Dibenz(a.h)anthracene	53-70-3	0.5	µg/L	<0.9	<1	<10	<1	<1

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW	IT1_MID	IT1_DEEP	IT2_SHALLOW	IT2_MID
				Client sampling date / time: [25-MAR-2010]	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-001	ES1005598-002	ES1005598-003	ES1005598-004	ES1005598-005
EP075B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(g.h.i)perylene	191-24-2	0.5	µg/L	<0.9	**3**	**10**	<1	<1
^ Sum of PAHs	----	0.5	µg/L	<0.9	**134**	**393**	**2**	**70**
EP075C: Phthalate Esters								
Dimethyl phthalate	131-11-3	0.5	µg/L	<0.9	<1	<10	<1	<1
Diethyl phthalate	84-66-2	0.5	µg/L	<0.9	<1	<10	<1	<1
Di-n-butyl phthalate	84-74-2	2	µg/L	<2	**2**	<10	**5**	**5**
Butyl benzyl phthalate	85-68-7	2	µg/L	<2	<2	<10	<2	<2
bis(2-ethylhexyl) phthalate	117-81-7	20	µg/L	<20	<20	<20	<20	<20
Di-n-octylphthalate	117-84-0	0.5	µg/L	<0.9	<1	<10	<1	<1
EP075D: Nitrosamines								
N-Nitrosomethylethylamine	10595-95-6	0.5	µg/L	<0.9	<1	<10	<1	<1
N-Nitrosodiethylamine	55-18-5	0.5	µg/L	<0.9	<1	<10	<1	<1
N-Nitrosopyrrolidine	930-55-2	1	µg/L	<1	<1	<10	<1	<1
N-Nitrosomorpholine	59-89-2	0.5	µg/L	<0.9	<1	<10	<1	<1
N-Nitrosodi-n-propylamine	621-64-7	0.5	µg/L	<0.9	<1	<10	<1	<1
N-Nitrosopiperidine	100-75-4	0.5	µg/L	<0.9	<1	<10	<1	<1
N-Nitrosodibutylamine	924-16-3	0.5	µg/L	<0.9	<1	<10	<1	<1
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1	µg/L	<2	<2	<20	<2	<2
Methapyrilene	91-80-5	0.5	µg/L	<0.9	<1	<10	<1	<1
EP075E: Nitroaromatics and Ketones								
2-Picoline	109-06-8	0.5	µg/L	<0.9	<1	<10	<1	<1
Acetophenone	98-86-2	0.5	µg/L	<0.9	**2**	<10	<1	<1
Nitrobenzene	98-95-3	0.5	µg/L	<0.9	<1	<10	<1	<1
Isophorone	78-59-1	0.5	µg/L	<0.9	<1	<10	<1	<1
2.6-Dinitrotoluene	606-20-2	1	µg/L	<1	<1	<10	<1	<1
2.4-Dinitrotoluene	121-14-2	1	µg/L	<1	<1	<10	<1	<1
1-Naphthylamine	134-32-7	0.5	µg/L	<0.9	<1	<10	<1	<1
4-Nitroquinoline-N-oxide	56-57-5	0.5	µg/L	<0.9	<1	<10	<1	<1
5-Nitro-o-toluidine	99-55-8	0.5	µg/L	<0.9	<1	<10	<1	<1
Azobenzene	103-33-3	0.5	µg/L	<0.9	<1	<10	<1	<1
1.3.5-Trinitrobenzene	99-35-4	0.5	µg/L	<0.9	<1	<10	<1	<1
Phenacetin	62-44-2	0.5	µg/L	<0.9	<1	<10	<1	<1
4-Aminobiphenyl	92-67-1	0.5	µg/L	<0.9	<1	<10	<1	<1
Pentachloronitrobenzene	82-68-8	0.5	µg/L	<0.9	<1	<10	<1	<1
Pronamide	23950-58-5	0.5	µg/L	<0.9	<1	<10	<1	<1
Dimethylaminoazobenzene	60-11-7	0.5	µg/L	<0.9	<1	<10	<1	<1
Chlorobenzilate	510-15-6	0.5	µg/L	<0.9	<1	<10	<1	<1

