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SPECIALISTS IN LIVING AND WORKING PLACES

STAGE 2 ENVIRONMENTAL SITE ASSESSMENT, ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT, PROPOSED HOSPITAL SITE

Prepared for:

NSW Health Administration Corporation
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8 - 10 Loftus Street
SYDNEY
NSW 2000

Report Date: 16 March 2007
Project Ref: ENVILCOV00298AA

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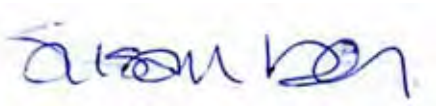	
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SPECIALISTS IN LIVING AND WORKING PLACES

16 March 2007

NSW Health Administration Corporation
C/- Burns Bridge
Suite 2, Level 9
8 - 10 Loftus Street
SYDNEY
NSW 2000

Attention: David Hume

Dear David

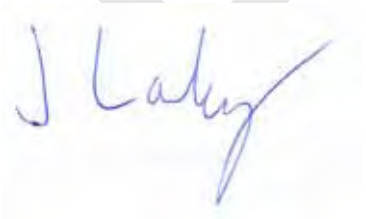
RE: Stage 2 Environmental Site Assessment, Royal North Shore Hospital Redevelopment, Proposed Hospital Site

Coffey Environments Pty Ltd (Coffey Environments) are pleased to provide our Stage 2 Environmental Site Assessment for the above site.

This report should be read in conjunction with the attached Statement of Limitations, which contains important information about the report.

We trust that the report meets with your current requirements. If you require further information, please do not hesitate to contact Susan Dillon or the undersigned on 02 9911 1000.

For and on behalf of Coffey Environments Pty Ltd



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EXECUTIVE SUMMARY

This report presents the findings of a Stage 2 Environmental Site Assessment (ESA) undertaken by Coffey Environments Pty Limited (Coffey Environments) of the proposed Hospital Site within the Royal North Shore Hospital precinct.

NSW Health Administration Corporation (NSW Health) propose to redevelop the existing Royal North Shore Hospital, including construction of new hospital buildings, refurbishment of a number of existing buildings, demolition of a number of buildings and divestment of some land for redevelopment. For reporting purposes, the site has been divided into two areas, namely the Hospital Site, which will accommodate new hospital buildings, and the Divestment Site, which contains land to be divested. This report documents the Stage 2 ESA within the Hospital Site. A separate report has been prepared documenting a concurrent Stage 2 ESA undertaken within the Divestment Site.

It is important to note that the site being investigated only comprises the portion of the hospital redevelopment site which is not covered by existing hospital buildings 1 and 2. The area investigated and defined as the 'Hospital Site' within this report was defined by Burns Bridge and is shown on Figure 2.

The objectives of the Stage 2 ESA were:

- To assess the suitability of the Hospital Site, with respect to contamination for the proposed hospital land-use (which is considered to be consistent with a commercial / industrial land-use scenario);
- To recommend further investigations and /or remediation requirements (if any) for the Hospital Site to be considered suitable for the proposed development;
- To assess the waste classification of soils at the Hospital Site for offsite disposal.

The objectives of the investigations were addressed through the following scope of works:

- Review of results from previous investigations undertaken by Coffey Geosciences in the Royal North Shore Hospital Precinct
- Collection of soil samples from a total of twenty boreholes, thirty-eight hand-auger holes and thirty surface soil locations across the Hospital and Divestment Sites;
- Collection of groundwater samples from three monitoring wells previously installed at the site;
- Data assessment, incorporating investigation data from the previous and current works; and
- Reporting the findings in a report, specific to the Hospital Site.

Based on the investigations undertaken to date, it is considered that for the Hospital Site to be suitable, with respect to contamination, for the proposed hospital land-use (i.e. commercial / industrial land-use) remediation, management or further assessment will be required to address the following contamination related issues:

Asbestos in surface soils around buildings– Asbestos has been identified in surface soil around buildings on the site and is most likely derived from weathering of asbestos-containing building materials. It is recommended that further assessment be undertaken to define the lateral and vertical extent of the contamination. This should include further sampling and analysis as well as correlation between sampling results in soil and the findings of the hazardous building materials assessment being undertaken by Coffey Environments. The asbestos impacted soils should then be remediated or managed. As asbestos is present in surface soils around the buildings, it is recommended that

remediation or management of asbestos in surface soil around buildings be undertaken in the short term.

Demolition of Buildings – It is recommended that buildings be demolished using appropriate methodologies and controls to avoid further contamination of surrounding and underlying soils. It would also be preferable to demolish the buildings prior to remediation of surrounding soils due to the potential for recontamination of the soils either prior to or during demolition, although short term risks from asbestos in surface soils would need to be considered when making this decision.

Areas Beneath Existing Buildings and Pavements – No sampling was undertaken beneath existing buildings during this assessment. Following demolition of buildings and pavements on the site, it is recommended that an assessment of the presence of contamination in these areas be undertaken based on a walkover of the areas and sampling and analysis. If contamination is identified then remediation or management would be required.

TPH Hotspot – A TPH hotspot has been identified at HA139 and should be remediated.

USTs - While no evidence of USTs has been found on the Hospital Site, given the size and age of the hospital it is considered possible that as yet unidentified USTs could be present. During redevelopment, if any USTs are encountered they should be removed and any associated contaminated soil remediated.

Fill Material – Fill material was observed across the Hospital Site ranging in thickness from 0.3 to 1.7m, across the majority of the site.

Some PAH contamination was detected within fill material, however, statistical analysis indicated that for commercial / industrial land-use, PAH within the fill would be unlikely to pose a health risk.

Asbestos in the form of bundles of fibres was detected in two fill samples collected from below the surface. This indicates that asbestos is unlikely to be widespread throughout the fill material. However, it is the experience of Coffey Environments that asbestos containing materials (such as fragments of fibre cement sheeting) are commonly present in fill material within Sydney. Even where significant asbestos is not identified in field investigations, it is not uncommon for such asbestos containing materials to be found during earthworks and to be randomly distributed through fill material. While the percentage of asbestos containing materials in fill material is likely to be very low, the DEC have not provided a threshold below which asbestos can be considered acceptable and therefore asbestos containing materials within the fill, if present, would likely require remediation or management. For this reason, it would be considered prudent to assume that fill material could potentially be asbestos containing (requiring remediation or management) unless indicated otherwise through detailed validation sampling

Potential remediation options are discussed in Section 9 of this report. It is recommended that the developer undertake a review of potential remedial options based on their specific development plans. Once the remedial / management strategies have been selected and any required further investigation completed, it is recommended that a remedial action plan (RAP) be prepared detailing remediation and validation procedures for each development zone.

We recommend that the RAP contain an asbestos management plan for the earthworks to manage the known asbestos and the potential for other asbestos containing material to be encountered. It is noted that any works where asbestos in soil is exposed would need to be undertaken under the supervision of an AS1 licensed asbestos contractor in accordance with WorkCover guidelines. The RAP should also

contain a contingency plan in the event that any as yet unidentified contamination or contamination sources are identified during the construction works.

Any soil requiring offsite disposal (e.g. for excavation of basements, for remediation etc) would need to be classified in accordance with the NSW DEC (2004) *Environmental Guidelines*: *Assessment, Classification and Management of Liquid and Non-Liquid Wastes*. Based on the available results, it is considered that fill material across the site should be assumed to classify as asbestos waste requiring disposal to a Solid Waste Class 1 or 2 landfill unless further sampling specific to soil proposed to be disposed offsite demonstrates an inert waste classification. While none have been identified to date, it is also possible that there could be some pockets of higher classification (i.e. industrial or hazardous waste). If any evidence of potentially contaminated material different to that described in the previous sections is identified then sampling of that material should be undertaken to determine the waste classification.

The available results indicate that the majority of natural soils across the Hospital Site are likely to classify as virgin excavated natural material (VENM). It is important to note that prior to classification of natural soil in any area as VENM, validation of the surface of the natural soil in that area (based on visual observation and laboratory analysis) would be required following the removal of overlying fill to demonstrate that the fill material had been adequately removed and had not impacted the underlying natural soils. It is possible there could be some localised areas where contamination could be present within the natural soils, preventing their classification as VENM. Following the removal of any such impacted soils validation sampling would be required to indicate the remaining natural soils classified as VENM.

We draw your attention to the attached information sheet ‘Important Information About Your Environmental Report’ as well as the limitations section of the report.

This report is to be used by NSW Health (the principal) and the future Private Public Partnership Contractor who will build and operate the new hospital, subject to:

- The use of the reports by any parties is subject to being under the same terms of agreement formed between Coffey and NSW Health (a copy of which is attached in Appendix A); and
- Any users of the reports acknowledging the limitations section of the reports and using the reports in full.

No other parties are authorised to use this report without the prior written approval of Coffey Environments.

1 INTRODUCTION

1.1 Background

This report presents the findings of a Stage 2 Environmental Site Assessment (ESA) undertaken by Coffey Environments Pty Limited (Coffey Environments) at the proposed hospital site within the Royal North Shore Hospital precinct. The site is located to the north of Pacific Highway in St Leonards, Sydney (Figure 1).

NSW Health Administration Corporation (NSW Health) propose to redevelop the site of the Royal North Shore Hospital, including construction of new hospital buildings, refurbishment of a number of existing buildings, demolition of a number of buildings and divestment of some land for redevelopment. For reporting purposes, the site has been divided into two areas, namely the Hospital Site, which will accommodate new hospital buildings, and the Divestment Site, which contains land to be divested. The current layout of both the Divestment Site and the Hospital Site areas is presented on Figure 2 and the proposed development layout pertaining to the Hospital Site is shown on Figure 3. This report documents the Stage 2 ESA within the Hospital Site. A separate report has been prepared documenting a concurrent Stage 2 ESA undertaken within the Divestment Site.

