9 July 2013

Lend Lease Developments
30 The Bond,
30 Hickson Road,
Miller's Point, NSW 2000

Attention: **James Hammill**

Dear James,

RE: Supplementary Monitoring & Assessment Works - The Haymarket, Sydney

1. Introduction

Coffey Environments Australia Pty Ltd (Coffey) was commissioned by Lend Lease Development (LLD) to carry out additional groundwater and surface water monitoring in relation to the proposed redevelopment of the Haymarket, Sydney. Specifically, these monitoring works aim to gather data to assess whether groundwater encountered during the proposed redevelopment of the site could be discharged to local sewer connection or existing stormwater conduits that drain to Cockle Bay. Coffey was also appointed to carry out a preliminary dewatering appraisal to estimate the inflow of water anticipated during a possible localised construction excavation.

The scope of the monitoring and assessment works has been developed in response to comments made by the Environment Protection Authority (EPA) in their letter addressed to the Department of Planning and Infrastructure dated 10th May 2013 following a review of information submitted within LLD's Stage 1 Development Application (DA) for the redevelopment of the Haymarket Precinct.

Details of the planned assessment are provided in Coffey's proposal dated 27th May 2013 (ref: ENAURHOD04498AA-P07).

2. Proposed Development

LLD, on behalf of Darling Harbour Live, has applied for planning approval for development of the Haymarket Precinct for a mixture of residential and commercial uses with surrounding public realm having managed landscaped and paved areas. No basements are proposed as part of this development. As such, extensive construction dewatering is not anticipated during construction. However, localised elements of the development, such as service shafts and utilities, may require temporary dewatering during construction. Due to the design adopted, LLD do not anticipate any ongoing groundwater monitoring or management.

The proposed development will be constructed in a number of stages. As such, the anticipated peak volume of water abstracted from construction excavations at any one time would be less than if the development was constructed in a single stage.

At present, the following options are available to manage groundwater extracted from construction excavations:

Coffey Environments Australia Pty Ltd ABN 65 140 765
Level 19, Tower B, Citadel Tower 799 Pacific Highway
Chatswood NSW 2067 Australia
T +61 2 9406 1000 F +61 2 9406 1002 coffey.com

- temporary storage, transport and disposal offsite at a licensed liquid waste facility;
- on-site treatment and discharge to Cockle Bay via stormwater drains; or
- on site treatment and discharge to sewer connection.

As the site development is likely to occur in stages, one of the above options may be preferred for a particular stage of the project due to change in disposal quantity and access to means of disposal. For these reasons, LLD has not selected a preferred water management option, or specific discharge location. Selection of the most appropriate groundwater management treatment options will be determined and approved in accordance with the regulatory requirements as part of the detailed construction planning process.

3. Objectives

The objectives of additional groundwater and surface water monitoring were:

a) Present an assessment of water quality conditions in Cockle Bay relative to the Guidelines for Fresh and Marine Water Quality and the Marine Water Quality Objectives for NSW Ocean Waters;

b) Provide an assessment of the suitability of groundwater for discharge either to sewer under a trade waste agreement or to Cockle Bay via local stormwater drainage. This assessment would consider available groundwater data, and data collected during this assessment;

c) Comment on whether treatment of groundwater would be required prior to discharge either to sewer or to stormwater drain;

d) Outline recommendations for monitoring to periodically check that groundwater discharges meet quality limits relevant for discharges to Cockle Bay or local sewer connection; and

e) Assess potential water inflows expected during possible localised construction excavation as part of the proposed redevelopment of the site.

4. Site Description

The site is located within the Haymarket district of Sydney's Central Business District and comprises the Sydney Entertainment Centre (SEC), associated car park and surrounding public realm. The location of the site is shown in Figure 1.

The site occupies an area of approximately 3.7ha and is generally bound by Pier Street and the off-ramp linking Pier Street and Darling Drive to the north. Hay Street forms the southern boundary to the site. The light rail corridor forms the west and Harbour Street to the east. The boundaries of the site are shown in Figure 2.

The site historically formed a part of Long Cove, a watercourse which extended generally north-south through the site. Much of the central parts of the site remained submerged until c.1860 where large scale land reclamation took place to establish railway and marine port infrastructure to the north of the site.

5. Review of Hydrogeological Conditions

Published geological records indicate the fill material overlies Quaternary-aged alluvium, which comprises gravel, sand, silt and clay deposits. Fill materials comprised heterogeneous mixtures of gravelly sand, sandy gravel, gravelly clay, clay and sandy clay/silt. The thickness of fill materials recorded within the site was variable ranging between 0.4m and 5.0m below ground surface (mbgs), with the thickness of fill materials increasing along the Long Cove paelochannel. The alluvial deposits are underlain by residual soil and rock of Triassic-aged Hawkesbury Sandstone Formation which comprises sandstone, quartz and shale. The sandstone bedrock beneath the SEC is intersected by the Great Sydney Dyke, which

comprises a dolerite intrusion through the sandstone. The dyke is orientated in a southeast-northwest direction through the southern part of the site (Coffey, August 2011a).

Recent ground investigations (Coffey, January 2013) recorded groundwater strikes at depths 2.4mbgs (BH120) to 3.0mbgs (BH118, BH127) which coincided predominantly with the upper alluvial deposits.

Coffey (August 2011a) reported that groundwater flows in a northerly direction towards Cockle Bay. Standing groundwater levels were recorded in MW120 using a data logger to assess the influence on tidal fluctuations (Coffey, January 2013). Groundwater levels measured over a 5 day period ranged between 0.751m and 0.788m Australian Height Datum (AHD), which suggests that tidal fluctuations have negligible influence on groundwater levels within the site.

No water bodies are located within the site. Cockle Bay is the nearest surface water feature and is located approximately 475m to the north. Coffey (June 2012b) notes that there are a number of artificial water features within land surrounding the site (e.g. Sydney Chinese Garden of Friendship site). It is understood these water bodies are tanked structures which are hydraulically separated from the underlying groundwater.

6. Review of Stormwater & Sewer Drainage Plans

The site is served by an established sewer and stormwater drainage network. Plans showing the location of this existing infrastructure are provided in Appendix A. These records indicate that stormwater from the site is channelled towards Cockle Bay via two separate conduits which pass through the site. The discharge locations shown in Hyder Consulting Drawing SKC013 (Rev. 02) (refer Appendix A) was used to determine the surface water sampling locations at the southern end of Cockle Bay.

7. Fieldwork & Laboratory Analysis

Investigation works for this assessment occurred on 20th and 21st June 2013 and included:

- Rising/falling head tests on two ground water monitoring wells (CBH9/MW9 and NBH/MW25) to estimate the hydraulic conductivity of the aquifer;
- Groundwater sampling from existing nine (9) groundwater wells installed within, or immediately adjacent to the Haymarket site. The groundwater wells sampled included BH1, CBH/MW6, CBH/MW9, BH12, BH13, NBH/MW25, NBH/MW30, BH120 and BH124. The location of these groundwater wells is shown in Figure 3; and
- Surface water sampling at three separate locations from Cockle Bay, including two locations at the southern end of Cockle Bay (SW1 and SW2) at existing stormwater discharge points, and one reference sampling point (SW3) located at the Pyrmont Bay Ferry Wharf. The surface water sampling locations are shown in Figure 4. Both a primary and field duplicate sample was collected from each sampling location to assess potential variability in chemical concentrations.

Groundwater and surface water sampling methodologies used in this assessment are presented in Appendix B.

- Groundwater and surface water samples were submitted for analysis at Eurofins MGT laboratory who hold NATA accreditation for the analyses scheduled. Groundwater samples were analysed for:
  - i) Total Petroleum Hydrocarbons (TPH)
  - ii) Benzene, Toluene, Ethylbenzene and Xylene (BTEX)
  - iii) Polycyclic Aromatic Hydrocarbons (PAH)
  - iv) Heavy metals including arsenic, cadmium, chromium (total), copper, iron, lead, manganese, mercury, nickel and zinc.

v) Major anions (nitrate, chloride, and sulphate) and cations (sodium, calcium, magnesium and potassium), ammonia and alkalinity

- Surface water samples were analysed for the above parameters with the exception of major anions and cations, and alkalinity;
- Laboratory analytical results are summarised in tables presented in Appendix E. Laboratory analytical certificates are presented in Appendix F; and
- The following field Quality Control (QC) measures were employed during the sampling event:

  i) Collection and analysis of one blind duplicate sample (DUP1). A primary and blind duplicate sample was collected from MW25.

  ii) Collection and analysis of one equipment rinsate sample (WB). The equipment rinsate sample was collected by pouring deionised water over the IP meter following decontamination (refer Appendix B).

  iii) Inclusion and analysis of one laboratory prepared trip blank (TB) and trip spike sample (TS).

  iv) Samples were collected in laboratory provided containers and transported to the laboratory under Chain of Custody control.