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW Client sampling date / time: [25-MAR-2010] ES1005598-001	IT1_MID 24-MAR-2010 15:00 ES1005598-002	IT1_DEEP 24-MAR-2010 15:00 ES1005598-003	IT2_SHALLOW 24-MAR-2010 15:00 ES1005598-004	IT2_MID 24-MAR-2010 15:00 ES1005598-005
EP075F: Haloethers								
Bis(2-chloroethyl) ether	111-44-4	0.5	µg/L	<0.9	<1	<10	<1	<1
Bis(2-chloroethoxy) methane	111-91-1	0.5	µg/L	<0.9	<1	<10	<1	<1
4-Chlorophenyl phenyl ether	7005-72-3	0.5	µg/L	<0.9	<1	<10	<1	<1
4-Bromophenyl phenyl ether	101-55-3	0.5	µg/L	<0.9	<1	<10	<1	<1
EP075G: Chlorinated Hydrocarbons								
1.3-Dichlorobenzene	541-73-1	0.5	µg/L	<0.9	<1	<10	<1	<1
1.4-Dichlorobenzene	106-46-7	0.5	µg/L	<0.9	<1	<10	<1	<1
1.2-Dichlorobenzene	95-50-1	0.5	µg/L	<0.9	<1	<10	<1	<1
Hexachloroethane	67-72-1	0.5	µg/L	<0.9	<1	<10	<1	<1
1.2.4-Trichlorobenzene	120-82-1	0.5	µg/L	<0.9	<1	<10	<1	<1
Hexachloropropylene	1888-71-7	0.5	µg/L	<0.9	<1	<10	<1	<1
Hexachlorobutadiene	87-68-3	0.5	µg/L	<0.9	<1	<10	<1	<1
Hexachlorocyclopentadiene	77-47-4	0.5	µg/L	<0.9	<1	<10	<1	<1
Pentachlorobenzene	608-93-5	0.5	µg/L	<0.9	<1	<10	<1	<1
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.9	<1	<10	<1	<1
EP075H: Anilines and Benzidines								
Aniline	62-53-3	0.5	µg/L	<0.9	<1	<10	<1	<1
4-Chloroaniline	106-47-8	0.5	µg/L	<0.9	<1	<10	<1	<1
2-Nitroaniline	88-74-4	1	µg/L	<1	<1	<10	<1	<1
3-Nitroaniline	99-09-2	1	µg/L	<1	<1	<10	<1	<1
Dibenzofuran	132-64-9	0.5	µg/L	<0.9	**6**	<10	<1	**4**
4-Nitroaniline	100-01-6	0.5	µg/L	<0.9	<1	<10	<1	<1
Carbazole	86-74-8	0.5	µg/L	<0.9	**7**	**10**	<1	**11**
3.3`-Dichlorobenzidine	91-94-1	0.5	µg/L	<0.9	<1	<10	<1	<1
EP075I: Organochlorine Pesticides								
alpha-BHC	319-84-6	0.3	µg/L	<0.9	<1	<10	<1	<1
beta-BHC	319-85-7	0.3	µg/L	<0.9	<1	<10	<1	<1
gamma-BHC	58-89-9	0.3	µg/L	<0.9	<1	<10	<1	<1
delta-BHC	319-86-8	0.3	µg/L	<0.9	<1	<10	<1	<1
Heptachlor	76-44-8	0.3	µg/L	<0.9	<1	<10	<1	<1
Aldrin	309-00-2	0.3	µg/L	<0.9	<1	<10	<1	<1
Heptachlor epoxide	1024-57-3	0.3	µg/L	<0.9	<1	<10	<1	<1
alpha-Endosulfan	959-98-8	0.3	µg/L	<0.9	<1	<10	<1	<1
4.4`-DDE	72-55-9	0.3	µg/L	<0.9	<1	<10	<1	<1
Dieldrin	60-57-1	0.3	µg/L	<0.9	<1	<10	<1	<1
Endrin	72-20-8	0.3	µg/L	<0.9	<1	<10	<1	<1
beta-Endosulfan	33213-65-9	0.3	µg/L	<0.9	<1	<10	<1	<1
4.4`-DDD	72-54-8	0.3	µg/L	<0.9	<1	<10	<1	<1