The work was commissioned by Burns Bridge, on behalf of NSW Health, in November 2006, in response to a proposal submitted by Coffey Environments on 23 October 2006 (reference ENVILCOV00298AA-P02).

Geotechnical investigations and Hazardous Building Materials Assessments were undertaken concurrently with the Stage 2 ESA for both the Hospital Site and the Divestment Site and are reported separately.

1.2 Parties Authorised to Use this Report

This report is to be used by NSW Health (the principal) and the future Private Public Partnership Contractor who will build and operate the new hospital, subject to:

- The use of the reports by any parties is subject to being under the same terms of agreement formed between Coffey and NSW Health (a copy of which is attached in Appendix A); and
- Any users of the reports acknowledging the limitations section of the reports and using the reports in full.

No other parties are authorised to use this report without the prior written approval of Coffey Environments.

1.3 Objectives and Scope of Work

The objectives of the environmental site investigation were:

- To assess the suitability of the Hospital Site, with respect to contamination, for use as a hospital (which is considered consistent with a commercial / industrial land-use);
- To recommend further investigations and /or remediation requirements (if any) for the site to be considered suitable for the proposed land-use;
- To assess the waste classification of soils at the Hospital Site for offsite disposal.

The objectives of the investigations were addressed through the following scope of works:

- Collection of soil samples from boreholes, hand-augers and areas of exposed surface soil;
- Collection of groundwater samples from three monitoring wells previously installed;
- Data assessment, incorporating investigation data from the previous and current works; and
- Reporting the findings in a report, specific to the Hospital Site.

The investigation for the Hospital Site was undertaken in conjunction with the investigation for the Divestment Site and utilised data from the Divestment Site where considered appropriate.

2 SUMMARY OF PREVIOUS INVESTIGATIONS

2.1 General

Two previous investigations have been carried out by Coffey Geosciences Pty Limited in the grounds of the Royal North Shore Hospital. The results of these investigations are summarised in the following sub-sections. The investigation data from the previous reports has been utilised in the assessment of the Hospital Site. Borehole logs and laboratory results from the previous assessments are included in Appendix B.

2.2 Coffey Geosciences Preliminary Contamination Assessment – Entire RNSH Site

2.2.1 Objectives and Scope of Work

Coffey Geosciences Pty Limited previously carried out a Preliminary Contamination Assessment (PCA) within the grounds of the existing Royal North Shore Hospital, generally covering the areas to the east of Reserve Road and hereafter referred to as the grounds of the Royal North Shore Hospital. The areas investigated included the Divestment Site and part of the Hospital Site. The PCA was undertaken for Northern Sydney Health and the findings were documented in a report dated September 2004 (reference S21855/4-AM). Geotechnical investigations were undertaken concurrently with the PCA and were reported separately.

The objective of the PCA was to provide preliminary information with respect to contamination, to assist with the master planning and initial design of the Royal North Shore Hospital redevelopment, including:

- Identification of potentially contaminating activities that were being performed within the grounds of the Royal North Shore Hospital at the time of reporting and that may have been performed in the past;
- A preliminary assessment, with respect to contamination, of the likely suitability of the grounds of the Royal North Shore Hospital for the proposed development;
- A preliminary assessment of the waste classification of the soils;
- An assessment of the requirements for further investigations, to render the grounds of the Royal North Shore Hospital suitable for the proposed development;
- A preliminary assessment of the contamination status of the groundwater;
- A preliminary assessment of any waste management issues with respect to investigations.

This objective was met by completing the following scope of works:

- A history review and visit to the grounds of the Royal North Shore Hospital, to identify potential areas or environmental concern and contaminants of concern;
- Field investigations, including the drilling of twelve boreholes and installation of three groundwater monitoring wells;
- Laboratory testing of soils and groundwater sampling; and
- Data assessment and reporting.

2.2.2 Summary of Site History

The history review revealed that the grounds of the Royal North Shore Hospital had been used for hospital related activities for approximately the last 100 years. The original hospital building is known as Building 31 and is located in the centre of the Divestment Site. Several extensions, additions, refurbishments and constructions of buildings were identified, however, no demolitions were recorded. Asbestos, lead paint and galvanised iron were widely used in the buildings and were noted to still be present at the time of reporting.

The review indicated little evidence of deep fill within the grounds of the Royal North Shore Hospital. Wastes generated from the hospital were generally disposed of offsite and no known waste burial areas were identified. A waste collection area was noted adjacent to Building 22, where waste products including chemical containers, scrap metals and car batteries were collected prior to disposal. This area is located in the central/eastern areas of the Divestment Site, to the east of the Hospital Site.

The PCA identified the presence, or former presence, of two underground diesel storage tanks, one above ground diesel storage tank and a generator. These features were located in the north-east and centre of the Divestment Site, to the north and east of the Hospital Site.

The possibility of ash being present in the vicinity of Westbourne Road, to the north of the Hospital Site, was identified during the PCA history review. The ash is considered to have been generated in the boiler house before it was converted to gas powered, from an ash bunker or from an incinerator, all located in the east of the Divestment Site, to the east of the Hospital Site.

2.2.3 Field and Laboratory Investigations

The field investigations comprised soil sampling from twelve boreholes and groundwater sampling from three monitoring wells. In addition, one surface soil sample was collected.

Selected soil samples collected from the boreholes were submitted for a suite of chemical analysis including heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury), polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylene (BTEX), total petroleum hydrocarbons (TPH), organo-chlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and asbestos which were assessed to be potential contaminants of concern based on the history review. Groundwater samples were analysed for metals, TPH, BTEX and PAH.

2.2.4 Results

The investigations revealed the presence of benzo(a)pyrene in one sample in excess of the human health based soil investigation level for residential, commercial and open space land-uses. Arsenic and nickel were also detected in soil at concentrations in excess of the phytotoxicity based investigation levels, but below the health-based investigation levels for residential, commercial and open space land-uses. In the groundwater samples, arsenic, copper, nickel and zinc were detected in excess of the adopted investigation criteria.

2.2.5 Conclusions

The Preliminary Contamination Assessment concluded that widespread contamination that would pose a major constraint to the grounds of the Royal North Shore Hospital being developed as a hospital was unlikely to be present. However, localised benzo(a)pyrene in excess of human-health based investigation levels and phytotoxic concentrations of heavy metals were encountered. Given the limited

nature of the investigations, it was considered that further investigations would be required to assess if further contamination was present and to assess the extent of any such contamination. Additional investigations recommended included further assessment of the following:

1. Extent and contamination status of fill across the grounds of the Royal North Shore Hospital);
2. The extent of hydrocarbon contamination (if any) associated with underground and above ground storage tanks;
3. The extent of contamination in the vicinity of the boiler house and incinerator (Building 21) including the potential for dioxins to be present;
4. The extent of contamination associated with the engineering and maintenance workshop and waste collection bay (Building 22);
5. The extent of asbestos, lead and zinc contamination in near surface soil adjacent to buildings;
6. The waste classification of soils required to be disposed of off-site, either to facilitate redevelopment or for remediation purposes; and
7. The contamination status of groundwater.

Of these, recommendations 1, 5, 6 and 7 are applicable to the Hospital Site.

2.3 Coffey Geosciences Environmental Site Assessment – Research and Education Building Site

2.3.1 General

Coffey Geosciences Pty Limited undertook an Environmental Site Assessment (ESA) at the site of the proposed Research and Education Building (R&E site) in the north of the existing Royal North Shore Hospital grounds. The results of the ESA were presented in a report dated 20 August 2006, reference S22564.01-AH. At the time of the investigations, the R&E site was occupied by a number of hospital-related accommodation and commercial buildings, identified as Buildings 4, 5, 11 and 11A. The proposed development was understood to comprise a 14-storey building, with 3 to 4 basement levels. The ESA was undertaken concurrently with a geotechnical investigation, which was reported separately.

It is noted that the R&E site is not included within the Divestment Site or the Hospital Site, however, the data obtained during the investigation is considered relevant to the current investigation and therefore has been included in the current report.

2.3.2 Objectives and Scope of Work

The objectives of the ESA in the R&E site were to:

- Assess the suitability of the R&E site for the proposed commercial / industrial land-use;
- Assess remediation or management requirements to make the R&E site suitable for the proposed land-use; and
- To assess the waste classification of soils within the R&E site for off-site disposal.

The objectives of the ESA were met through the following scope of work:

- Collection of soil samples from ten sampling locations, comprising one borehole and nine hand-augers;
- Laboratory testing of soil samples for a suite of potential contaminants of concern, including polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylene (BTEX), polychlorinated biphenyls (PCBs), organo-chlorine pesticides (OCPs), heavy metals and asbestos; and
- Data analysis and reporting.

2.3.3 Results

None of the contaminants tested for in soil samples from the R&E site were detected at concentrations in excess of the soil investigation criteria for commercial / industrial land-use. Concentrations of all contaminants tested for were also below the inert waste criteria.

2.3.4 Conclusions and Recommendations

Based on the results obtained, the ESA concluded that the R&E site was likely to be suitable for the proposed commercial/industrial land-use. Any fill materials requiring offsite disposal were considered likely to classify as inert waste and natural soils as VENM.

However, it was noted that at the time of the investigations, buildings covered approximately half of the R&E site, limiting areas where investigations could be undertaken. It was recommended that further investigations be undertaken in the footprint of the buildings following demolition.

3 SITE DESCRIPTION

3.1 Location and Site Features

3.1.1 Site Identification

The Royal North Shore Hospital is identified as Lot 21 DP 863329 within the Willoughby Council municipality. The Hospital Site forms part of this lot.