  Field QC data is presented in Tables 5 and 6 in Appendix E. An appraisal of the QC procedures adopted for this assessment is presented within Appendix G.

8. Discussion of Results

8.1 Water Quality Assessment Criteria

Discussion of selection of water quality assessment criteria is provided in Appendix D and values are included in data summary tables where appropriate.

8.2 Assessment of Surface Water Quality

With reference to the visual amenity objectives set out within Marine Water Quality Objectives for NSW Ocean Waters, the following was noted during the collection of the surface water samples:

- No visual or olfactory indications of chemical contamination were observed during the collection of surface water samples at any of the sampling locations;
- Floating debris occurred at the three sampling locations. Debris included general rubbish items (e.g. food wrappers, drink containers etc.) but were not present on a widespread basis; and
- Evidence of nuisance organisms (e.g. phytoplankton scums, filamentous algal mats, blue-green algae, and sewage fungus etc.) was not observed at any of the sampling locations.

Analytical results from the six surface water samples collected from Cockle Bay were compared against the trigger values for the protection of marine water species (refer Table 4, Appendix E). In summary, the following was noted:

- The water quality reported within samples collected at the southern end of Cockle Bay were generally comparable to the samples collected at the reference sampling point (SW3) located at the Pyrmont Bay Ferry Wharf;
- Concentrations of TPH, BTEX and PAH compounds were reported below the LOR in all samples collected;
- Concentrations of arsenic, cadmium, chromium, iron, lead, manganese and nickel were reported below the LOR in all samples collected;

- Concentrations of copper were reported above the assessment criterion in one sample (SW2B; 0.005mg/L) collected from the southern end of Cockle Bay. It is noted that both samples collected from the reference sampling location (SW3A and SW3B; both reported a concentration of 0.006mg/L) also reported concentrations of copper above the assessment criterion; and
- Concentrations of mercury were reported in one sample collected from the southern end of Cockle Bay (SW1A; 0.0002mg/L). All other samples reported concentrations below the laboratory limit of reporting (LOR).

In summary, the findings of the surface water quality assessment are considered to be indicative of a modified and highly trafficked marine environment. The analytical results of samples collected from Cockle Bay suggest that chemical quality of this water body generally meets the trigger levels for the protection of marine aquatic species as set out within ANZECC (2000). The presence of heavy metals such as copper and mercury may be attributable to antifouling measures applied to older ships and other marine structures, and/or derived from runoff from the urban environment which surrounds Cockle Bay, rather than a specific point source. With reference to the visual amenity criteria set out within the Marine Water Quality Objectives for NSW Ocean Waters, it is assessed that Cockle Bay generally meet these criteria although the presence of occasional floating debris was observed during sampling.

8.3 Assessment of Groundwater Quality – Discharge to Stormwater System

Analysis of groundwater samples collected from across the site indicates a pH neutral, brackish to saline environment which is consistent with historical reclamation of the land and with the proximity of the site to Cockle Bay.

A review of the proportion of major cations and anions within groundwater samples collected from the site indicates that the chemistry of groundwater within the central part of the site (i.e. those areas that were historically reclaimed) considerably different to that along the periphery of the site. The dominant ions present within samples collected from the central parts of the site are sodium and chloride, which is likely to be associated with the former Long Cove channel that historically dissected the site.

The ion balance is presented in Table 3 in Appendix E, and is illustrated graphically in Figure A

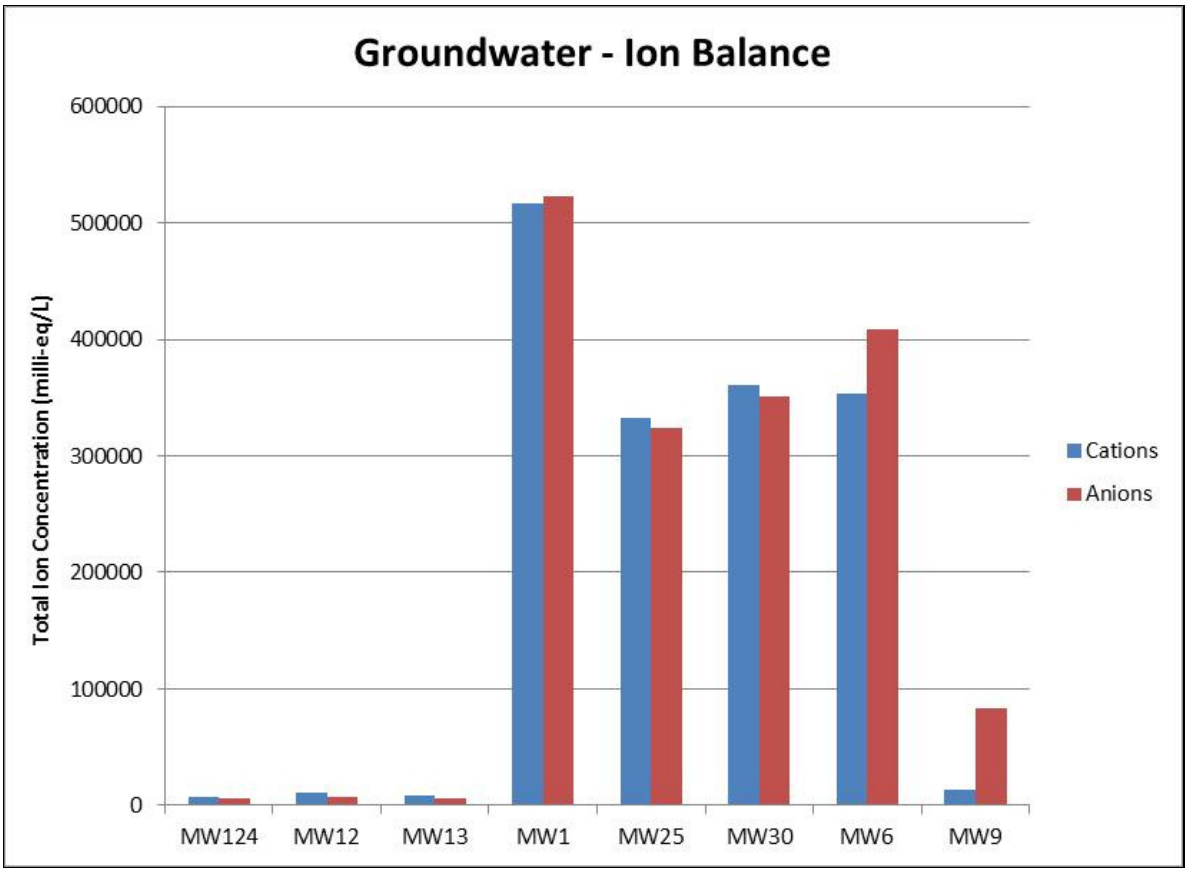


Figure A: Ion balance of groundwater samples collected within the site.