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW	IT1_MID	IT1_DEEP	IT2_SHALLOW	IT2_MID
Client sampling date / time				[25-MAR-2010]	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-001	ES1005598-002	ES1005598-003	ES1005598-004	ES1005598-005
EP075I: Organochlorine Pesticides - Continued								
Endosulfan sulfate	1031-07-8	0.3	µg/L	<0.9	<1	<10	<1	<1
4.4`-DDT	50-29-3	0.6	µg/L	<0.9	<1	<10	<1	<1
EP075J: Organophosphorus Pesticides								
Dichlorvos	62-73-7	0.3	µg/L	<0.9	<1	<10	<1	<1
Dimethoate	60-51-5	0.3	µg/L	<0.9	<1	<10	<1	<1
Diazinon	333-41-5	0.3	µg/L	<0.9	<1	<10	<1	<1
Chlorpyrifos-methyl	5598-13-0	0.3	µg/L	<0.9	<1	<10	<1	<1
Malathion	121-75-5	0.3	µg/L	<0.9	<1	<10	<1	<1
Fenthion	55-38-9	0.3	µg/L	<0.9	<1	<10	<1	<1
Chlorpyrifos	2921-88-2	0.3	µg/L	<0.9	<1	<10	<1	<1
Pirimphos-ethyl	23505-41-1	0.3	µg/L	<0.9	<1	<10	<1	<1
Chlorfenvinphos	470-90-6	0.3	µg/L	<1	<1	<11	<1	<1
Prothiofos	34643-46-4	0.3	µg/L	<0.9	<1	<10	<1	<1
Ethion	563-12-2	0.3	µg/L	<0.9	<1	<10	<1	<1
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	210	40	30
C10 - C14 Fraction	----	50	µg/L	<50	100	1350	<50	210
C15 - C28 Fraction	----	100	µg/L	<100	900	3050	240	3580
C29 - C36 Fraction	----	50	µg/L	<50	450	950	90	320
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	1450	5350	330	4110
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	95.5	97.2	121	104	107
Toluene-D8	2037-26-5	0.1	%	118	96.5	110	115	102
4-Bromofluorobenzene	460-00-4	0.1	%	114	90.4	116	111	99.1
EP075S: Acid Extractable Surrogates								
2-Fluorophenol	367-12-4	0.1	%	57.2	63.0	72.9	64.8	60.2
Phenol-d6	13127-88-3	0.1	%	35.4	44.5	Not Determined	47.3	40.4
2-Chlorophenol-D4	93951-73-6	0.1	%	70.4	79.1	89.0	84.6	75.2
2.4.6-Tribromophenol	118-79-6	0.1	%	63.3	75.1	86.4	84.5	72.7
EP075T: Base/Neutral Extractable Surrogates								
Nitrobenzene-D5	4165-60-0	0.1	%	68.9	76.9	87.8	83.6	73.4
1.2-Dichlorobenzene-D4	2199-69-1	0.1	%	60.0	64.5	81.0	69.3	65.6
2-Fluorobiphenyl	321-60-8	0.1	%	65.2	72.1	91.0	79.3	69.2
Anthracene-d10	1719-06-8	0.1	%	68.7	79.8	104	86.7	77.0
4-Terphenyl-d14	1718-51-0	0.1	%	64.3	81.4	93.8	83.9	89.4
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	109	111	104	118	122