It is important to note that the site being investigated only comprises the portion of the hospital redevelopment site which is not covered by existing hospital buildings 1 and 2. The area investigated and defined as the 'Hospital Site' within this report was defined by Burns Bridge and is shown on Figure 2.

3.1.2 Current Site Layout

The Hospital Site is located within the grounds of the current Royal North Shore Hospital and has an area of approximately 16,000m^2. The Hospital Site is bounded to the north by the site of the new Research and Education Building (currently comprising a vacant lot), to the west by existing hospital buildings (Buildings 1 and 2), to the south by existing hospital buildings, landscaped areas, access roads and car parking and to the east by vacant grass-covered open space (the former site of Building 13) with further buildings beyond (see Figure 2). The general topography of the Hospital Site was noted to slope gently from north-west to south-east.

The Hospital Site was noted to be covered by a mixture of concrete and bitumen pathways and roads, grass areas, garden beds and hospital related buildings. A summary of the buildings and structures noted to be present within the Hospital Site at the time of the investigations is provided below:

- Multi-storey office buildings (Buildings 11, 23 and 24) in the centre and south-western corner of the site, comprising mainly brick-built buildings. A previous hazardous materials survey undertaken by IT Environmental (Ref: J101087A-R01) identified several areas of asbestos and fibro around the buildings, including in eaves, boiler lagging and wall panels. In addition, flaking paint, considered likely to be lead-based, was noted in all buildings;
- A covered and underground walkway between the eastern and western site areas and providing an underpass beneath Reserve Road;
- The external parts of the buildings within the Hospital Site were generally noted to be in a good condition, though some areas of flaking paint were noted in the previous IT survey. A number of concrete and bitumen-paved roads, pathways and car-parking areas were present through-out the site, which also appeared to be in generally good condition though some minor cracks and potholes were observed. Garden and landscaped areas were noted to be generally well-maintained and vegetation appeared to be healthy. A small car park at the entrance to the existing hospital buildings was raised above adjacent land to south indicating this area had been filled during construction of the car park.

A large, grass-covered open space area was present in the eastern part of the Hospital Site, which was previously occupied by Building 13. This area was noted to also lie partly within the Divestment Site. At the time of the investigations, a strip of exposed soil was present across the grass where a service trench had recently been laid, however, this was covered with turf during the investigation period.

Surface stormwater drains were noted throughout the Hospital Site, which appeared to run in a roughly south-east direction and into a large conduit immediately to the south of the Divestment Site boundary.

No evidence of potential contamination, such as staining or discolouration of soils, was observed during the investigations within the Hospital Site.

3.1.3 Proposed Development

Proposed development within the Hospital Site comprises a multi-storey hospital building and courtyard area, which will extend across the current alignment of Reserve Road and join the existing hospital buildings to the immediate west of the site. The far eastern part of the Hospital Site will be occupied by car-parking areas and access roads.

3.2 Surrounding Land-Uses

The Hospital Site is located within the grounds of the Royal North Shore Hospital, to the north of Pacific Highway in St Leonards, Sydney. Land-uses in the surrounding area generally comprise hospital buildings, residential and commercial developments and are summarised below:

- A vacant lot, currently comprising exposed soil and understood to be the site of the proposed Research and Education Building, was present to the immediate north west of the Hospital Site, with Westbourne Street and commercial and industrial buildings beyond;
- Existing hospital buildings were noted to the immediate north-east, east and south-east, comprising accommodation, clinics, treatment facilities and offices. Herbert Street, mixed commercial and residential high-rise buildings, railway lines and St Leonard's train station were noted beyond;
- Existing hospital buildings, comprising the main hospital facilities were located to the immediate west of the Hospital Site. Gore Hill Oval comprising open recreational space with limited seating and changing facilities was noted to the south-west. On the western side of the Oval, Gore Hill Crematorium, Cemetery and Garden of Remembrance were noted.

3.3 Local Geology and Hydrogeology

3.3.1 Summary

The Sydney 1:100,000 geological map produced by the Geological Survey of NSW, Department of Minerals and Energy (1983) indicated that the Hospital Site is underlain by Ashfield Shale, described as black to dark grey shale and laminite. Hawkesbury Sandstone, described as medium to coarse grained quartz sandstone with very minor shale and laminite lenses, was also indicated to underlie the shale. An intermediate unit, known as the Mittagong Formation and comprising interbedded shale, laminite and medium grained quartz sandstone, was indicated to be found between the Ashfield Shale and Hawkesbury Sandstone in some locations.

It was considered that the Ashfield Shale was likely to be of considerable thickness at higher elevations in the St Leonards area, such as the northern part of the Divestment Site and the site of the Research and Education Building. At lower elevations, it was considered likely that the shale would be less thick before the underlying Mittagong Formation (if present) and Hawkesbury Sandstone was encountered.

The shale and sandstone was expected to be overlain by residual soils, derived from the weathering of the bedrock. Fill was also expected at some locations.

Regional groundwater was expected to occur mainly within joints, bedding partings and fractures within the bedrock, or perched within the overlying fill and/or natural soils. The flow of groundwater was expected to be to the south or south west, towards Sydney Harbour or following the topography of the Hospital Site.

The nearest surface water body is the Berry Creek, approximately 750m to the south of the Hospital Site, which flows in a southerly direction entering Sydney Harbour in Gore Cove before joining the Parramatta River.

3.3.2 Previous Investigations

The previous investigations undertaken within the grounds of the existing Royal North Shore Hospital confirmed the expected regional geology as summarised below:

Table 1: General Geological Conditions Encountered during Previous Investigations

Unit	General Description	Typical Depth to Unit Base (m)	Typical Thickness of Unit (m)
Topsoil and Fill	Silty Clay and Clayey Silt, some Gravely Clay, some occasional ash	0.3 to 2	0.3 to 2
Residual Soil	Silty Clay: medium and high plasticity, very stiff and hard	1.1 to 3.55	0.6 to 3.3
Ashfield Shale	Shale with Sandstone Laminations and Shale	7.36 to >20	4.76 to >16.2
Mittagong Formation/ Hawkesbury Sandstone	Interbedded Sandstone, Laminite and Shale, less laminated and predominantly Sandstone with increasing depth	>20 (termination depth of deepest boreholes)	-

Groundwater was monitored in standpipes installed in three boreholes during the previous investigations and was encountered at depths of between 4.39m and 8.65m below ground level (72.75 – 87.52m AHD). Groundwater was encountered within the bedrock in each of the boreholes, noted to comprise shale, shale with sandstone laminations and sandstone.

The data was considered insufficient to determine the flow direction of groundwater below the grounds of the Royal North Shore Hospital, though shallow groundwater was conjectured to flow in a generally east to south-east direction. This is generally consistent with the topography of the area

4 REGULATORY BACKGROUND AND APPLICABLE GUIDELINES

4.1 Soil Investigation Criteria

The investigation criteria for soil were established based on the following references:

- NSW DEC (2006) Guidelines for the NSW Auditor Scheme (Second Edition);
- NSW EPA (1994) Guidelines for Assessing Service Station Sites; and
- NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measure (NEPM).

Other references were used to supplement the above references where appropriate.

The NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme and the NEPM present health based investigation levels for different land-uses (e.g. industrial / commercial, residential, recreational etc.) as well as provisional phytotoxicity based investigation levels.

The proposed land-use within the Hospital Site is understood to comprise a new hospital building with a courtyard area and associated car parking. This is considered to be consistent with a commercial / industrial land-use setting.

For commercial and industrial sites, human health based investigation levels (HILs) for commercial/industrial land-uses, provided in Column 4 of Appendix II in the NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme (Second Edition) may be adopted as soil investigation levels. The phytotoxicity based investigation levels are not applicable to commercial / industrial sites although should be considered if there are to be large areas of open space.

NSW EPA (2006) Guidelines do not provide threshold levels for volatile petroleum hydrocarbon compounds. NSW EPA (1994) Guidelines for Assessing Service Station Sites provide an indication of acceptable cleanup levels for petroleum hydrocarbons compounds at service station sites to be reused for sensitive land-uses. The EPA has advised that these guidelines should also be used for less sensitive land-uses. For semi-volatile petroleum hydrocarbons (C16 – C35 and >C35) investigation levels are provided in the NSW EPA (2006) Guidelines, however, these are based on the NEPM health-based criteria, which require the laboratory analysis to unequivocally differentiate between aromatic and aliphatic compounds. If this cannot be done, the C10 – C40 criteria in the service station guidelines should be applied. For this investigation, we have adopted the service station guidelines for all petroleum hydrocarbon fractions.

There are currently no national or DEC-endorsed guidelines relating to human health or environmental investigation of material containing asbestos on sites. NSW DEC (2006) advise that until such guidelines become available, auditors must exercise their professional judgement when assessing if a site is suitable for a specific use in the light of evidence that asbestos may be a contaminant of concern. NSW DEC (2006) states that NSW Health will provide advice to auditors on a case-by-case basis where appropriate. The NSW DEC previously provided interim advice that “no asbestos in the soil at the surface is permitted”. Enhealth (2005) ‘Guidelines for Asbestos in the Non-Occupational Environment’, provides some guidance on assessing and managing asbestos in soil although does not provide a threshold concentration or investigation level for asbestos.

The NSW DEC does not provide any guidelines for the assessment of dioxins and furans in soils. Therefore, for assessing the contamination levels of soil with regards to dioxins and furans, the guidelines accepted in two European countries were used:

1. Netherlands – Basler, A (1994) Organohalogen Compounds Vol. 20, 567-570 (Conference Proceedings Dioxin 1994, Kyoto Japan);
2. Germany – van Zorge, J and A. Liem (1994) Organohalogen Compounds Vol. 20, 567-570 (Conference Proceedings Dioxin 1994, Kyoto Japan).