Groundwater samples have been collected from the site over five separate rounds although not all wells were sampled during each round. Groundwater analytical data collected from previous and the most recent sampling events are presented in Table 1 in Appendix E. This data has been compared to the trigger values for the protection of marine water species set within ANZECC (2000). In summary, the results indicated:

- No Phase Separated Hydrocarbon (PSH) was observed in any of the monitoring wells;
- Concentrations of PAH were reported below the LOR in all samples collected during the most recent event. Concentrations of PAH compounds were identified above the LOR in groundwater samples from MW9, MW25, MW30 during a previous sampling event. Analysis of filtered duplicate samples indicated that the reported PAH compounds were attributable to the inclusion of fine suspended sediment rather than dissolved within the groundwater itself (Coffey; Jan 2013);
- Compounds including BTEX, VOC and SVOC were reported below the LOR in all samples;
- TPH C_6-C_9 was identified in one groundwater sample from MW120 at 30µg/L which is slightly above the LOR (20µg/L). On review of the soil results, TPH C_6-C_9 and other indicator compounds such as Benzene, Toluene, Ethylbenzene, Xylene were not recorded above the LOR in any of the seven soil samples from this borehole (Coffey, Jan 2013). Furthermore, soil headspace measurements ranged from 0.9ppm to 10ppm suggesting a low likelihood that volatile hydrocarbons are present within the soil at this location. TPH C_6-C_9 was not reported above the LOR in groundwater samples collected during the June 2013 sampling event;

- TPH C_{10}-C_{14} and C_{15}-C_{28} were reported at concentrations less than the LOR with exception for the groundwater sample collected from MW124 during June 2013 sampling event. Concentrations of TPH C_{10}-C_{14} and C_{15}-C_{28} where reported at 80µg/L and 200µg/L respectively which is slightly above the LOR. During the previous sampling round, insufficient water was present to collect a representative sample from this well. Soil data (Coffey Jan 2013) from this position indicates that TPH C_{10}-C_{14} and C_{15}-C_{28} compounds were reported at depths between 2.9m and 4.8m below ground surface (mbgs), which may be the source of TPH impact to groundwater reported at this location;
- Arsenic, copper, chromium, lead, zinc were reported at concentrations above the assessment criteria in a number of samples. It is noted that arsenic, copper and zinc were reported at concentrations exceeding the assessment criteria in at least one sample from each of the previous groundwater monitoring events, where metals were scheduled for analysis;
- Concentrations of iron were reported above the aesthetic assessment criterion in one sample (MW124; 3.6mg/L) of the eight samples submitted for analysis. It is noted that pH of the groundwater sample recovered from MW124 was slightly acidic (6.31) which may promote the release of iron from the underlying sandstone;
- Manganese was reported at concentrations exceeding the assessment criterion in four samples (MW124, MW13, MW6, MW25) of the eight submitted for analysis; and
- Concentrations of ammonia were reported above the adopted assessment criteria in six of the eight samples submitted for analysis. Groundwater samples collected during previous events were not analysed for ammonia. The presence of ammonia in groundwater may derive from the degradation of organic materials within the naturally occurring alluvial sediment within an anaerobic environment, or leaking sewer pipes which is not uncommon with older infrastructure, particularly where land has been reclaimed.

In summary, it is assessed that the direct discharge to Cockle Bay of groundwater abstracted from excavations during construction would contribute to the existing contaminant load within Cockle Bay. In consideration of the magnitude of chemical concentrations detected in the majority of groundwater samples, and the dilution potential of receiving stormwater and that of Cockle Bay itself, it is assessed that any increases in chemical concentrations would generally be below the limits of detection. However, detailed assessment would be required where excavation dewatering is proposed in areas of the site where elevated concentrations of certain chemical stressors have been reported; namely MW124 (TPH, iron and ammonia), MW1 (copper and zinc) and MW9 (Ammonia). This assessment would form part of the detailed construction management planning process for each stage of the proposed development.

As well as possible chemical stressors, groundwater abstracted from excavations at the site is likely to include suspended solids. Direct discharge of sediment laden groundwater to stormwater drains that discharge to Cockle Bay would almost certainly generate visual sediment 'plumes' which would be aesthetically unacceptable. It is noted that a proportion of the chemical constituents reported within groundwater readily adsorb to sediment, which may lead to further concentration of certain chemical constituents in areas surrounding the existing stormwater outfalls.

8.4 Assessment of Groundwater Quality – Discharge to Sewer

Available groundwater analytical results were compared to the chemical acceptance standards set out within Sydney Water's *Acceptance Standards and Charging Rates for 2013–14 – Industrial Customers*. The output of this comparison is summarised in Table 2, Appendix E. In summary, the following is noted:

- All chemical constituents were reported below the chemical acceptance standards set by Sydney Water; and

- With reference to available laboratory data and electrical conductivity measurements during the collection of groundwater samples, it is assessed that the concentrations of Total Dissolved Solids (TDS) reported in samples collected from MW1, MW25, MW30, MW6 and MW9 exceed the allowable level stipulated by Sydney Water. In consideration of the setting of the site, it assessed that the TDS load is primarily due to the presence of marine salts. Samples collected from MW124, MW12 and MW13 report a TDS less than the limit stipulated by Sydney Water.

8.5 Requirements for Treatment

On the basis of groundwater analytical data available for the site, it is assessed that groundwater abstracted from excavations within the site during construction would not be suitable for direct discharge to existing stormwater drainage or local sewer connection without some prior treatment which would depend on the location of dewatering.

Groundwater abstracted from excavations during construction is likely to have high levels of suspended solids and treatment would be required to reduce the sediment load prior to discharge from site. However, where discharge to sewer is proposed, the extent of treatment for suspended solids required would be less than that required for discharge to stormwater drainage system.

Treatment of suspended solids within groundwater would typically be achieved through primary sedimentation and filtration processes. However, further appraisal of the settleable characteristics of the sediment would be required to determine if flocculation is necessary, particularly where discharge to the stormwater system is proposed. This appraisal would form part of the detailed construction management planning process for each stage of the proposed development.

As noted in Section 2, several options to manage groundwater extracted from construction excavations are available. The selection of a specific management option and discharge location would depend on factors including the staging of site development, requirements for dewatering during that particular stage and the quality of water likely to be encountered as part of proposed works. A specific management option and discharge location, quantities and programme would be provided with any application for consent to discharge to the existing stormwater or sewer network.

8.6 Recommendations for Water Monitoring During the Construction Phase

Discharge of treated groundwater to either stormwater or sewer connections would require consent prior to discharge. Coffey understands that Sydney Water and the City of Sydney (in consultation with the NSW EPA) would be the consent authority for discharging groundwater to sewer and stormwater network respectively. The conditions of this consent would stipulate the minimum requirements for monitoring.

At this stage, based on the known site history, monitoring of treated groundwater is likely to include:

- pH;
- Suspended and Total Dissolved Solids;
- Heavy metals including arsenic, cadmium, chromium, copper, iron, lead, nickel, manganese, mercury and zinc;
- Inorganics including ammonia, nitrate, sulphide and sulphite; and
- Petroleum Hydrocarbons (TPH, BTEX and PAH)

In addition to the above, it is assessed that discharge rates would also need to be monitored and recorded.

8.7 Preliminary Dewatering Appraisal

8.7.1 Overview

Coffey understands that the proposed development does not include basements or other structures of substantial area below the groundwater level. Hence, extensive construction dewatering will not be required. However, elements of the development may require localised dewatering. These elements could include:

- Trenches for drainage and sewer works;
- Lift pits associated with new tower structures;
- Water retention structures as part of WSUD initiatives; and
- Grease traps for trade waste generated from retail uses.

It is understood that these elements will be tanked and will not experience groundwater inflow/seepage during operation. However, these elements may require temporary localised dewatering during construction.

Coffey understands that design of the above listed elements is currently incomplete and details on the likely location and geometry of such structures are currently unavailable. Furthermore, construction programme information is not available. As such, it is not possible to reliably estimate the volume of water expected to be discharged, or the frequency of any discharges during construction at this stage. However, data from the rising/falling head tests carried out have been used to estimate groundwater inflow/seepage rates anticipated within typical excavations likely to be constructed on site during the proposed redevelopment. These inflow rates may be used to develop volume estimates associated with excavation dewatering.

8.7.2 Rising/Falling Head Test

To estimate the hydraulic conductivity of the aquifer, rising/falling head test has been carried out on groundwater monitoring wells CBH9/MW9 and NBH/MW25. Testing involved introduction of a plastic tube filled with sand into the borehole. This displaced water causing a temporary water level rise. The water level gradually recovered and the recovery was monitored using a pressure transducer and a data logger (a falling head test). Once the water level had recovered, the plastic tube was removed resulting in a temporary reduction in water level in the borehole. The water level gradually recovered and the gradual rise was monitored using a pressure transducer and data logger (a rising head test). A Solinst 'Levellogger' data logger (Serial No. 10175958) was used to measure changes in water levels during the rising and falling head tests.

The results of the rising and falling head tests were analysed using the methods developed Hvorslev (1951) were used to assess the hydraulic conductivity of materials adjacent to the borehole screen.

Analysis involves matching a straight-line solution to water-level displacement data collected during the test. The results of this assessment are presented in Figures 1 to 4 in Appendix H, and summarised in Table 8.1 below.