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT1_SHALLOW	IT1_MID	IT1_DEEP	IT2_SHALLOW	IT2_MID
				Client sampling date / time: [25-MAR-2010]	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-001	ES1005598-002	ES1005598-003	ES1005598-004	ES1005598-005
EP080S: TPH(V)/BTEX Surrogates - Continued								
Toluene-D8	2037-26-5	0.1	%	**114**	**106**	**108**	**98.9**	**112**
4-Bromofluorobenzene	460-00-4	0.1	%	**98.4**	**102**	**114**	**98.8**	**114**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP Client sampling date / time: 24-MAR-2010 15:00 ES1005598-006	STILLING WELL(SW) 24-MAR-2010 15:00 ES1005598-007	QC331 24-MAR-2010 15:00 ES1005598-008	QC333 24-MAR-2010 15:00 ES1005598-009	TB307 24-MAR-2010 15:00 ES1005598-010
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	**23400**	**40200**	----	----	----
ED009: Anions								
Chloride	16887-00-6	0.50	mg/L	**10100**	**23400**	**19500**	----	----
Fluoride	16984-48-8	0.02	mg/L	<0.02	**1.49**	**1.03**	----	----
Sulfate	14808-79-8	0.50	mg/L	**607**	**3160**	**2430**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**198**	**94**	**104**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**198**	**94**	**104**	----	----
ED040T: Total Major Anions								
^ Sulfur as S	----	1	mg/L	**231**	**880**	**901**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**604**	**440**	**644**	----	----
Magnesium	7439-95-4	1	mg/L	**344**	**1400**	**1170**	----	----
Sodium	7440-23-5	1	mg/L	**6070**	**12500**	**11700**	----	----
Potassium	7440-09-7	1	mg/L	**214**	**473**	**438**	----	----
EG020F: Dissolved Metals by ICP-MS								
Iron	7439-89-6	0.05	mg/L	**4.78**	<0.50	<0.50	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG050F Low: Dissolved Hexavalent Chromium - Low								
Hexavalent Chromium	18540-29-9	0.002	mg/L	<0.002	<0.002	<0.002	----	----
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS								
Arsenic	7440-38-2	0.5	µg/L	**0.6**	**2.1**	**2.5**	<0.5	----
Barium	7440-39-3	1	µg/L	**259**	**8**	**91**	<1	----
Beryllium	7440-41-7	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	----
Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	<0.2	<0.2	----
Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	<0.5	**2.7**	----
Cobalt	7440-48-4	0.2	µg/L	**18.6**	<0.2	**0.7**	<0.2	----
Copper	7440-50-8	1	µg/L	<1	**4**	<1	<1	----
Lead	7439-92-1	0.2	µg/L	**0.4**	**0.4**	**1.0**	<0.2	----
Manganese	7439-96-5	0.5	µg/L	**466**	**2.6**	**414**	<0.5	----
Nickel	7440-02-0	0.5	µg/L	**5.6**	<0.5	**2.1**	**1.1**	----
Vanadium	7440-62-2	0.5	µg/L	<0.5	**1.0**	**1.8**	<0.5	----
Zinc	7440-66-6	5	µg/L	**15**	**13**	**6**	<5	----
EK025G: Free cyanide by Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP	STILLING WELL(SW)	QC331	QC333	TB307
				Client sampling date / time: 24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-006	ES1005598-007	ES1005598-008	ES1005598-009	ES1005598-010
EK025G: Free cyanide by Discrete Analyser - Continued								
Free Cyanide	----	0.004	mg/L	<0.004	<0.004	**0.045**	----	----
EK028G: Weak Acid Dissociable Cyanide By Discrete Analyser								
Weak Acid Dissociable Cyanide	----	0.004	mg/L	<0.004	<0.004	**0.085**	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**5.99**	<0.10	<0.10	----	----
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	**303**	**728**	**603**	----	----
^ Total Cations	----	0.01	meq/L	**328**	**691**	**650**	----	----
^ Ionic Balance	----	0.01	%	**3.96**	**2.59**	**3.77**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**30**	<1	**130**	----	----
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	1	µg/L	**265**	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	**65**	<5	<5	<5	<5
Ethylbenzene	100-41-4	2	µg/L	**7**	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	**32**	<2	<2	<2	<2
Styrene	100-42-5	5	µg/L	**10**	<5	<5	<5	<5
ortho-Xylene	95-47-6	2	µg/L	**18**	<2	<2	<2	<2
Isopropylbenzene	98-82-8	5	µg/L	<5	<5	<5	<5	<5
n-Propylbenzene	103-65-1	5	µg/L	<5	<5	<5	<5	<5
1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	<5	<5	<5	<5
sec-Butylbenzene	135-98-8	5	µg/L	<5	<5	<5	<5	<5
1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	<5	<5	<5	<5
tert-Butylbenzene	98-06-6	5	µg/L	<5	<5	<5	<5	<5
p-Isopropyltoluene	99-87-6	5	µg/L	<5	<5	<5	<5	<5
n-Butylbenzene	104-51-8	5	µg/L	<5	<5	<5	<5	<5
EP074B: Oxygenated Compounds								
Vinyl Acetate	108-05-4	50	µg/L	<50	<50	<50	<50	<50
2-Butanone (MEK)	78-93-3	50	µg/L	<50	<50	<50	<50	<50
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	<50	<50	<50	<50
2-Hexanone (MBK)	591-78-6	50	µg/L	<50	<50	<50	<50	<50
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	5	µg/L	<5	<5	<5	<5	<5
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP	STILLING WELL(SW)	QC331	QC333	TB307
				Client sampling date / time: 24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-006	ES1005598-007	ES1005598-008	ES1005598-009	ES1005598-010
EP074D: Fumigants - Continued								
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	<5	<5	<5
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	<50	<50	<50
Chloromethane	74-87-3	50	µg/L	<50	<50	<50	<50	<50
Vinyl chloride	75-01-4	50	µg/L	<50	<50	<50	<50	<50
Bromomethane	74-83-9	50	µg/L	<50	<50	<50	<50	<50
Chloroethane	75-00-3	50	µg/L	<50	<50	<50	<50	<50
Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	<50	<50	<50
1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	<5	<5	<5
Iodomethane	74-88-4	5	µg/L	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	<5	<5	<5
1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	<5	<5	<5
1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	<5	<5	<5
Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	<5	<5	<5
1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	<5	<5	<5
Trichloroethene	79-01-6	5	µg/L	<5	<5	<5	<5	<5
Dibromomethane	74-95-3	5	µg/L	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	<5	<5	<5
1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	<5	<5	<5
Tetrachloroethene	127-18-4	5	µg/L	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	<5	<5	<5
Pentachloroethane	76-01-7	5	µg/L	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	<5	<5	<5
Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	<5	<5	<5
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	5	µg/L	<5	<5	<5	<5	<5
Bromobenzene	108-86-1	5	µg/L	<5	<5	<5	<5	<5
2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	<5	<5	<5
4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	541-73-1	5	µg/L	----	----	----	<5	<5
1.4-Dichlorobenzene	106-46-7	5	µg/L	----	----	----	<5	<5