These Dutch and German guidelines suggest an upper threshold limit of 1000 Toxic Equivalents, TEQ ppt for residential land-use.

The adopted soil investigation levels are included in Tables LR1 and LR2.

4.2 Waste Classification

The procedures for classifying waste are detailed in the NSW EPA *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes (1999*) updated 2004. Non-virgin excavated material and material excavated from a contaminated area must be classified using the procedures in Technical Appendix 1 of the guidelines prior to offsite disposal to a licensed landfill.

Soil requiring disposal is classified by comparing analytical results from the material to threshold criteria provided in the guidelines. The guidelines provide threshold concentrations for three different waste categories, namely; inert waste; solid waste; and industrial waste. The wastes that fail to meet the criteria for industrial waste are classified as hazardous waste. The guidelines classify various solid wastes into these categories by virtue of being a particular waste type. For those wastes that are not classified into a waste category, the guidelines provide threshold values for total concentrations and leachable concentrations based on toxicity characteristics leaching procedures (TCLP) test. These threshold levels are given for about 50 contaminants and groups of contaminants. For a waste to be classified under a given category, both total and leachable concentrations of the waste should meet the respective threshold concentrations. The waste may be classified solely based on total concentrations (i.e. without undertaking leachability testing), but the applicable threshold concentrations when leachability testing is not undertaken are significantly lower (i.e. more stringent) than would apply when leachability testing is undertaken.

Soil containing asbestos classified as industrial waste however may be disposed of to a landfill licensed to accept solid waste providing concentrations of other contaminants meet the solid waste criteria and the landfill is licensed to accept asbestos containing soil.

Virgin Excavated Natural Material (VENM) is defined as clay, gravel, soil or rock that is not mixed with any other waste and that:

a) has been excavated from areas that are not contaminated, as a result of industrial, commercial, mining or agricultural activities, with manufactures chemicals and that does not contain sulphidic ores or soils, or

b) consists of excavated materials that meet such criteria as may be approved by the EPA.

The applicable waste classification criteria are presented in Table LR3.

4.3 Groundwater

For assessing groundwater quality, it is first necessary to assess the beneficial uses of groundwater down gradient of the investigation area being assessed.

No registered groundwater bore search was undertaken as part of the Stage 1 investigations at the site. However, given that the investigation area and the surrounding down gradient areas are underlain by Ashfield Shale or Hawkesbury Sandstone, the shallow groundwater down gradient of the investigation area is considered to have little beneficial usage. It is therefore considered unlikely that the shallow groundwater down gradient of the investigation area would be used. It is considered that the groundwater would eventually discharge to Sydney Harbour. Potential beneficial reuses of the Sydney Harbour water include:

- Sustaining aquatic ecosystems; and
- Recreational use.

The threshold concentrations presented in the ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality are considered applicable for the protection of aquatic ecosystems of the receiving waters. As these guidelines apply to receiving waters, it is generally conservative to apply these to groundwater discharging to receiving waters.

ANZECC (2000) advocates a site-specific approach to developing guideline trigger values based on such factors as local biological affects data, the current level of disturbance of the ecosystem etc. The guidelines present “low risk guidelines trigger values” which are defined as concentrations of key performance parameters below which there is a low risk that adverse biological effects will occur. It is important to note that these are not threshold values at which an environmental problem is likely to occur if exceeded. Rather, if the trigger values are exceeded, then further action is required which may include either further site-specific investigations to assess whether or not there is an actual problem, or management/remedial action.

Low risk trigger values are provided for the protection of 80-99% of species in marine waters (presented in Table 3.4.1 of the guidelines), with the trigger value depending on the health of the receiving waters.

It is considered that the marine water trigger values are applicable for investigating chemical concentrations in groundwater at the site, as the receiving body is a marine water body.

It is understood that the NSW EPA’s policy is that the trigger values for the protection of 95% of aquatic ecosystems should be used except where contaminants are potentially bioaccumulative in which case the trigger values for protection of 99% of species should be used. Therefore, we have selected trigger values for protection of 95% of marine water species for the majority of contaminants, and 99% of marine water species for bioaccumulative contaminants for initial comparison purposes.

ANZECC (2000) states that there is currently insufficient data to derive high reliability trigger values for various contaminants. For these contaminants, low reliability trigger values have been adopted when necessary.

ANZECC (2000) state that there is currently insufficient data to derive a high reliability trigger value for total petroleum hydrocarbons (TPH) but propose a low reliability trigger value for TPH of 7μg/L. This guideline is generally considered by industry to be overly conservative and is also well below the TPH detection limit that most laboratories can achieve. Another commonly internationally used guideline for TPH is contained in Dutch (1994), which present a target, and intervention values for mineral oils. The

average of the target and intervention values (325μg/L) is commonly used as an intervention level for TPH and will be adopted as investigation criteria for this site.

Guidelines for the recreational water use are also presented in the ANZECC (2000) (Table 5.2.3 of the guidelines). These guidelines are generally less sensitive than the aquatic ecosystem guidelines.

The adopted guideline concentrations are presented in Table LR4.

5 IDENTIFICATION OF AREAS OF ENVIRONMENTAL CONCERN (AECS)

Using the information obtained in previous investigations, Areas of Environmental Concern (AECs) identified within the Hospital Site included.

Table 2: Areas of Environmental Concern within the Hospital Site

Area of Concern	Issue	Potential Chemicals of Concern
1. Entire Site	Presence of fill material, particularly to the north of Building 5, to the south and southeast of Building 22, in the vicinity of Westbourne Street and also the remainder of the site	PAH, metals, asbestos, TPH, BTEX, OCPs, PCBs
4. Entire Site	Asbestos, lead and zinc around existing and previous structures resulting from leaching / weathering of external hazardous building materials.	Asbestos and metals.

A number of additional AECs were identified within the Divestment Site, which were used in the design of the field investigations. The AECs within the Divestment Site, in addition to those listed above, are summarised in Table 3. These AECs are not considered applicable to the Hospital Site, although the previous report did raise the potential for as yet unidentified underground storage tanks (USTs) to be present across the Royal North Shore Hospital precinct.

Table 3: Specific Areas of Environmental Concern within the Divestment Site

Area of Concern	Issue	Potential Chemicals of Concern
2. South of Building 22 and west of Building 9	Existing and previous underground and aboveground diesel tanks	TPH, BTEX, PAH, Metals.
3. Vicinity of Building 21	Boiler and incinerator	TPH, BTEX, PAH, dioxin
5. Vicinity of Building 22	Engineering/maintenance workshop and waste collection bay	TPH, BTEX, PAH, Total Phenol, VOC and SVOC.

6 FIELD AND LABORATORY INVESTIGATIONS

6.1 Soil

6.1.1 Rationale for Field Investigations

The field investigation program was designed based on information obtained from the previous assessments undertaken at the site and the identification of potential AECs which are summarised in Section 5 of this report. The sampling locations were targeted to assess specific potential AECs, such as former tanks and the engineering workshop, as well assessing site-wide AECs such as the presence of fill materials and to provide general coverage of accessible areas of the site. The field investigations for both the Divestment Site and the Hospital Site were designed and undertaken as one program.

The program of investigations in relation to the identified AECs is summarised below

Table 4: Investigations in relation to AECs

Issue / Area of Concern	Number of Sampling Locations	Depth of Investigation Below Ground	Chemicals of Concern	Number of samples from each location for analysis	Analysis Suite (% of samples for each analyte)
1. Fill material – entire site, particularly area to the north of Building 5, area to the south and southeast of Building 22 and vicinity of Westbourne Street, but also the remainder of the site	45	To below the base of fill (typically 0.5m to 2m) or earlier refusal.	PAH, metals, asbestos, TPH, BTEX, OCPs, PCBs	2 allowing for assessment of different fill layers	PAH: 100% Metals: 100% Asbestos: 100% TPH/BTEX: 50% OCP/PCB: 17%
2a. Existing and previous underground and aboveground diesel tanks to the west of Building 9	4	Locations targeting the underground tank to around 4m or earlier refusal. Locations targeting the aboveground tank shallower.	TPH, BTEX, PAH, Metals.	1.5	TPH/BTEX: 100% PAHs: 100% Metals: 100%
2b. Existing and	3	Locations	TPH,	1.5	TPH/BTEX: 100%

Issue / Area of Concern	Number of Sampling Locations	Depth of Investigation Below Ground	Chemicals of Concern	Number of samples from each location for analysis	Analysis Suite (% of samples for each analyte)
previous underground and aboveground diesel tanks to the south of Building 22		targeting the underground tank to around 4m or earlier refusal. Locations targeting the aboveground tank shallower	BTEX, PAH, Metals		PAHs: 100% Metals: 100%
3. Boiler and incinerator – vicinity of Building 21	5	Generally near surface sampling as top down contamination.	TPH, BTEX, PAH, dioxin	1	TPH/BTEX: 100% PAHs: 100% Dioxin: 40%
4. Asbestos, lead and zinc around existing and previous structures resulting from leaching / weathering of external hazardous building materials.	30	Surface sampling as top down contamination.	asbestos and metals.	1	Asbestos: 100% Metals: 100%
5. Engineering/maintenance workshop and waste collection bay – vicinity of Building 22	6	Generally near surface sampling as top down contamination Selected deeper samples	TPH, BTEX, PAH, Total Phenol, VOC and SVOC.	1.5	TPH/BTEX: 100% PAHs: 100% Phenol/VOC/SVOC: 20%

The sampling locations are summarised in the table below.