Table 8.1 – Hydraulic Conductivity Assessment from of Falling and Rising Head Tests

Borehole	Falling Head Test Result (m/d)	Rising Head Test Result (m/d)
CBH/MW9	0.06	0.07
NBH/MW25	0.18	0.11

Results for NBH/MW25 indicated higher permeability than that reported for CBH9/MW9. Falling and rising head test results reflect only a small volume of material surrounding a borehole as a result they may not be representative of the material properties over the site.

8.7.3 Assessment of Groundwater Inflow Rates during Construction

Elements of the development noted in Section 8.7.1 that may require dewatering during construction above fall within two broad categories:

i) Narrow longitudinal excavations where one side of the excavation area is significantly longer than the other, such as trenches for drainage/sewer lines; and

ii) Rectangular excavations, such as for lift pits and water retention (tank) structures.

Therefore, a preliminary assessment of the likely groundwater inflow during construction to two types of excavation has been presented in this section. A longitudinal excavation running north-south across the site (representative of trench excavation for drainage/sewer construction) and rectangular excavations (representative of excavation for lift pits, stair bases, grease traps, or other water retention structures).

The assessment was made using analytical methods assuming radial flow to rectangular excavations and parallel flow to linear excavations (trenches).

For the purpose of these assessments the following assumptions were made:

- Groundwater level is 2.4m below ground (based on site measurements);
- Hydraulic conductivity of fill is 0.2m/d (i.e. upper end of falling/rising head test results);
- Excavation of pits will be constructed no more than 2m below the groundwater level and excavation of trenches no more than 1m below groundwater level;
- Low permeability rock at a depth of 10m below ground level (typical value from earlier field studies); and
- No high permeability features such as gravel filled trenches intersect excavations below the water table.

Based on these assumptions it is assessed that inflow to individual open pits of up to 5m x 10m would be unlikely to exceed 0.2L/s and inflows to trenches would be unlikely to exceed 0.5L/s per 100m length of trench. Inflows would be greatest immediately following excavation and would reduce over time as the extent of influence gradually increases.

Should materials different from those anticipated for this assessment be encountered in subsequent investigations or during excavation it is recommended that further advice be obtained.

It is noted that this advice does not address stability of open excavations. Coffey recommends that specific geotechnical advice should be obtained in relation to shoring or battering of excavations deeper than 1.5m, or excavations below the groundwater table.

9. Limitations

Coffey notes that subsurface conditions are inherently variable both with location horizontally and vertically and over time. It is impractical to assess conditions at every location on a site and Coffey has used professional judgement of suitably qualified and experienced staff to provide an interpretation of conditions across the site.

The reader is directed to “Important Information About your Coffey Environmental Report”, which is attached to this text.

10. Closure

We trust the assessment outlined herein meets your immediate requirements. If you do have any further queries, please do not hesitate to contact us.

The attached document entitled “Important Information about your Coffey Report” presents additional information about the uses and limitations of this report.

Yours sincerely,

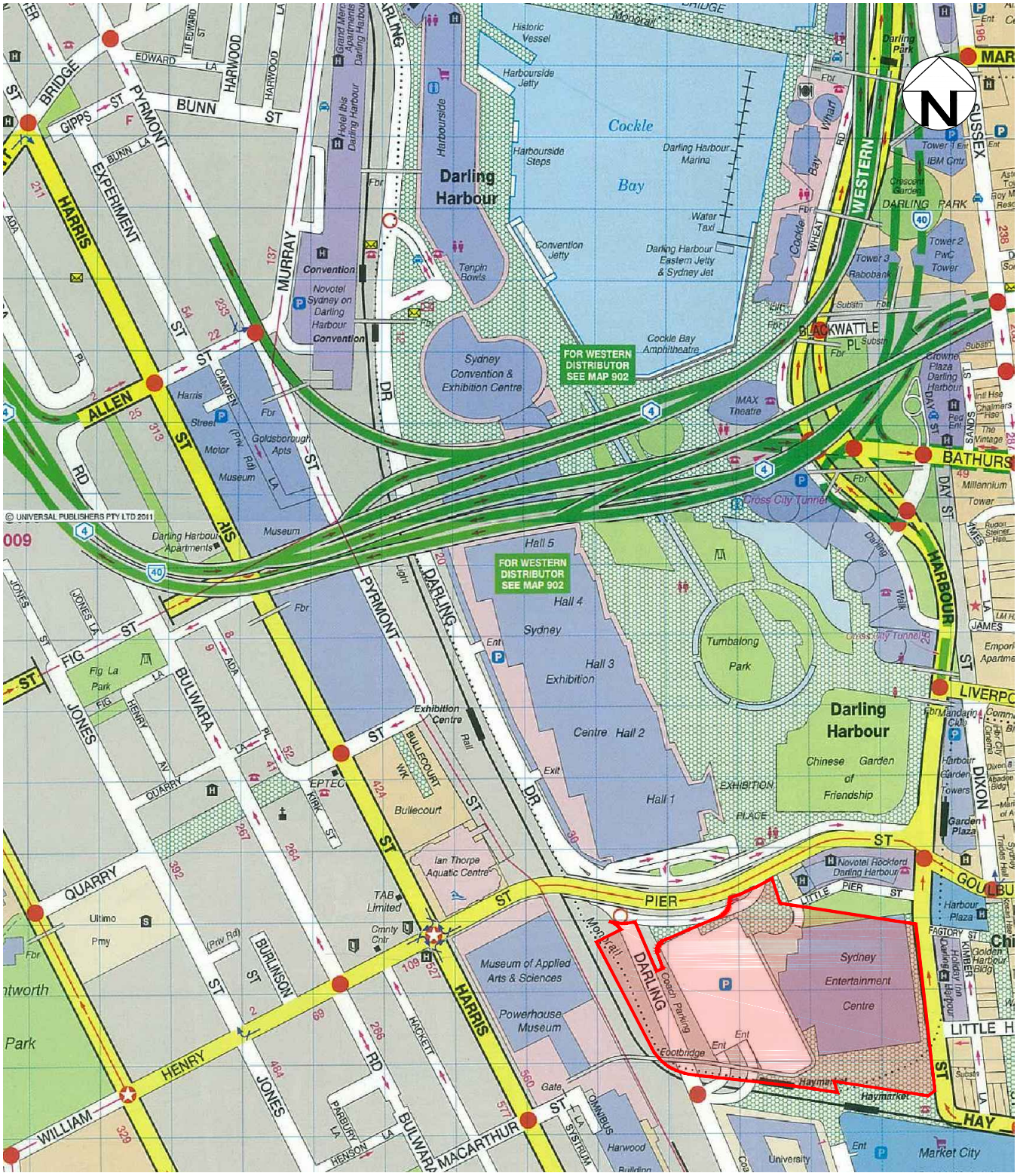
Matthew Locke
Senior Associate

Michael Dunbavan
Senior Principal

Attachments:

Important Information about your Coffey Report

FIGURES



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LEGEND

SITE BOUNDARY
(REFER TO APPENDIX B, RYGATE PLAN No. 75813-3 FOR SURVEY DETAIL)

drawn	MV
approved	ML
date	03/07/13
scale	AS SHOWN
original size	A4

coffey

client: LEND LEASE DEVELOPMENT

project: SUPPLEMENTARY MONITORING & ASSESSMENT WORKS TO RESPOND TO EPA COMMENTS ON GROUNDWATER
THE HAYMARKET, SYDNEY, NEW SOUTH WALES