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP	STILLING WELL(SW)	QC331	QC333	TB307
				Client sampling date / time: 24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-006	ES1005598-007	ES1005598-008	ES1005598-009	ES1005598-010
EP074F: Halogenated Aromatic Compounds - Continued								
1.2-Dichlorobenzene	95-50-1	5	µg/L	----	----	----	<5	<5
1.2.4-Trichlorobenzene	120-82-1	5	µg/L	----	----	----	<5	<5
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	<5	<5	<5
EP074G: Trihalomethanes								
Chloroform	67-66-3	5	µg/L	<5	<5	<5	<5	<5
Bromodichloromethane	75-27-4	5	µg/L	<5	<5	<5	<5	<5
Dibromochloromethane	124-48-1	5	µg/L	<5	<5	<5	<5	<5
Bromoform	75-25-2	5	µg/L	<5	<5	<5	<5	<5
EP074H: Naphthalene								
Naphthalene	91-20-3	7	µg/L	----	----	----	<7	<7
EP075A: Phenolic Compounds								
Phenol	108-95-2	0.5	µg/L	**7**	<0.9	<1	----	----
2-Chlorophenol	95-57-8	0.3	µg/L	<1	<0.9	<1	----	----
2-Methylphenol	95-48-7	0.5	µg/L	**31**	<0.9	<1	----	----
3- & 4-Methylphenol	1319-77-3	0.5	µg/L	**35**	<2	<2	----	----
2-Nitrophenol	88-75-5	0.5	µg/L	<1	<0.9	<1	----	----
2.4-Dimethylphenol	105-67-9	0.5	µg/L	**195**	<0.9	**1**	----	----
2.4-Dichlorophenol	120-83-2	0.3	µg/L	<1	<0.9	<1	----	----
2.6-Dichlorophenol	87-65-0	0.3	µg/L	<1	<0.9	<1	----	----
4-Chloro-3-Methylphenol	59-50-7	0.3	µg/L	<1	<0.9	<1	----	----
2.4.6-Trichlorophenol	88-06-2	0.3	µg/L	<1	<0.9	<1	----	----
2.4.5-Trichlorophenol	95-95-4	0.3	µg/L	<1	<0.9	<1	----	----
Pentachlorophenol	87-86-5	0.6	µg/L	<2	<2	<2	----	----
EP075B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	µg/L	**159**	<0.9	**17**	----	----
2-Methylnaphthalene	91-57-6	0.5	µg/L	**4**	<0.9	**4**	----	----
2-Chloronaphthalene	91-58-7	0.5	µg/L	<1	<0.9	<1	----	----
Acenaphthylene	208-96-8	0.5	µg/L	**2**	<0.9	**11**	----	----
Acenaphthene	83-32-9	0.5	µg/L	**1**	<0.9	**6**	----	----
Fluorene	86-73-7	0.5	µg/L	**1**	<0.9	**12**	----	----
Phenanthrene	85-01-8	0.5	µg/L	**2**	<0.9	**22**	----	----
Anthracene	120-12-7	0.5	µg/L	<1	<0.9	**6**	----	----
Fluoranthene	206-44-0	0.5	µg/L	<1	<0.9	**15**	----	----
Pyrene	129-00-0	0.5	µg/L	<1	<0.9	**15**	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.5	µg/L	<1	<0.9	<1	----	----
Benz(a)anthracene	56-55-3	0.5	µg/L	<1	<0.9	**8**	----	----
Chrysene	218-01-9	0.5	µg/L	<1	<0.9	**8**	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP	STILLING WELL(SW)	QC331	QC333	TB307
				Client sampling date / time: 24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-006	ES1005598-007	ES1005598-008	ES1005598-009	ES1005598-010
EP075B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(b) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	µg/L	<2	<2	**12**	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	µg/L	<1	<0.9	<1	----	----
Benzo(a)pyrene	50-32-8	0.3	µg/L	<1	<0.9	**6**	----	----
3-Methylcholanthrene	56-49-5	0.5	µg/L	<1	<0.9	<1	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	µg/L	<1	<0.9	**2**	----	----
Dibenz(a.h)anthracene	53-70-3	0.5	µg/L	<1	<0.9	<1	----	----
Benzo(g.h.i)perylene	191-24-2	0.5	µg/L	<1	<0.9	**3**	----	----
^ Sum of PAHs	----	0.5	µg/L	**165**	<0.9	**143**	----	----
EP075C: Phthalate Esters								
Dimethyl phthalate	131-11-3	0.5	µg/L	<1	<0.9	<1	----	----
Diethyl phthalate	84-66-2	0.5	µg/L	<1	<0.9	<1	----	----
Di-n-butyl phthalate	84-74-2	2	µg/L	**4**	**3**	**3**	----	----
Butyl benzyl phthalate	85-68-7	2	µg/L	<2	<2	<2	----	----
bis(2-ethylhexyl) phthalate	117-81-7	20	µg/L	<20	<20	<20	----	----
Di-n-octylphthalate	117-84-0	0.5	µg/L	<1	<0.9	<1	----	----
EP075D: Nitrosamines								
N-Nitrosomethylethylamine	10595-95-6	0.5	µg/L	<1	<0.9	<1	----	----
N-Nitrosodiethylamine	55-18-5	0.5	µg/L	<1	<0.9	<1	----	----