Table 5: Summary of Sampling Locations in AECs

Issue / Area of Concern	Sampling Locations
1. Fill material – entire site, particularly area to the north of Building 5, area to the south and southeast of Building 22 and vicinity of Westbourne Street, but also the remainder of the site	BH101 – BH111 BH113 – BH120 HA102 – HA106, HA109 – HA116, HA119 - HA121, HA124 – HA127, HA129, HA131 – HA137, HA139, HA140
2a. Existing and previous underground and aboveground diesel tanks to the west of Building 9 – not applicable to Hospital Site	BH111, BH112, HA107, HA108,
2b. Existing and previous underground and aboveground diesel tanks to the south of Building 22 – not applicable to Hospital Site	BH117, BH118, HA120
3. Boiler and incinerator – vicinity of Building 21 – not applicable to Hospital Site	BH105, BH116, HA122, HA123
4. Asbestos, lead and zinc around existing and previous structures resulting from leaching / weathering of external hazardous building materials.	SS1 – SS30
5. Engineering/maintenance workshop and waste collection bay – vicinity of Building 22 – not applicable to Hospital Site	BH105, BH116, HA117, HA118, HA119, HA140

In addition, twenty-one sampling locations from the previous assessments undertaken within the grounds of the Royal North Shore Hospital by Coffey Geosciences have been included in this investigation, including BH1 to BH12 from the 2004 PCA (grounds of the Royal North Shore Hospital to the east of Reserve Road) and HA1 to HA9 from the 2006 ESA (Research and Education Building).

This brings the total number of investigation locations (excluding the surface sample locations around the buildings) within the entire site (Divestment Site and Hospital Site) to seventy-seven. Of these, sixty-six were designed to provide general coverage of the site and eleven were located to specifically target AECs. The EPA Sampling Design Guidelines require around 80 locations for a site of 8ha (approximate area of the Divestment Site and Hospital Site combined). However, the number of locations is considered appropriate given the substantial proportion of the site which is covered by buildings and hence inaccessible for sampling. Further sampling within the footprints of the buildings would be required following demolition.

6.1.2 Soil Sampling

Soil sampling across both the Divestment Site and the Hospital Site was undertaken using a range of different methods at the site as summarised below:

Table 6: Summary of Sampling Methods and Field Personnel

	Equipment and Method	**Sampling Dates**	**Sampler**
Boreholes (BH101 – BH107)	Truck mounted explorer drill rig with solid flight augers, using a v-shaped stainless steel drill-bit until refusal and then continuing with a tungsten carbide drill-bit for at least 1m or until refusal. The seven boreholes were then continued using coring techniques to depths of 12m - 20m for geotechnical purposes	20 – 27 November 2006	Anton Delac – Coffey Environments Senior Geotechnician, Over four years experience in field investigations
Boreholes (BH108 – BH120)	Geoprobe drill rig using plastic push-tubes to obtain soil samples. Boreholes were drilled to the surface of natural soils or until refusal, whichever was shallower.	23 and 27 November 2006	Nathan Foster – Coffey Environments Environmental Engineer, 2 years geotechnical / environmental experience
Hand-augers (HA102 – – HA137, HA139, HA140)	Stainless steel hand-auger to 0.5m into natural soil, 1.0m or refusal, whichever is shallower	20 – 30 November 2006	Nathan Foster - as above Anton Delac – as above
Surface sampling	By hand using a clean pair of disposable gloves for each sample	28 November 2006	Nathan Foster - as above

Soil samples from boreholes and hand-auger holes were generally collected at the surface of each location and then at regular intervals, generally comprising 0.2 – 0.3m depth, 0.5 – 0.6m depth, 0.9 – 1.0m depth and then at 0.5m intervals until 0.5m into natural soils, or from each soil unit encountered. The surface samples were collected by hand from the upper 100mm in areas of exposed soil.

Each sample was divided into three sub-samples. One of the sub-samples was placed into a laboratory-supplied acid-rinsed 250mL glass jar, labelled with the job number, date, sampling location and depth, and placed in an ice-chilled cooler box for transport to the nominated testing laboratory. The second sub-sample was placed into a plastic zip-lock bag, also labelled with the job, date, location and depth, for asbestos testing. The third sub-sample was placed in a plastic bag and sealed for field PID headspace screening.

A photoionisation detector (PID) was used to screen the headspace gases of the bagged soil samples during field investigations. The PID provides a semi-quantitative indication of the presence of ionisable volatile organic compounds in the soil. The PID had a 10.6eV lamp calibrated with isobutylene gas at 100ppm prior to commencement of each day of fieldwork.

The approximate locations of the investigations were measured relative to site features by pacing. Sampling locations are shown on Figure 4. Borehole logs are presented in Appendix C.

6.1.3 Soil Field Quality Assurance and Quality Control

As Coffey Environment's Standard Operating Procedures are still being finalised, sampling activities were generally undertaken in accordance with the procedures and protocols outlined in Coffey Geosciences' Environmental Field Manual (QP15/5-E, June 1995, revised September 1997), which is based on industry accepted standard practice.

Equipment that came directly in contact with the soil (e.g. hand-auger, SPT sampler) was decontaminated between samples by scrubbing with a solution of Decon-90, a phosphate-free detergent, followed by rinsing with potable water. A clean pair of disposable gloves was used when handling each sample. A high pressure cleaner was used to decontaminate the drilling augers between boreholes.

Seven intra-laboratory duplicate soil samples and six inter-laboratory duplicate soil samples were collected and analysed for the combined Divestment Site and Hospital Site field investigation program. A summary of the duplicates is provided below.

Table 7: Summary of Duplicate Samples

Duplicate Samples	Primary Sample	Date	Inter / Intra Lab	Analysis
HA DUP02	HA118 0.0 – 0.1	21 November 2006	Intra-lab	PAH, TPH, BTEX, metals
DUP 1	BH102 0.7 – 1.0	21 November 2006	Intra-lab	PAH, metals
ENVI DUP 1	BH111 0.5 – 0.6	23 November 2006	Inter-lab	TPH, PAH, BTEX, metals
HA DUP 3	HA137 0.6 – 0.7	24 November 2006	Inter-lab	PAH, TPH, BTEX, metals
DUP 4	BH107 0.0 – 0.1	27 November 2006	Intra-lab	PAH, TPH, BTEX, metals

Duplicate Samples	Primary Sample	Date	Inter / Intra Lab	Analysis
HA DUP 1A	HA132 0.0 – 0.1	28 November 2006	Intra-lab	PAH, TPH, BTEX, metals
SS DUP 2	SS26	28 November 2006	Intra-lab	metals
SS DUP 3	SS27	28 November 2006	Intra-lab	metals
SS DUP 5	SS29	28 November 2006	Inter-lab	metals
SS DUP6	SS30	28 November 2006	Inter-lab	metals
HA DUP 2A	HA132 0.2 – 0.3	28 November 2006	Inter-lab	PAH, metals
HA DUP 5	HA102 0.0 – 0.1	29 November 2006	Intra-lab	PAH, TPH, BTEX, metals
HA DUP 4	HA133 0.0 – 0.1	29 November 2006	Inter-lab	PAH, TPH, BTEX, metals

The duplicates were used to assess whether the sampling and laboratory procedures adequately reproduced results. For duplicate sampling, the soil sample was divided evenly between two glass jars using gloved hands. The soil was not homogenised prior to duplicate sampling to minimise the potential loss of volatiles from the soil sample.

Water wash blank samples were collected from the hand-auger and SPT following decontamination to check the effectiveness of decontamination procedures and assess the potential for cross-contamination between hand-auger boreholes. Two wash blanks were submitted for analysis identified as WB 24.11.06 and WB 27.11.06.

Two trip spike and two trip blank samples were included with the analysis to assess the potential loss or gain of volatile contaminants during the sampling and transportation of the samples The trip spikes were identified as TS 24.11.06 and Trip Spike 27.11.06 and the trip blanks as TB 24.11.06 and Trip Blank 27.11.06.

Field quality control results are presented in Tables LR5 to LR7.

6.1.4 Soil Laboratory Analysis

The primary soil samples and intra-laboratory duplicates were dispatched to SGS, which is NATA registered for the analysis undertaken. The SVOC analysis was subcontracted by SGS to MGT Laboratories in Victoria and the dioxin analysis was sub-contracted to SGS in Belgium and this analysis

is also NATA accredited. The inter-laboratory duplicate soil samples were dispatched to ALS which is NATA accredited for the analysis undertaken.

Primary and secondary soil samples from the field investigations were dispatched to SGS and ALS on 28 November 2006 and 1 December 2006 under chain of custody conditions. From the time the samples were returned to Coffey Environments office until the time they were dispatched to the analytical laboratories the samples were stored in a large refrigerated cool room at a temperature of 4^{o}C.

The number of samples scheduled for each analysis is summarised in the table below.

Table 8: Summary of Soil Sample Analysis

Analysis	**Number of samples submitted for testing**		
	Current investigation	Previous Investigations	TOTAL
Polycyclic Aromatic Hydrocarbons (PAHs)	96	34	130
Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc)	126	34	160
Total Petroleum Hydrocarbons (TPH)	62	34	96
Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	62	34	96
Asbestos	120	20	140
Organochlorine Pesticides (OCPs)	15	9	24
Polychlorinated Biphenyls (PCBs)	15	9	24
Volatile Organic Compounds (VOCs)	2	0	2
Semi-Volatile Organic Compounds	2	0	2
Dioxin	2	0	2
TCLP (metals)	10	5	15
TCLP (PAHs)	10	5	15

Soil samples were selected for analysis based on location, depth, field observations and PID results with a majority of samples spread across fill material layers and a small number of samples selected from underlying natural soil. At least one sample was selected for analysis from each location. From sampling locations designed to target fill areas, two samples from each location were selected for analysis (where two samples were available). For specific AECs, the analysis suite was designed to

target particular contaminants of concern as described in Tables 3 and 4. The remaining samples were kept on hold at the laboratory in case further analysis was required.