title: SITE LOCATION MAP

project no: ENAURHOD04498AB-D01

figure no: FIGURE 1

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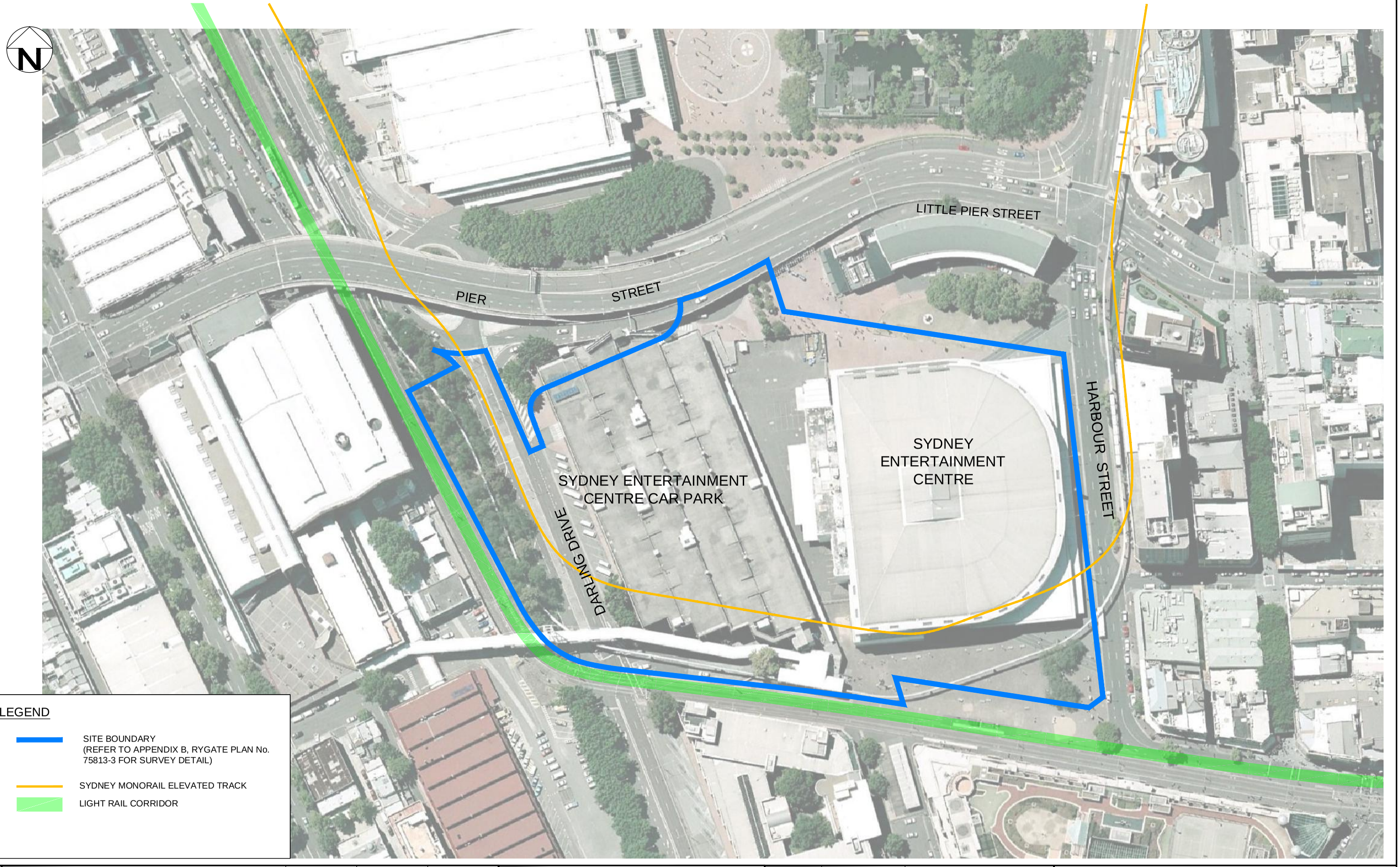

revision	description	drawn	approved	date

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drawn	MV
approved	ML
date	03/07/13
scale	1:1500
original size	A3

coffey

client: LEND LEASE DEVELOPMENT

project: SUPPLEMENTARY MONITORING & ASSESSMENT WORKS TO RESPOND TO EPA COMMENTS ON GROUNDWATER THE HAYMARKET, SYDNEY, NEW SOUTH WALES

title: SITE LAYOUT PLAN

project no: ENAURHOD04498AB-D01 figure no: FIGURE 2

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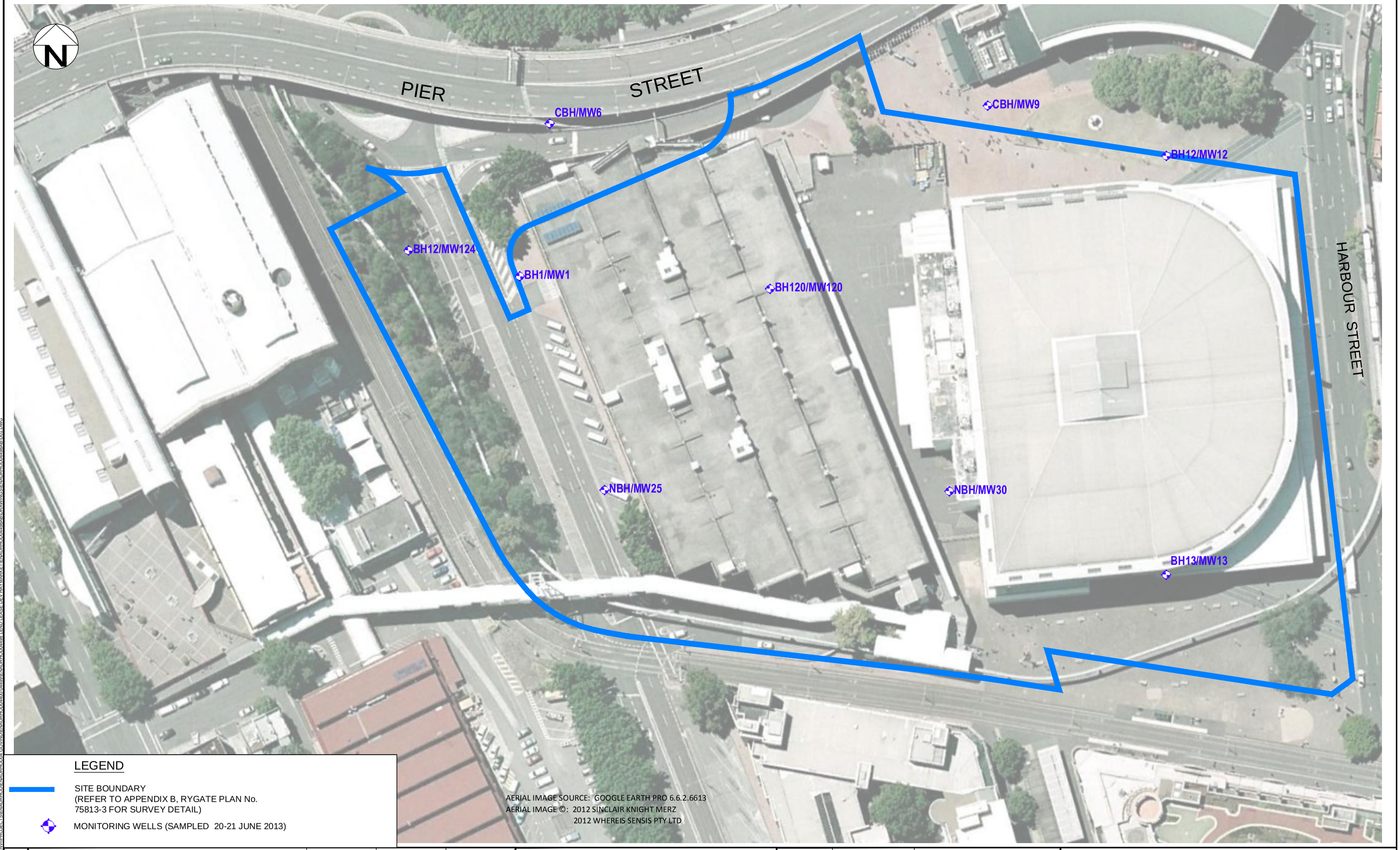

LEGEND

SITE BOUNDARY
(REFER TO APPENDIX B, RYGATE PLAN No. 75813-3 FOR SURVEY DETAIL)