N-Nitrosopyrrolidine	930-55-2	1	µg/L	<1	<1	<1	----	----
N-Nitrosomorpholine	59-89-2	0.5	µg/L	<1	<0.9	<1	----	----
N-Nitrosodi-n-propylamine	621-64-7	0.5	µg/L	<1	<0.9	<1	----	----
N-Nitrosopiperidine	100-75-4	0.5	µg/L	<1	<0.9	<1	----	----
N-Nitrosodibutylamine	924-16-3	0.5	µg/L	<1	<0.9	<1	----	----
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1	µg/L	<2	<2	<2	----	----
Methapyrilene	91-80-5	0.5	µg/L	<1	<0.9	<1	----	----
EP075E: Nitroaromatics and Ketones								
2-Picoline	109-06-8	0.5	µg/L	<1	<0.9	<1	----	----
Acetophenone	98-86-2	0.5	µg/L	<1	<0.9	<1	----	----
Nitrobenzene	98-95-3	0.5	µg/L	<1	<0.9	<1	----	----
Isophorone	78-59-1	0.5	µg/L	<1	<0.9	<1	----	----
2.6-Dinitrotoluene	606-20-2	1	µg/L	<1	<1	<1	----	----
2.4-Dinitrotoluene	121-14-2	1	µg/L	<1	<1	<1	----	----
1-Naphthylamine	134-32-7	0.5	µg/L	<1	<0.9	<1	----	----
4-Nitroquinoline-N-oxide	56-57-5	0.5	µg/L	<1	<0.9	<1	----	----
5-Nitro-o-toluidine	99-55-8	0.5	µg/L	<1	<0.9	<1	----	----
Azobenzene	103-33-3	0.5	µg/L	<1	<0.9	<1	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP	STILLING WELL(SW)	QC331	QC333	TB307
				Client sampling date / time: 24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-006	ES1005598-007	ES1005598-008	ES1005598-009	ES1005598-010
EP075E: Nitroaromatics and Ketones - Continued								
1.3.5-Trinitrobenzene	99-35-4	0.5	µg/L	<1	<0.9	<1	----	----
Phenacetin	62-44-2	0.5	µg/L	<1	<0.9	<1	----	----
4-Aminobiphenyl	92-67-1	0.5	µg/L	<1	<0.9	<1	----	----
Pentachloronitrobenzene	82-68-8	0.5	µg/L	<1	<0.9	<1	----	----
Pronamide	23950-58-5	0.5	µg/L	<1	<0.9	<1	----	----
Dimethylaminoazobenzene	60-11-7	0.5	µg/L	<1	<0.9	<1	----	----
Chlorobenzilate	510-15-6	0.5	µg/L	<1	<0.9	<1	----	----
EP075F: Haloethers								
Bis(2-chloroethyl) ether	111-44-4	0.5	µg/L	<1	<0.9	<1	----	----
Bis(2-chloroethoxy) methane	111-91-1	0.5	µg/L	<1	<0.9	<1	----	----
4-Chlorophenyl phenyl ether	7005-72-3	0.5	µg/L	<1	<0.9	<1	----	----
4-Bromophenyl phenyl ether	101-55-3	0.5	µg/L	<1	<0.9	<1	----	----
EP075G: Chlorinated Hydrocarbons								
1.3-Dichlorobenzene	541-73-1	0.5	µg/L	<1	<0.9	<1	----	----
1.4-Dichlorobenzene	106-46-7	0.5	µg/L	<1	<0.9	<1	----	----
1.2-Dichlorobenzene	95-50-1	0.5	µg/L	<1	<0.9	<1	----	----
Hexachloroethane	67-72-1	0.5	µg/L	<1	<0.9	<1	----	----
1.2.4-Trichlorobenzene	120-82-1	0.5	µg/L	<1	<0.9	<1	----	----
Hexachloropropylene	1888-71-7	0.5	µg/L	<1	<0.9	<1	----	----
Hexachlorobutadiene	87-68-3	0.5	µg/L	<1	<0.9	<1	----	----
Hexachlorocyclopentadiene	77-47-4	0.5	µg/L	<1	<0.9	<1	----	----
Pentachlorobenzene	608-93-5	0.5	µg/L	<1	<0.9	<1	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<1	<0.9	<1	----	----
EP075H: Anilines and Benzidines								
Aniline	62-53-3	0.5	µg/L	**4**	<0.9	<1	----	----
4-Chloroaniline	106-47-8	0.5	µg/L	<1	<0.9	<1	----	----
2-Nitroaniline	88-74-4	1	µg/L	<1	<1	<1	----	----
3-Nitroaniline	99-09-2	1	µg/L	<1	<1	<1	----	----
Dibenzofuran	132-64-9	0.5	µg/L	**1**	<0.9	**7**	----	----
4-Nitroaniline	100-01-6	0.5	µg/L	<1	<0.9	<1	----	----
Carbazole	86-74-8	0.5	µg/L	**16**	<0.9	**7**	----	----
3.3`-Dichlorobenzidine	91-94-1	0.5	µg/L	<1	<0.9	<1	----	----
EP075I: Organochlorine Pesticides								
alpha-BHC	319-84-6	0.3	µg/L	<1	<0.9	<1	----	----
beta-BHC	319-85-7	0.3	µg/L	<1	<0.9	<1	----	----
gamma-BHC	58-89-9	0.3	µg/L	<1	<0.9	<1	----	----
delta-BHC	319-86-8	0.3	µg/L	<1	<0.9	<1	----	----
Heptachlor	76-44-8	0.3	µg/L	<1	<0.9	<1	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP Client sampling date / time: 24-MAR-2010 15:00 ES1005598-006	STILLING WELL(SW) 24-MAR-2010 15:00 ES1005598-007	QC331 24-MAR-2010 15:00 ES1005598-008	QC333 24-MAR-2010 15:00 ES1005598-009	TB307 24-MAR-2010 15:00 ES1005598-010