6.2 Groundwater

6.2.1 Groundwater Sampling

Groundwater monitoring and sampling was undertaken in response to the recommendations within the 2004 PCA. Groundwater samples were collected from three monitoring wells installed as part of the previous investigations at the site, namely BH4, BH5 and BH9. A description of the monitoring well construction details is provided is the 2004 PCA report and are presented on the boreholes logs provided in Appendix C.

Groundwater sampling was undertaken by Martina Carosi, a Coffey Environmental Scientist with 1 year experience in environmental site assessments.

Groundwater samples were collected from the monitoring wells on 27 November 2006, in accordance with the following protocols:

- Prior to purging, the groundwater levels were measured in each well and the water quality meter was calibrated;
- Purging of the wells was undertaken prior to sampling using a disposal bailer until temperature, pH and electrical conductivity (EC) readings were stabilised;
- Field measurement of pH, EC, temperature and redox potential following purging but prior to sampling;
- Use of a new, dedicated PVC bailer for sample collection from each well;
- Samples to be analysed for heavy metals were field filtered using a new, dedicated 0.45μm filter for each sample; and
- Samples were collected into appropriately preserved laboratory supplied containers and placed in a cooler box filled with ice.

The records of groundwater purging and sampling are presented in Appendix D.

6.2.2 Groundwater Field Quality Assurance and Quality Control

As Coffey Environment's Standard Operating Procedures are still being finalised, sampling activities were generally undertaken in accordance with the procedures and protocols outlined in Coffey Geosciences' Environmental Field Manual (QP15/5-E, June 1995, revised September 1997), which is based on industry accepted standard practice.

One duplicate sample was collected from monitoring well BH4 and submitted to the primary laboratory for analysis. As clean disposable bailers were used to sample each well, no decontamination procedures were required and no wash blank sample was collected. The groundwater quality meter was decontaminated between each borehole. No trip spike or trip blank was used during the groundwater sampling round as volatile contaminants were not identified as contaminants of concern during the PSA.

Field quality control results are presented in Tables LR5 to LR7.

6.2.3 Laboratory Analysis

The primary and intra-laboratory duplicate soil samples were dispatched to SGS, which is NATA registered for the analysis undertaken, on 28 November 2006 under chain of custody conditions.

From the time the samples were returned to Coffey Environments office until the time they were dispatched to the analytical laboratories the samples were stored in a large refrigerated cool room at a temperature of 4^{o}C.

Based on the results of the previous investigations, which identified heavy metals within the groundwater samples, and the elevated detection limit used for PAHs in the previous sampling round, each of the samples were submitted for heavy metals and ultra-trace PAH.

7 RESULTS

7.1 Subsurface Conditions

7.1.1 Soil

Based on the results of the fieldwork, the geology within the investigation area is consistent with the regional geology indicated by the Sydney 1:100,000 Geological Sheet. Across the investigation area there are relatively shallow and variable thicknesses of topsoil and fill, overlying residual soil, overlying bedrock. The bedrock comprises shale and sandstone of variable strength and weathering characteristics.

Fill was encountered in each borehole and hand-auger location within the Divestment Site and Hospital Site, with the exception of two boreholes and one hand-auger from the previous investigations, where topsoil was recorded to directly overlie natural materials. The fill was observed to range in thickness between 0.1m and 2.3m, with the thickest fill noted at the southern boundary of the Divestment Site (boreholes BH106 and BH109) and the south-western corner of the Hospital Site (borehole BH101) which was drilled in a filled car park area. Fill depths observed across the Hospital Site were observed to range between around 0.3m and 1.7m. The base of fill materials was reached in each of the borehole locations and in fourteen of the hand-auger holes. Fill was generally described as sandy or clayey silt, clayey or silty sand overlying silty or sandy clay. A surface deposit of gravelly sand or gravelly clay was also noted above the silt and clay in the western part of the Hospital Site. Anthropogenic materials, including fragments of brick, sandstone, concrete and terracotta and occasional ash were noted within the fill materials at approximately 50% of sampling locations.

Natural soil at the site was generally found to comprise of residual clays, with occasional pockets of sand also noted. The clays were described as ranging from low to medium to high plasticity, grey, brown or yellow with occasional red mottling and ironstone staining. The clays were described as very stiff and hard. The sand was described as fine to medium grained, red and brown with occasional sandstone fragments.

Bedrock was encountered in twenty-eight of the boreholes and was generally described as grey shale or weathered shale, or fine to medium grained grey and yellow weathered sandstone. Bedrock was encountered between 0.9m and 3.9m depth. The shale, inferred to be the Ashfield Shale, was encountered in the more elevated areas of the Hospital and Divestment Sites and was also encountered within the R&E site during previous investigations. Towards the south and east of the Divestment Site, Ashfield Shale overlying laminite and sandstone inferred to be Mittagong Formation/Hawkesbury Sandstone was encountered. At the most southern and eastern borehole locations (BH3, BH9, BH106 and BH107) the shale was not present and sandstone belonging to either the Mittagong Formation or Hawkesbury Sandstone was cored. It should be noted that the boundaries between the various units can be gradational and the Mittagong Formation and Hawkesbury Sandstone can be difficult to differentiate.

No evidence of significant contamination was observed in the boreholes or hand-auger holes during the investigations, with the exception of ash within fill materials. A hydrocarbon odour was detected at one hand-auger location (HA139) though no staining or discolouration of soils in this area was noted.

The subsurface conditions encountered at the Divestment and Hospital Sites have been summarised in Table 9.

Table 9: Summary of Sub Surface Conditions

Unit	General Description	Typical Depth to Unit Base (m)	Typical Thickness of Unit (m)
Topsoil and Fill	Clayey or silty sand and sandy silt, overlying silty and sandy clay. Occasional surface deposit of gravelly sand or gravely clay Fill materials were noted to contain non-soil materials such as brick fragments, concrete fragments and ash in approximately 50% of locations.	0.3 to 1.8	0.3 to 1.8
Residual Soil	Silty/sandy Clay: low to medium, to medium and high plasticity, very stiff and hard Occasional fine to medium grained sand	1.0 to 2.6	0.2 to 1.2
Ashfield Shale A	Shale: Extremely weathered to highly weathered	3.2 to >9.8	2.2 to >9.8
Ashfield Shale B	Shale: Highly weathered to slightly weathered	15.5 and 18.6 (BH101 and BH104 only)	4.5 and 8.6 (BH101 and BH104 only)
Mittagong Formation/ Hawkesbury Sandstone	Interbedded Sandstone, Laminite and Shale, less laminated and predominantly Sandstone with increasing depth	Drilled to the termination depth of BH101 and BH104.	-

7.1.2 PID Results

A total of 212 soil samples from the current and previous investigations across the Royal North Shore Hospital were subjected to PID headspace screening. The PID readings were detected between 0.0ppm and 17.3ppm, indicating that volatile ionisable organic compounds were not present at significant concentrations in the samples screened. The PID results are presented in Appendix E.

7.1.3 Groundwater

Groundwater was not encountered in the augered/pushtube portions of the boreholes nor in the hand-auger holes. Groundwater could not be monitored in the cored sections of the boreholes as potable water was used as a drilling fluid.

Three groundwater monitoring wells were installed in boreholes BH4, BH5 and BH9 during the PCA. It was noted that borehole BH5 falls within the Hospital Site while borehole BH4 and BH9 lie within the Divestment Site. Water levels were monitored during the previous and the current investigations and are summarised in Table 10.

The monitored groundwater levels indicated that the likely groundwater flow direction is to the south-east, which is consistent with the previous investigations and the topography of the area, although given the limited number of wells this direction should be considered as indicative only.

Table 10: Summary of Groundwater Levels

Well ID	Measurement Date	Water Level in m AHD	Depth Below Ground Surface (m)
BH4	10/6/04	80.31	5.00
	17/6/04	80.93	4.39
	22/6/04	80.71	4.60
	24/11/06	80.52	4.75
BH5	10/6/04	87.52	8.45
	17/6/04	87.32	8.65
	22/6/04	87.39	8.58
	24/11/06	86.25	9.6
BH9	15/6/04	72.81	6.62
	17/6/04	72.75	6.68
	22/6/04	72.73	6.70
	24/11/06	73.64	5.71

7.1.4 Groundwater Quality Parameters

Groundwater parameters were measured throughout the purging of the wells during the previous and the current investigations. The results of the groundwater purging are summarised below and presented in Appendix D.

- Groundwater pH was measured between 5.08 and 5.82 in the previous investigations and between 3.63 and 4.89 during the current investigations, indicating acidic conditions. Acidity of the groundwater was noted to increase between the investigations;
- Temperature was recorded between 23.1 C and 25.2 C during the previous investigations and between 19.1 C and 20.8 C during the current investigations;
- Electrical conductivity (EC) was detected between 735 uS/cm and 2054 uS/cm during the previous investigations and between 288 uS/cm and 1284 uS/cm during the current investigations, indicating fresh to slightly brackish water.
- Redox potential was recorded between 24.8mV and 159.1mV during the previous investigations, indicating oxidising conditions. During the current investigations, Redox potential was detected between 67mV and 261mV, indicating oxidising conditions.

7.1.5 Laboratory Results

The laboratory analytical reports are presented in Appendix F. The soil results are presented in tables LR1 to LR3 and the groundwater results are presented in Table LR4.

7.1.6 Quality Assurance and Quality Control (QAQC) Results and Data Usability

Data quality objectives for the investigations are presented in Appendix G. An assessment of whether data quality indicators (DQIs) outlined in NSW DEC (2006) and the DQOs were met by the investigation has been prepared and is presented in Appendix H. An assessment was made of data completeness, comparability, representativeness, precision and accuracy based on field and laboratory considerations.