MONITORING WELLS (SAMPLED 20-21 JUNE 2013)

revision	description	drawn	approved	date

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Scale (metres) 1:1000

drawn	MV
approved	ML
date	03/07/13
scale	AS SHOWN
original size	A3

coffey

client: LEND LEASE DEVELOPMENT

project: SUPPLEMENTARY MONITORING & ASSESSMENT WORKS TO RESPOND TO EPA COMMENTS ON GROUNDWATER THE HAYMARKET, SYDNEY, NEW SOUTH WALES

title: GROUNDWATER SAMPLING LOCATIONS

project no: ENAURHOD04498AB-D01 figure no: FIGURE 3

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LEGEND

SW ✕ SURFACE WATER SAMPLE LOCATION (JUNE 2013)

revision	description	drawn	approved	date

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 6.6.2.6613
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scale	AS SHOWN
original size	A3

coffey

client: LEND LEASE DEVELOPMENT

project: SUPPLEMENTARY MONITORING & ASSESSMENT WORKS TO RESPOND TO EPA COMMENTS ON GROUNDWATER THE HAYMARKET, SYDNEY, NEW SOUTH WALES

title: GROUNDWATER SAMPLING LOCATIONS

project no: ENAURHOD04498AB-D01 figure no: FIGURE 4

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REFERENCES

Information from the following reports was used to prepare this assessment:

- Coffey Geotechnics (July 2011); *Environmental Desk Study: Proposed Sydney International Convention and Entertainment Centre, Darling Harbour* prepared for SHFA.
- Coffey Geotechnics (August 2011a) *Geotechnical Investigation Report: Proposed Sydney International Convention and Entertainment Centre, Darling Harbour* prepared for SHFA.
- Coffey Geotechnics (August 2011b); *Contamination Investigation, Sydney International Convention and Entertainment Centre* prepared for SHFA.
- Coffey Geotechnics (May 2012); *Geotechnical Investigation Report: Proposed Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney* prepared for INSW.
- Coffey Geotechnics (June 2012a); *Stage 1 – Preliminary Environmental Investigation, Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney* prepared for INSW.
- Coffey Geotechnics (June 2012b); *Stage 2 – Detailed Site Investigation: Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney* prepared for INSW.
- Coffey Geotechnics (August 2012); *Supplementary Site Investigation: Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney* prepared for INSW.
- Coffey Geotechnics (January 2013); *Supplementary Site Investigation: Factual Report, Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour* prepared for INSW.
- Coffey Environments (February, 2013); *Site Investigation Factual Report: Haymarket Precinct, Darling Harbour, Sydney, NSW* prepared for INSW.
- Coffey Environments (March 2013); *Overarching Remedial Action Plan: Haymarket Precinct, Darling Harbour, Sydney, NSW* prepared for LLD.
- Coffey Environments (June 2013); Site Specific Remedial Action Plan for the Haymarket Planning Application, Haymarket, Sydney, NSW prepared for LLD.

APPENDIX A

PLANS SHOWING THE LOCATION OF EXISTING SEWER AND STORMWATER INFRASTRUCTURE

EXISTING STORMWATER NOTES

THE EXISTING STORMWATER SHOWN ON THIS DRAWING HAS BEEN PLOTTED FROM INFORMATION SUPPLIED FROM CITY OF SYDNEY COUNCIL AND SYDNEY WATER REPORT "CITY AREA SWC 30 CAPACITY ASSESSMENT – JULY 1996". THE EXISTING STORMWATER INFORMATION HAS BEEN PREPARED ONLY TO SHOW THE APPROXIMATE POSITIONS OF ANY KNOWN STORMWATER AND MAY NOT BE AS CONSTRUCTED OR ACCURATE. HYDER CONSULTING CAN NOT GUARANTEE THAT THE STORMWATER INFORMATION SHOWN ON THIS DRAWING ACCURATELY INDICATES THE PRESENCE OR ABSENCE OF STORMWATER INFRASTRUCTURE OR THEIR LOCATION AND WILL ACCEPT NO LIABILITY FOR INACCURACIES IN THE STORMWATER INFORMATION SHOWN FROM ANY CAUSE WHATSOEVER.

SYDNEY INTERNATIONAL CONVENTION, EXHIBITION AND ENTERTAINMENT PRECINCT

TITLE:

EXISTING STORMWATER

DRAWN BY: KMc
DATUM: AHD
SCALE (A1): AS SHOWN
DRAWING NO: SKC013
PROJECT NO: AA004399
REV: 02

0 30 60 90 120 150m
1 : 1500

Date Plotted: 23 May 2012 - 08:46AM File Name: F:\AA004399\E-CAD\C-Civil\B-Sketches\SKC013-AA004399-NSD-00-EXISTING-STORMWATER.dwg V1

A0

SP0012

SP0013

SP0014

BLACKWATTLE BAY SWING ST

HAY ST STORMWATER CHANNEL

BENNELONG SUBWAY

THE TANK STREAM

INFORMATION ELSEWHERE: see GUIDE ref 117378
INFORMATION ELSEWHERE: see GUIDE ref 112133

DBYD Address:
n/a Area Bounded By Darling Drive, Pier St And Tumbalong Park
Sydney NSW 2000

DBYD Job No: 102874

DBYD Sequence No: 26622268

SYDNEY WATER CORPORATION

Scale: 1:2000

Date of Production: 08/10/2012

Plan 1 of 1

0m 30m 60m 90m 120m 150m

APPENDIX B

GROUNDWATER AND SURFACE WATER SAMPLING METHODOLOGY

B.1 GROUNDWATER SAMPLING METHODOLOGY

Groundwater monitoring wells were sampled by appropriately quality environmental scientists in general accordance with the methodology outlined in Table B.1.

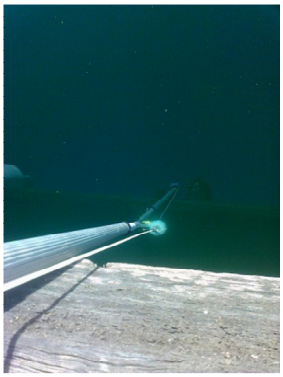
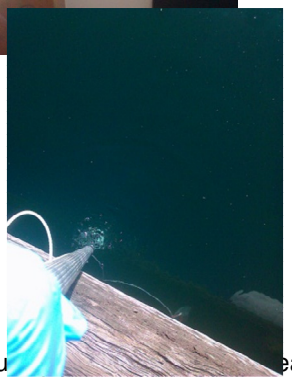
Table B.1: Groundwater Sampling Methodology

Activity	**Detail / Comments**
Groundwater Level & LNAPL Measurements	Groundwater levels and the apparent thickness of any Light Non Aqueous Phase Liquids (LNAPL) were measured using an oil/water interface probe (IP).
Well Purging	Well purging was undertaken in accordance with Coffey Standard Operating Procedure (SOP) using a peristaltic (low-flow) pump with disposal tubing for each well. During purging, groundwater was monitored for pH, Temperature, Dissolved Oxygen, Electrical Conductivity and Redox Potential. In general each well was purged to remove a minimum of three equipment volumes (i.e. volume of sample tubing and flow-through cell) and/or stabilisation of the above water quality parameters (i.e +/- 10%). The following specific comments are noted with regard to well purging: • MW120 was purged dry after the removal of 0.4L. Insufficient water volume to measure post-purge water quality parameters. • MW124 was purged dry after the removal of 1L groundwater. Insufficient water volume to measure post-purge water quality parameters. Groundwater samples were collected from MW120 and MW124 approximately 24hours after well purging.
Sampling Method	In general, groundwater samples were collected following the stabilisation of groundwater quality parameters. Groundwater samples were recovered from each of the monitoring wells using low flow sampling with a peristaltic pump in accordance with Coffey SOP. Due to the poor recharge in MW120, it was not possible to collect sufficient groundwater volume for the full suite of chemical parameters. Samples collected from MW120 were analysed for metals and BTEX compounds. Groundwater sampling records are provided in Appendix C.
Sample Splitting	A blind duplicate sample (DUP1) was collected from MW25 by filling up two sample containers from the same low flow tubing.
Decontamination Procedure	The IP was decontaminated by scrubbing with Decon 90 solution and rinsed with deionised water between wells.
Sample Preservation	Samples were placed in laboratory supplied bottles containing appropriate preservatives and were filled to minimise headspace. Groundwater samples collected for metals were filtered using disposable 0.45µm filter packs. Sample containers were immediately capped and placed in an insulated container filled ice. The samples were dispatched to a NATA accredited laboratory under chain of custody control.

B.2 SURFACE WATER SAMPLING METHODOLOGY

Surface water samples were collected by appropriately quality environmental scientists in general accordance with the methodology outlined in Table B.2.