EP075I: Organochlorine Pesticides - Continued								
Aldrin	309-00-2	0.3	µg/L	<1	<0.9	<1	----	----
Heptachlor epoxide	1024-57-3	0.3	µg/L	<1	<0.9	<1	----	----
alpha-Endosulfan	959-98-8	0.3	µg/L	<1	<0.9	<1	----	----
4.4`-DDE	72-55-9	0.3	µg/L	<1	<0.9	<1	----	----
Dieldrin	60-57-1	0.3	µg/L	<1	<0.9	<1	----	----
Endrin	72-20-8	0.3	µg/L	<1	<0.9	<1	----	----
beta-Endosulfan	33213-65-9	0.3	µg/L	<1	<0.9	<1	----	----
4.4`-DDD	72-54-8	0.3	µg/L	<1	<0.9	<1	----	----
Endosulfan sulfate	1031-07-8	0.3	µg/L	<1	<0.9	<1	----	----
4.4`-DDT	50-29-3	0.6	µg/L	<1	<0.9	<1	----	----
EP075J: Organophosphorus Pesticides								
Dichlorvos	62-73-7	0.3	µg/L	<1	<0.9	<1	----	----
Dimethoate	60-51-5	0.3	µg/L	<1	<0.9	<1	----	----
Diazinon	333-41-5	0.3	µg/L	<1	<0.9	<1	----	----
Chlorpyrifos-methyl	5598-13-0	0.3	µg/L	<1	<0.9	<1	----	----
Malathion	121-75-5	0.3	µg/L	<1	<0.9	<1	----	----
Fenthion	55-38-9	0.3	µg/L	<1	<0.9	<1	----	----
Chlorpyrifos	2921-88-2	0.3	µg/L	<1	<0.9	<1	----	----
Pirimphos-ethyl	23505-41-1	0.3	µg/L	<1	<0.9	<1	----	----
Chlorfenvinphos	470-90-6	0.3	µg/L	<1	<1	<1	----	----
Prothiofos	34643-46-4	0.3	µg/L	<1	<0.9	<1	----	----
Ethion	563-12-2	0.3	µg/L	<1	<0.9	<1	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	**350**	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L	**1860**	<50	**140**	<50	----
C15 - C28 Fraction	----	100	µg/L	**2790**	<100	**950**	<100	----
C29 - C36 Fraction	----	50	µg/L	**200**	<50	**340**	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	**4850**	<50	**1430**	<50	----
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**94.4**	**97.3**	**96.1**	**86.8**	**88.5**
Toluene-D8	2037-26-5	0.1	%	**110**	**100**	**115**	**106**	**106**
4-Bromofluorobenzene	460-00-4	0.1	%	**112**	**100**	**109**	**110**	**110**
EP075S: Acid Extractable Surrogates								
2-Fluorophenol	367-12-4	0.1	%	**69.2**	**63.4**	**73.5**	----	----
Phenol-d6	13127-88-3	0.1	%	**45.5**	**45.1**	**51.1**	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**85.1**	**82.0**	**88.3**	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%	**82.3**	**80.6**	**84.0**	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: IT2_DEEP	STILLING WELL(SW)	QC331	QC333	TB307
				Client sampling date / time: 24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00	24-MAR-2010 15:00
				ES1005598-006	ES1005598-007	ES1005598-008	ES1005598-009	ES1005598-010
EP075T: Base/Neutral Extractable Surrogates								
Nitrobenzene-D5	4165-60-0	0.1	%	**85.5**	**83.8**	**86.7**	----	----
1.2-Dichlorobenzene-D4	2199-69-1	0.1	%	**74.0**	**72.8**	**77.3**	----	----
2-Fluorobiphenyl	321-60-8	0.1	%	**79.3**	**80.8**	**82.8**	----	----
Anthracene-d10	1719-06-8	0.1	%	**84.9**	**84.9**	**88.1**	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**94.2**	**82.7**	**94.8**	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**108**	**108**	**110**	**99.1**	----
Toluene-D8	2037-26-5	0.1	%	**94.6**	**109**	**102**	**94.6**	----
4-Bromofluorobenzene	460-00-4	0.1	%	**98.3**	**97.7**	**95.7**	**96.2**	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	120
Toluene-D8	2037-26-5	88	110
4-Bromofluorobenzene	460-00-4	86	115
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	21	100
Phenol-d6	13127-88-3	10	94
2-Chlorophenol-D4	93951-73-6	23	134
2.4.6-Tribromophenol	118-79-6	10	123
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	35	114
1.2-Dichlorobenzene-D4	2199-69-1	32	129
2-Fluorobiphenyl	321-60-8	43	116
Anthracene-d10	1719-06-8	27	133
4-Terphenyl-d14	1718-51-0	33	141
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	120
Toluene-D8	2037-26-5	88	110
4-Bromofluorobenzene	460-00-4	86	115