Field quality control results are presented in Tables LR5 to LR7.

The assessment revealed that:

- Data Completeness – the data is adequately complete;
- Data Comparability – the data is adequately comparable;
- Data Representativeness – the data is adequately representative;
- Data Precision – the data is adequately precise;
- Data Accuracy – the data is adequately accurate.

Overall, it is considered that the investigation and the data adequately complied with the DQOs as presented in Appendix G.

7.2 Comparison of Soil Results with Human Health Based Soil Investigation Levels (HILs)

The results from investigations in both the Divestment Site and the Hospital Site have been compared to the relevant soil investigation levels, as discussed in Section 4 of this report and are summarised in Table 11, below.

Table 11: Summary of Exceedances of Adopted Soil Investigation Levels

Contaminant	Number of results in excess of HIL for commercial and industrial land-use	Maximum Concentration (mg/kg)
Benzo(a)pyrene	1	5.6mg/kg
Total PAH	0	71 mg/kg
TPH (C10 – C36)*	1	2720 mg/kg
Lead	0	670 mg/kg
Arsenic	0	130 mg/kg
Zinc	0	1700 mg/kg
Copper	0	210 mg/kg
Mercury	0	3.5 mg/kg
Nickel	0	73 mg/kg
Cadmium	0	3.8 mg/kg

* exceeds the guidelines for assessing service station sites.

Asbestos was also detected in fourteen soil samples in the form of loose fibres and fragments of asbestos-cement sheeting.

TPH (C6 – C9), OCPs, PCB, VOCs and SVOCs were not detected above the laboratory reporting limits in any of the samples submitted for these analyses.

Dioxin concentrations were below the adopted investigation level in the two samples analysed (both from the Divestment Site).

The locations at which benzo(a)pyrene concentrations exceeds the HIL and in which asbestos was detected are shown on Figures 5 and 6.

7.3 Comparison of Soil Results with Waste Classification Criteria

- Total benzo(a)pyrene concentrations were detected at concentrations in excess of the inert waste criteria in fourteen of the 130 samples;

- No other total concentrations of contaminants tested for exceeded the inert waste criteria;
- Asbestos was detected in fourteen samples, requiring a minimum classification as solid waste;
- TCLP metal and PAH results were below the inert waste criteria.

7.4 Comparison of Groundwater Results with Groundwater Investigation Levels (GILs)

- Nickel and zinc were detected in groundwater samples at concentrations in excess of the aquatic ecosystem protection based GILs during both sampling rounds. The concentrations detected were comparable between both rounds;
- Arsenic was detected in two groundwater samples at concentrations in excess of the aquatic ecosystem protection based GILs during both sampling rounds. The concentrations detected were comparable between both rounds;
- Copper was detected in all three groundwater samples at concentrations in excess of the ANZECC (2000) Trigger Values for Marine Water (95% protection of Species) during this sampling round and in one sample from the previous sampling round. The concentrations detected were comparable between both rounds;
- PAHs were not detected above the laboratory reporting limits during either sampling round;
- TPH and BTEX were not detected above the laboratory reporting limits during the previous sampling round. TPH and BTEX were not tested for during this sampling round.

8 DISCUSSION

8.1 Contamination in Potential Areas of Concern

8.1.1 TPH Hotspot

Odorous soil was observed in hand-auger hole HA139 located in the former Building 13 area. The hand-auger hole was only extended to 0.2m depth and hence the vertical extent of the impact is not known.

TPH C10-C36 was detected in a surface sample from HA139 at a concentration of 2720mg/kg which exceeds the service station criteria of 1000mg/kg.

The source of this contamination is not known however is considered likely to be the result of a surface spillage of oil. The extent has not been defined, however, is considered likely to be localised. Remediation of this TPH hotspot is recommended.

8.1.2 AEC 4 – Surface Soils Impacted by Weathering/Leaching of Hazardous Building Materials

Thirty surface soil samples were collected from areas of exposed soil adjacent to buildings in the Hospital and Divestment Sites to assess whether weathering or leaching of hazardous building materials (such as asbestos from fibre cement sheeting or lagging, lead from lead based paint or zinc from galvanised iron) had occurred and impacted adjacent surface soils.

Elevated heavy metals were detected in many of the samples however, at concentrations below the HILs for commercial / industrial land-use.

Asbestos in the form of bundles of fibres were detected in nine of the surface soil samples as well as in a number of surface samples collected from hand-auger holes also adjacent to buildings. In the Hospital Site asbestos was detected in the lawn area formed in the footprint of Building 13 following its recent demolition and in surface soils adjacent to buildings 23, 25 and 34. It is considered that the asbestos detected is primarily attributable to weathering of asbestos containing materials in the buildings. It is considered that remediation or management of asbestos in surface soils around buildings on the site will be required for the site to be considered suitable for any of the proposed land-uses. Further, more detailed sampling around the buildings would be recommended to better define the extent of the contamination (noting that asbestos could still potentially be present adjacent to buildings where asbestos was not detected in this assessment). It is also recommended that the results be correlated to the hazardous building materials survey currently being undertaken by Coffey Environments once this survey is completed. As asbestos has been detected in exposed surface soils, it is recommended that remediation / management of the asbestos be undertaken in the short term.

It is recommended that the buildings be demolished in a manner to reduce the potential for further impacts from hazardous building materials to the surrounding and underlying soils. Following demolition of buildings, sampling in the building footprints will be required to assess for impacts beneath the buildings.

8.1.3 AEC1 – Fill materials

The investigations undertaken identified the presence of fill materials throughout the Hospital Site, observed to range in thickness from around 0.3m to 1.7m. The deepest fill was observed in the carpark in the south-western corner of the Hospital Site which is raised above the surrounding land to the south. The fill was observed to consist mainly of silt sand, silty and sandy clay, with non-soil materials, such as brick and concrete fragments identified within the fill at approximately 50% of sampling locations.

OCP, PCB, BTEX, TPH C6-C9 and heavy metals were either not detected or detected at concentrations below the adopted soil investigation levels in the samples analysed for these compounds. TPH C10-C36 was detected in one sample at a concentration exceeding the relevant soil investigation levels and is considered likely to be associated with a hotspot as discussed in Section 8.1.1. This indicates there is a low likelihood of widespread contamination associated with these compounds being present within the fill material at the Hospital Site.

The PAH compound benzo(a)pyrene (BaP), was detected in one fill sample within the Divestment Site at concentrations exceeding the HIL for commercial / industrial land-use. The 95% upper confidence limit (95% UCL) of the mean of the BaP concentrations in fill material was calculated using the USEPA program Pro-UCL Version 3.0 to be 0.9mg/kg (based on the 95% Chebyshev (Mean, Sd) distribution) which is well below the commercial / industrial HIL indicating PAH contamination in the fill would be unlikely to pose a risk to human health in a commercial / industrial setting.

Asbestos in the form of bundles of fibres was detected in five fill samples across the Hospital and Divestment sites. Of these, three were surface samples and considered more likely to be attributable to impacts from buildings (see Section 8.1.2). Asbestos in the form of bundles of fibres was only observed in two samples analysed below the surface. This indicates that asbestos is unlikely to be widespread throughout the fill material. However it is the experience of Coffey Environments that asbestos containing materials (such as fragments of fibre cement sheeting) are commonly present in fill material within Sydney. Given the size and age of the hospital buildings, it is also considered possible that asbestos pipes may be present at the site. Even where significant asbestos is not identified in field investigations, it is not uncommon for such asbestos containing materials to be found during earthworks and to be randomly distributed through fill material. While the percentage of asbestos containing materials in fill material is likely to be very low, the DEC have not provided a threshold below which asbestos can be considered acceptable and therefore asbestos containing materials within the fill, if present, would likely require remediation or management.

8.2 Groundwater

Three groundwater monitoring wells were previously installed across the RNSH during the preliminary ESA including:

- BH4 – South to southwest part of the RNSH (mid- to up-gradient);
- BH5 – North-western corner of the of the RNSH (up-gradient);
- BH9 – Eastern boundary of the RNSH (down-gradient).

Groundwater was encountered approximately 4m to 10m below the ground surface within the bedrock. Insufficient data was available to assess the groundwater flow direction. However, it appears that shallow groundwater at the investigation area generally flows towards the east to southeast. Industrial areas are located to the north of the investigation area. However, given the topography and the

expected groundwater flow direction, it is considered that groundwater from the industrial areas is unlikely to migrate onto the site.

Groundwater samples were collected from the monitoring wells for laboratory analysis. Chemicals of concern analysed were generally either not detected above the laboratory reporting limits (TPH, BTEX and PAH) or detected well below the respective aquatic ecosystem based GILs (some heavy metals), with the exceptions of arsenic, copper, nickel and zinc, which exceeded the aquatic ecosystem based investigation level in one or more samples.

Given that the heavy metal concentrations were generally comparable or higher in the up-gradient samples to the down-gradient samples, that concentrations of metal detected in soil were low to moderate and that the groundwater is located within the bedrock, it is considered that the metal exceedances are unlikely to be associated with the hospital activities at the site and are more likely to represent regional groundwater quality.

Given the above discussed results, the relatively low permeability subsurface and the relatively deep groundwater table, it is considered that widespread groundwater contamination attributable to site activities is unlikely to be present within the Hospital Site.

Groundwater disposal options would need to be assessed if basement dewatering were to be required. Given the heavy metal concentrations exceeding the ANZECC (2000) GILs, dewatered groundwater would be unlikely to be able to be disposed directly into the stormwater system without treatment.

8.3 Waste Classification of Soil

Any soil requiring offsite disposal (e.g. for excavation of basements, for remediation etc) would need to be classified in accordance with the NSW DEC (2004) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes.