Table B.2: Surface Water Sampling Methodology

Activity	Detail / Comments
Sampling Method	Surface water samples were collected from three sampling locations shown in Figure 4 using a dedicated long handled Swing Sampler. The pivoting head of the Swing Sampler was fixed so that the sampling bottle was in parallel with the sampler handle. The sample bottle was secured using elastic bands and masking tape. An indicator mark 1m above the top of sample container was made on the extendable handle of the Swing Sampler so that water samples were collected at practically the same depth. A small piece of plastic film was placed over the top of the open sample bottle and secured with an elastic band (refer Picture (a)). The elastic band was attached to a separate length of cord which was held by the environmental scientist carrying out the sampling. Once the plastic cover was in place, the sample bottle was lowered to a depth of approximately 1m below the surface of the water (refer Picture (b)). At the sampling depth, the cord was pulled, which dislodged the plastic film allowing water to enter the sampling bottle (refer Picture (c)). (a)  (b)  (c)  Water qu easured from a sample of the water brought to surface. Surface water sampling records are provided in Appendix C. A primary and field duplicate sample was collected from each sampling location to assess chemical variability between samples. These samples are denoted with the suffix 'A' and 'B'. Each sample was collected using separate laboratory supplied bottles. No sample splitting was carried out. A new piece of plastic film was used when collecting

Activity	Detail / Comments
	each sample.
Sample Preservation & Decontamination	Samples were placed in 1L unpreserved laboratory supplied bottles and were filled to minimise headspace. A new sample container was used to collect each sample. As such, no decontamination of sampling equipment was considered necessary. Each sample bottle was capped and placed in an insulated container filled ice. The samples were dispatched to a NATA accredited laboratory under chain of custody control.

APPENDIX C

GROUNDWATER & SURFACE WATER SAMPLING RECORDS

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Well Gauging Form

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 20/6/13

PROJECT MANAGER: ML

FIELD EQUIPMENT:

Equipment Used: *IP Meter IP Serial Number: Rental

REFER TO SOPs WHEN GAUGING WELLS:

SOP - Monitoring Well Gauging and SOP – Decontamination of Sampling Equipment

Time of Day	Well ID	Well Diameter	Total Well Depth note 1	Depth to PSH (NAPL) [A]	Depth to Groundwater [B]	PSH Thickness [B-A]	Height of Well Stick-Up	COMMENTS (note 2) ODOUR, COLOUR, SHEEN, NAPL (and its colour), REMEDIATION SYSTEM, etc	PID
		mm	m	mBTOC	mBTOC	mm	m		
	MW9	50	5.730	—	2.270	—	flush	Well in good condition. No odour	0.1
	MW24	〃	5.520	—	5.275	—	〃	〃	0.0
	MW25	〃	7.278	—	4.335	—	〃	〃	0.3
	MW13	〃	5.734	—	2.830	—	〃	〃	0.0
	MW12	〃	7.684	—	3.402	—	〃	Concrete/mud in well gattic, around well cap.	0.2
	MW120	〃	2.771	—	2.617	—	〃	Well in good condition. No odour.	0.0
	MW30	〃	4.346	~~2.316~~	2.289	—	〃	Particulate organic matter (POM) - orange. some water in gattic	0.0
	MW6	〃	5.436	—	2.382	—	〃	Well in good condition. Slight HC ~~No~~ odour.	0.4
	MW1	〃	7.170	—	4.105	—	〃	〃 No odour.	0.2
Unidentified well in	MW	50	40.740	—	21.528	—	flush	No well cap. Top of casing appears slightly damaged. Well casing slanted.	

Entertainment Centre loading dock/operations carpark area.

Notes: 1 Indicate in 'Comments' column if measured Total Well Depth differs from log. 2 Do not attempt to sniff the monitoring well to detect any odours, only note any apparent odour when the well cap is opened

coffey environments

Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 21/6/13

PROJECT MANAGER: ML

WELL ID: MW1 **DIAMETER:** 50 mm **WELL DEPTH:** 7.170m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 4.110 m below TOC

After Pump Installation: 4.095 m below TOC

Pump Intake Depth: ~6.5M

WELL HEADSPACE PID READING

PID READING

PPM: 0.2

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
11:35a.m.		1	4.270	3.45	ppm	40.8	mS	7.35		53	mV	17.8	°C		✓				No odour. Pale grey.
11:37		2	4.370	3.79		39.4		7.34		59		18.4			✓				" Colourless
11:39		3	4.455	3.40		40.7		7.34		70		18.5		✓	✓				" "
11:41		4	4.620	2.64		42.0		7.34		77		18.6		✓	✓				" Pale brown
11:43		5	4.775	2.53		43.4		7.39		71		18.9			✓				" "
11:45		6	4.770	3.22		44.0		7.47		19		19.4			✓				" "
11:47		7	5.120	2.96		44.2		7.49		8		19.6			✓				" "
		8	5.315	3.14		44.0		7.51		1		19.5			✓				" "
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

coffey environments

Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHODO44498AB

FIELD PERSONNEL: PD/ACM **DATE:** 21/6/13

PROJECT MANAGER: ML

WELL ID: MW6 **DIAMETER:** 50 mm **WELL DEPTH:** 5.436 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental*

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 2.382 m below TOC

After Pump Installation: 2.361 m below TOC

Pump Intake Depth: ~4.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.4

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
10:39 a.m.		1	2.870	0.33	ppm	35.5	mS	6.94		-95	mV	19.4	°C			✓			No odour. Brown
10:41		2	3.170	0.35		36.7		6.93		-99		20.0			✓				" "
10:43		3	3.390	0.33		36.6		6.93		-99		20.1			✓				" "
10:45		4	3.670	0.28		36.6		6.93		-100		20.2			✓				" "
10:47		5	4.110	0.35		35.0		6.95		-98		20.0			✓				" Pale grey
10:49		6	4.520	1.81		27.1		7.07		-92		19.9			✓				" Pale grey brown
10:51		7	4.910	2.25		26.1		7.09		-81		19.9			✓				" "
10:53		8	5.260	1.77		28.3		7.06		-77		20.1			✓				" "
16:24	Sample		~~6.60~~	6.08		36.1		7.44		-42		19.0			✓				No odour, tinge yellow
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

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Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD / ACM **DATE:** 20/6/13

PROJECT MANAGER: ML

WELL ID: MW9 **DIAMETER:** 50 mm **WELL DEPTH:** _____ m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 2.180 m below TOC

After Pump Installation: 2.155 m below TOC

Pump Intake Depth: ~ 5.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.1

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
10:54a.m		1	2.620	1.36	ppm	1239	uS/cm	6.81		-125	mV	21.5	°C		✓				No odour. Grey.
10:56		2	2.800	0.87		1239		6.80		-133		22.5			✓				〃 〃
10:58		3	2.965	0.64		1240		6.83		-143		22.6			✓				〃 〃
11:00		4	3.163	0.63		1230		6.97		-139		22.4			✓				〃 〃
11:02		5	3.294	0.74		1224		7.03		-142		22.9			✓				〃 〃
11:04		6	3.380	0.62		1221		7.06		-140		22.8			✓				〃 〃
11:06		7	3.475	0.50		1232		7.10		-141		22.2			✓				〃 〃
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

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Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 20/6/13

PROJECT MANAGER: ML

WELL ID: MW12 **DIAMETER:** 50 mm **WELL DEPTH:** 7.684 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 3.410 m below TOC

After Pump Installation: 3.377 m below TOC

Pump Intake Depth: ~7.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.2

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
3:56pm.		1	3.740	0.80	ppm	936	uS/cm	6.57		87	mV	21.8	°C			✓			No odour. Red brown.
3:58		2	3.960	0.84		938		6.56		84		22.3				✓			" "
4:00		3	4.130	0.87		939		6.56		81		22.4				✓			" "
4:02		4	4.290	0.84		943		6.55		73		22.3			✓				" Pale red brown.
4:04		5	4.428	0.88		937		6.54		66		22.5			✓				" "
4:06		6	4.550	0.88		951		6.55		55		22.4			✓				" Red Brown.
		~~7~~																	
		~~8~~																	
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

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Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AA

FIELD PERSONNEL: PD/ACM **DATE:** 20/6/13

PROJECT MANAGER: ML

WELL ID: MW13 **DIAMETER:** 50 mm **WELL DEPTH:** 5.734 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 2.840 m below TOC