CONTRACT WORK
WO:
LAB: Labmark
DATE:
SPLIT:

AECOM

Form: Declaration Area

Chain of Custody & Analysis Request Form

AECOM - Sydney
PO Box 726
Pymble NSW 2073 Australia
Tel: 61 2 8484 8999
Fax: 61 2 8484 8989
Email anthony.davis@aecom.com, kate.pigram@aecom.com

Laboratory Details
Lab. Name: ALS
Lab. Address: 277 Woodpark Rd, Smithfield
Contact Name:
Lab. Ref:
Tel: 87848555
Fax: 87848500
Preliminary Report by:
Final Report by:
Lab Quote No: SY-259-09

Project Name: Barangaroo
Project Number: s4150014
Purchase Order Number: 1303951

Sample collected by: Kate Pigram
Sample Results to be returned to: Anthony Davis and Kate Pigram

Specifications: * Bottles include 1 X 1L plastic, 1x 500ml Amber, 2xHCL vials, ~~2 x H2SO4 vials~~, 1 x TOC vial, 1 x ultra trace metals, 1 x ferrous iron, 1 x 250 ml Cn, 1 x 250 ml purple, 1 x Cr VI

	(Tick)		
1. Urgent TAT required? (please circle: 24hr 48hr _____days)	☐ Yes	☐ No	☐ N/A
2. Fast TAT Guarantee Required?	☐ Yes	☐ No	☐ N/A
3. Is any sediment layer present in waters to be excluded from extractions?	☐ Yes	☐ No	☐ N/A
4. Special storage requirements?	☐ Yes	☐ No	☑ N/A
5. Preservation requirement: ☐ Fax ☐ Hard copy ☑ Email	☐ Yes	☐ No	☐ N/A
6. Other requirements?	☐ Yes	☐ No	☐ N/A

7. Report Format: ESDAT
8. Project Manager: Anthony Davis
tel:

Lab. ID	Sample ID	Sampling Date & time (on)	Sampling Date & Time (off)	Matrix: soil	Matrix: water	Matrix: other	Preservation: filt'ed	Preservation: acid	Preservation: ice	Preservation: other	Container (No. & type)	pH	Metals (M13 ultra trace)	Free Cyanide	WAD Cyanide	Cr VI (ultra trace)	TPH C6-C36	TDS	SVOC (ultra trace)	VOCs	Total Sulfur	Dissolved Iron	Nitrate	Ammonia	Total Organic Carbon	Major Cations and Anions	Minor Anions	Remarks & comments
1	IT1_shallow	~~24/03/2010~~	25-3-10		X		X	X	X		*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IT1-S
2	IT1_Mid	24/03/2010									*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IT1-M
3	IT1_Deep	24/03/2010									*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IT1-D
4	IT2_shallow	24/03/2010									*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IT2-S
5	IT2_Mid	24/03/2010									*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IT2-M
6	IT2_Deep	24/03/2010									*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IT2-D
7	Stilling Well(SW)	24/03/2010									*	~~X~~	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	SW
8	QC331	24/03/2010									*		X	X	X	X	X		X	X	X	X	X	X	X	X	X	
Acknowledge 9507	QC332	24/03/2010									*		X	X	X	X	X		X	X	X	X	X	X	X	X	X	Please forward to Labmark with COC
9	QC333	24/03/2010									*		X				X			X								Rinsate
10	TB307	24/03/2010			X			X	X	X	*									X								

Environmental Division
Sydney
Work Order
ES1005598
Telephone : +61-2-8784 8555

Relinquished By:
Name: Lauren Kontus
Date: 24 Mar 2010
Time:
of: AECOM

Received by: Keith 25/03/10 4:00 pm
Name:
Date:
Time:
of:

Relinquished By:
Name:
Date:
Time:
of:

Received by:
Name:
Date:
Time:
of:

Received in good condition?	Yes/No/NA	Method of Shipment	
Samples received chilled?	Yes/No/NA	Consignment Note No.	
	Yes/No/NA	Transport Co:	

Received in good condition?	Yes/No/NA	Method of Shipment	
Samples received chilled?	Yes/No/NA	Consignment Note No.	
	Yes/No/NA	Transport Co:	

Worldwide Locations

Australia	+61-2-8484-8999
Azerbaijan	+994 12 4975881
Belgium	+32-3-540-95-86
Bolivia	+591-3-354-8564
Brazil	+55-21-3526-8160
China	+86-20-8130-3737
England	+44 1928-726006
France	+33(0)1 48 42 59 53
Germany	+49-631-341-13-62
Ireland	+353 1631 9356
Italy	+39-02-3180 77 1
Japan	+813-3541 5926
Malaysia	+603-7725-0380
Netherlands	+31 10 2120 744
Philippines	+632 910 6226
Scotland	+44 (0) 1224-624624
Singapore	+65 6295 5752
Thailand	+662 642 6161
Turkey	+90-312-428-3667
United States	+1 978-589-3200
Venezuela	+58-212-762-63 39

Australian Locations

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Brisbane
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Melbourne
Newcastle
Perth
Sydney
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