The results suggest that the majority of fill material on the site is likely to classify as either inert or solid waste, noting that concentrations of all contaminants tested for were below the industrial waste criteria.

However, given the presence of benzo(a)pyrene in a number of fill samples exceeding the inert waste criteria and also the detection of asbestos in a number of fill and surface soil samples, it is considered that fill material across the site should be assumed to classify as asbestos containing solid waste (requiring disposal to a solid waste landfill licensed to accept asbestos containing soil) unless further sampling specific to soil proposed to be disposed offsite demonstrates otherwise.

While none have been identified to date, it is also possible that there could be some pockets of higher classification (i.e. industrial or hazardous waste). If any evidence of potentially contaminated material different to that described in the previous sections are identified then sampling of that material should be undertaken to determine the waste classification.

The available results indicate that the majority of natural soils across the Hospital Site are likely to classify as VENM. It is important to note that prior to classification of natural soil in any area as VENM, validation of the surface of the natural soil in that area(based on visual observation and laboratory analysis) would be required, following the removal of overlying fill, to demonstrate that the fill material had been adequately removed and had not impacted the underlying natural soils.

Although none have been identified, it is possible there could be some localised areas where contamination could be present within the natural soils, rendering them as non-VENM. Following the

removal of any such impacted soils, validation sampling would be required to indicate the remaining natural soils classified as VENM.

9 CONCLUSIONS AND RECOMMENDATIONS

Based on the investigations undertaken to date, it is considered that for the Hospital Site to be suitable, with respect to contamination, for the proposed hospital land-use (i.e. commercial / industrial land-use) remediation, management or further assessment will be required to address the following contamination related issues:

Asbestos in surface soils around buildings– Asbestos has been identified in surface soil around buildings on the site and is most likely derived from weathering of asbestos containing building materials. It is recommended that further assessment be undertaken to define the lateral and vertical extent of the contamination. This should include further sampling and analysis as well as correlation between sampling results in soil and the findings of the hazardous building materials assessment being undertaken by Coffey Environments. The asbestos impacted soils should then be remediated or managed. As asbestos is present in surface soils around the buildings, it is recommended that remediation or management of asbestos in surface soil around buildings be undertaken in the short term.

Demolition of Buildings – It is recommended that buildings be demolished using appropriate methodologies and controls to avoid further contamination of surrounding and underlying soils. It would also be preferable to demolish the buildings prior to remediation of surrounding soils due to the potential for recontamination of the soils either prior to or during demolition, although short term risks from asbestos in surface soils would need to be considered when making this decision.

Areas Beneath Existing Buildings and Pavements – No sampling was undertaken beneath existing buildings during this assessment. Following demolition of buildings and pavements on the site, it is recommended that an assessment of the presence of contamination in these areas be undertaken based on a walkover of the areas, sampling and analysis. If contamination is identified then remediation or management would be required.

TPH Hotspot – A TPH hotspot has been identified at HA139 and should be remediated.

USTs - While no evidence of USTs has been found on the Hospital Site, given the size and age of the hospital it is considered possible that as yet unidentified USTs could be present. During redevelopment, if any USTs are encountered they should be removed and any associated contaminated soil remediated.

Fill Material – Fill material was observed across the Hospital Site ranging in thickness from 0.3m to 1.7m.

Some PAH contamination was detected within fill material, however, statistical analysis indicated that for commercial / industrial land-use, PAH within the fill would be unlikely to pose a health risk.

Asbestos in the form of bundles of fibres was detected two fill samples collected from below the surface. This indicates that asbestos is unlikely to be widespread throughout the fill material. However it is the experience of Coffey Environments that asbestos containing materials (such as fragments of fibre cement sheeting) are commonly present in fill material within Sydney. Given the size and age of the hospital buildings, it is also considered possible that asbestos pipes may be present at the site. Even where significant asbestos is not identified in field investigations, it is not uncommon for such asbestos containing materials to be found during earthworks and to be randomly distributed through fill material. While the percentage of asbestos containing materials in fill material is likely to be very low, the DEC have not provided a threshold below which asbestos can be considered acceptable and therefore

asbestos containing materials within the fill, if present, would likely require remediation or management. For this reason, it would be considered prudent to assume that fill material could potentially be asbestos containing (requiring remediation or management) unless indicated otherwise through detailed validation sampling.

There are a range of remediation technologies available for treating contaminated soil. Of these, it is considered that excavation and landfilling and/or cap and contain are likely to be the most suitable for the contamination identified on this site.

Excavation and landfilling entails excavating the contaminated soil and disposing the soil at an off-site licensed landfill. The advantage of this option is that the contaminated fill material would be removed from site and therefore, restrictions on site use, notifications on the land title due to the presence of such material and ongoing maintenance costs can be avoided. Another advantage is the relatively short time of implementation. A disadvantage is that landfill disposal for a large volume of soil is expensive. Also excavations close to buildings may cause building subsidence.

Cap and contain entails providing a barrier (a cap) preventing or reducing the contact between site users and the contaminated soil. The cap could be formed from building slabs in building footprints and either pavement or a soil layer (typically minimum 0.5m thick) in other areas. Capping could either be applied with contaminated material in place or by excavation and encapsulation of the soil in another part of the site. A Site Environmental Management Plan would be needed to ensure the integrity of the cap is maintained and that any work penetrating the cap in the future is undertaken in accordance with adequate health and safety measures and environmental controls. It is important to note that selection of capping as the remediation strategy is likely to result in information advising the public of the presence of residual contamination being recorded on the Section 149(2) certificate. The main advantage of capping is the relatively low initial capital cost compared to the costs of offsite disposal. The contamination remaining on-site and thus carrying the associated liabilities is a disadvantage. The need for on-going monitoring and maintenance are other disadvantages.

It is recommended that the developer undertake a review of potential remedial options based on their specific development plans. Once the remedial / management strategies have been selected and any required further investigation completed, it is recommended that a remedial action plan (RAP) be prepared detailing remediation and validation procedures.

We recommend that the RAP contain an asbestos management plan for the earthworks to manage the known asbestos and the potential for other asbestos containing material to be encountered. It is noted that any works where asbestos in soil is exposed would need to be undertaken under the supervision of an AS1 licensed asbestos contractor in accordance with WorkCover guidelines. The RAP should also contain a contingency plan in the event that any as yet unidentified contamination or contamination sources, such as asbestos pipes, are identified during the construction works.

Any soil requiring offsite disposal (e.g. for excavation of basements, for remediation etc) would need to be classified in accordance with the NSW DEC (2004) *Environmental Guidelines*: *Assessment, Classification and Management of Liquid and Non-Liquid Wastes*. Based on the available results, it is considered that fill material across the site should be assumed to classify as asbestos waste requiring disposal to a Solid Waste Class 1 or 2 landfill unless further sampling specific to soil proposed to be disposed offsite demonstrates an inert waste classification. While none have been identified to date, it is also possible that there could be some pockets of higher classification (i.e. industrial or hazardous waste). If any evidence of potentially contaminated material different to that described in the previous

sections is identified then sampling of that material should be undertaken to determine the waste classification.

The available results indicate that the majority of natural soils across the Hospital Site are likely to classify as VENM. It is important to note that prior to classification of natural soil in any area as VENM, validation of the surface of the natural soil in that area (based on visual observation and laboratory analysis) would be required following the removal of overlying fill to demonstrate that the fill material had been adequately removed and had not impacted the underlying natural soils. It is possible there could be some localised areas where contamination could be present within the natural soils, preventing their classification as VENM. Following the removal of any such impacted soils validation sampling would be required to indicate the remaining natural soils classified as VENM.

10 LIMITATIONS

This report is to be used by NSW Health (the principal) and the future Private Public Partnership Contractor who will build and operate the new hospital, subject to:

- The use of the reports by any parties is subject to being under the same terms of Agreement formed between Coffey and NSW Health (a copy of which is attached in Appendix A); and
- Any users of the reports acknowledging the limitations section of the reports and using the reports in full.

No other parties are authorised to use this report without the prior written approval of Coffey Environments.

It is the nature of contaminated site investigation that the degree of variability in site conditions cannot be known completely and no sampling and analysis program can eliminate all uncertainty concerning the condition of the site. Professional judgement must be exercised in the collection and interpretation of the data.

In conducting this review and preparing the report, current guidelines for assessment and management of contaminated land were followed. This work has been conducted in good faith in accordance with Coffey's understanding of the client's brief and general accepted practice for environmental consulting.

No warranty, expressed or implied, is made as to the information and professional advice included in this report. The report is not intended for other parties or other uses. Anyone using this document does so at their own risk and should satisfy themselves concerning the applicability of its application and where necessary should seek expert advice in relation to the particular situation.

This report does not cover geotechnical or hazardous building materials issues. Separate reports have been prepared covering these aspects.

11 REFERENCES

ANZECC (1992) Australian Water Quality Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment & Conservation Council.

Basler, A (1994) Organohalogen Compounds Vol. 20, 567-570 (Conference Proceedings Dioxin 1994, Kyoto Japan);

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Important information about your **Coffey** Environmental Report

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of the land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Scope of Investigations

The work was conducted, and the report has been prepared, in response to specific instructions from the client to whom this report is addressed, within practical time and budgetary constraints, and in reliance on certain data and information made available to Coffey. The analyses, evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man and may change with time. For example, groundwater levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project and/or on the property.

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

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Important information about your **Coffey** Environmental Report

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered with redevelopment or on-going use of the site. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other professionals who are affected by the report. Have Coffey explain the report implications to professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to land development and land use. It is common that not all approaches will be necessarily dealt with in your environmental site assessment report due to concepts proposed at that time. As a project progresses through planning and design toward construction and/or maintenance, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Environmental reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

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