After Pump Installation: 2.740 m below TOC

Pump Intake Depth: ~5.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.0

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
3:01p.m.		1	3.210	0.05	ppm	1107	uS/cm	7.75		-270	mV	19.5	°C			✓			No odour. Brown.
3:03		2	3.320	0.75		978		7.41		-181		20.8				✓			〃 〃
3:05		3	3.425	0.70		763		7.36		-173		20.9				✓			〃 〃
3:07		4	3.565	0.53		900		7.30		-172		21.0			✓				〃 Pale grey
3:09		5	3.770	0.30		761		7.27		-175		21.2			✓				〃 Pale grey/brown
3:11		6	3.924	0.40		764		7.24		-173		21.0			✓				〃 Pale grey
3:13		7	4.080	0.46		767		7.23		-171		21.1			✓				〃 Colourless
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

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Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AA

FIELD PERSONNEL: PD / ACM **DATE:** 20/5/13

PROJECT MANAGER: ML

WELL ID: MW25 **DIAMETER:** 50 mm **WELL DEPTH:** 7.278 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 4.250 m below TOC

After Pump Installation: 4.253 m below TOC

Pump Intake Depth: ~6.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.3

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
2:07pm.		1	4.484	1.58	ppm	33.9	mS	6.89		-93	mV	20.6	°C			✓			No odour. Grey.
2:09		2	4.570	1.36		32.9		6.91		-103		21.7			✓				" Pale grey
2:11		3	4.620	1.27		31.7		6.89		-111		21.6			✓				" ~~Colourless~~ Pale grey
2:13		4	4.640	1.30		31.3		6.89		-118		21.6			✓				" Colourless
2:15		5	4.660	1.12		30.9		6.87		-129		21.5		✓					" "
		~~M~~																	
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ✓ N ☐ DUPLICATE ID: DUP1 **TRIPLICATE COLLECTED:** Y ☐ N ✓ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ✓ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

coffey environments

Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 21/6/13

PROJECT MANAGER: ML

WELL ID: MW30 **DIAMETER:** 50 mm **WELL DEPTH:** 4.346 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 2.289 m below TOC

After Pump Installation: 2.380 m below TOC

Pump Intake Depth: ~3.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.0

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
9:14am		1	2.380	1.28	ppm	34.0	mS	6.68		128	mV	17.0	°C				✓		No odour. Orange Particulate organic matter.
9:16		2	2.647	1.93		35.3		6.81		120		17.1						✓	No odour, orange, POM
9:18		3	2.734	1.39		35.4		6.81		120		17.1			✓				no odour, orange, traces POM
9:20		4	2.896	2.54		34.8		6.95		102		17.9			✓				no odour, orange, traces POM
9:22		5	2.995	2.78		33.7		7.03		56		18.0			✓				〃 〃 〃
9:24		6	3.040	4.08		34.1		7.10		18		17.8			✓				〃 Pale orange brown 〃
9:26		7	3.070	3.84		34.8		7.17		-2		17.8			✓				〃 Pale brown No POM 〃
9:28		8	3.080	2.46		34.9		7.13		-7		17.8			✓				〃 〃
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

coffey environments

Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 20/6/13

PROJECT MANAGER: ML

WELL ID: MW120 **DIAMETER:** 50 mm **WELL DEPTH:** 2.771 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 2.617 m below TOC

After Pump Installation: 2.620 m below TOC

Pump Intake Depth: ~2.5m

WELL HEADSPACE PID READING

PID READING

PPM: 0.0

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
8:30a.m.		400ml	DRY	5.67	ppm	579	us/cm	6.74		44	mV	18.0	°C			✓			No odour. Brown.
				Well	purged dry at			0.4L.											
			Collected	40ml	vials	+ Metals		samples.		Couldn't get other samples.									
			Couldn't collect	post purge		WQM		readings.											
			Very poor	poor		recharge.													
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

coffey environments

Groundwater Sampling Form (B) – Micro Purge

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD **DATE:** 20/6/13

PROJECT MANAGER: ML

WELL ID: MW124 **DIAMETER:** 50 mm **WELL DEPTH:** 5.520 m **SCREEN INTERVAL:** _____ to _____ m below TOC **STICK-UP:** flush mm

FIELD EQUIPMENT

Equipment ID: Rental

Meter ID: Rental

FIELD EQUIPMENT

Depth to Water - Before Pump Installation: 5.270 m below TOC

After Pump Installation: _____ m below TOC

Pump Intake Depth: ~5.0m

WELL HEADSPACE PID READING

PID READING

PPM: 0.0

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L) note 1	DEPTH TO WATER (m) note 2	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA																		
12:00pm.		1	5.269	1.19	ppm	891	us/cm	6.31		-67	mV	21.0	°C		✓				No odour. Colourless
		2		Well purged dry at 1L.															
		3																	
Post Purge:			Not enough water for WQM Reading. Samples collected.																
			Very poor recharge.																
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☑ N ☐ Unfiltered samples must not be put into a preserved container (ie. 'metals' bottle)

Notes: 1 Ensure minimum 3 'equipment' volumes including volume of pump bladder, flow cell and tubing
2 Drawdown during pumping to be limited to <100 mm where possible

Surface Water.

coffey environments

Groundwater Sampling Form (A) - General

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 21/6/13

PROJECT MANAGER: ML

WELL ID: SW1A & B **METER ID:** Rental **TOTAL WELL DEPTH:** N/A **SCREEN INTERVAL:** N/A

EQUIPMENT USED: BAILER ☐ WATERRA ☐ OTHER ☑ Surface Water Sampler **WELL DIAMETER:** N/A **WELL STICK-UP:** N/A

WELL GAUGING AND PURGE VOLUME CALCULATIONS

(TOTAL WELL DEPTH) – (DEPTH TO WATER) = (WATER COLUMN)

N/A m - _____ = _____ m

Use water column calculation together with the procedures in 'SOP- Groundwater Sampling - Bailers' to determine the correct volume to be purged from the well (enter this value in the field to the right)

LITRES PER 1 WELL VOLUME: N/A L

WELL HEADSPACE PID READING

PID READING PPM: N/A

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA		Approx.																
		SW1A	1m	6.76	ppm	48.6	mS	8.27		50	mV	19.0	°C	✓					No odour. Colourless
		SW1B	1m	8.72		49.1		8.27		58		17.5		✓					Marine water odour. Colourless
STABILISATION CRITERIA (3 readings within following ranges)				± 10%		± 3%		± 0.1 unit		± 10mV		± 0.2°C							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☐ N ☑ UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE)

Surface Water.

coffey environments

Groundwater Sampling Form (A) - General

PROJECT NAME: Land Lease, Haymarket **PROJECT NUMBER:** ENAURHOD04498AB

FIELD PERSONNEL: PD/ACM **DATE:** 21/6/13

PROJECT MANAGER: ML

~~Sample ID~~ **WELL ID:** SW2A & B **METER ID:** _____ **TOTAL WELL DEPTH:** N/A **SCREEN INTERVAL:** N/A

EQUIPMENT USED: **BAILER** ☐ **WATERRA** ☐ **OTHER** Surface water sampler **WELL DIAMETER:** N/A **WELL STICK-UP:** N/A

WELL GAUGING AND PURGE VOLUME CALCULATIONS

(TOTAL WELL DEPTH) – (DEPTH TO WATER) = (WATER COLUMN)

N/A
_____m - _____ = _____m

Use water column calculation together with the procedures in 'SOP- Groundwater Sampling - Bailers' to determine the correct volume to be purged from the well (enter this value in the field to the right)

LITRES PER 1 WELL VOLUME

N/A L

WELL HEADSPACE PID READING

PID READING

PPM: N/A

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		CLARITY – tick one					COMMENTS
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE	Clear	Slightly Cloudy	Cloudy	Very Cloudy	Turbid	ODOUR, COLOUR, SEDIMENTS, PSH COLLECTED, etc
0	NA		Approx.																
		SW2A	1m	7.82	ppm	49.5	mS	8.26		70	mV	18.3	°C	✓					No odour. Colourless
		SW2B	1m	7.62		49.0		8.26		75		17.8		✓					" "
STABILISATION CRITERIA (3 readings within following ranges)				**± 10%**		**± 3%**		**± 0.1 unit**		**± 10mV**		**± 0.2°C**							

DUPLICATE COLLECTED: Y ☐ N ☑ DUPLICATE ID: _____ **TRIPLICATE COLLECTED:** Y ☐ N ☑ TRIPLICATE ID: _____

WERE METALS FIELD FILTERED? Y ☐ N ☑ UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE)