

# **STATE RAIL AUTHORITY**

---

## **Macdonaldtown Triangle, Erskineville**

---

### **PHASE I AND II ENVIRONMENTAL SITE ASSESSMENTS**

## **VOLUME TWO**

---

13 June 2000

Ref. No.:110158.141

17 August 2000  
110158

Chris Hedstrom  
Senior Contaminated Land Management Officer  
State Rail Authority of New South Wales  
Level 5,  
Transport House  
11-31 York Street  
Sydney, NSW 2000

Dear Chris,

**RE: PHASE I AND PHASE II ENVIRONMENTAL SITE ASSESSMENT,  
MACDONALDTOWN TRIANGLE, ERSKINEVILLE, NEW SOUTH WALES –  
FINAL REPORT**

CH2M HILL AUSTRALIA Pty Ltd (CH2M HILL) is pleased to provide the State Rail Authority of New South Wales with three copies of the above mentioned final report (Ref. No. 110158.141).

If you have any questions please do not hesitate to contact the undersigned on 9966 1166.

Yours sincerely,  
CH2M HILL AUSTRALIA Pty Ltd

Lee Moore  
Environmental Geologist

Behrooz Tehrani  
Environmental Remediation  
Manager, Asia-Pacific

CH2M HILL AUSTRALIA Pty Ltd

AGL Building  
Level 16, 111 Pacific Highway  
NORTH SYDNEY NSW 2060  
Phone: (02) 9966 1166 Fax: (02) 9966 1453

This document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. This document should not be used or copied without written authorisation from State Rail Authority (SRA) and CH2M HILL AUSTRALIA Pty Ltd.

Ref. No.:110158.141

## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>.....</b>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
1.1 PHASE I OBJECTIVE AND SCOPE OF WORKS .....	1
1.2 PHASE II OBJECTIVE AND SCOPE OF WORKS .....	2
<b>2.0 PHASE I ASSESSMENT .....</b>	<b>4</b>
2.1 SITE DESCRIPTION .....	4
2.2 TOPOGRAPHY .....	5
2.3 SURFACE HYDROLOGY .....	5
2.4 SOILS .....	5
2.5 SUBSURFACE CONDITIONS .....	5
2.6 HYDROGEOLOGY .....	6
2.7 VEGETATION .....	6
2.8 ZONING .....	6
2.9 ADJACENT LANDUSE .....	6
2.10 SITE IDENTIFICATION .....	7
2.11 SITE HISTORY .....	7
2.12 AERIAL PHOTOGRAPHS .....	9
2.13 EPA, COUNCIL AND WORKCOVER RECORDS .....	10
<b>3.0 PREVIOUS INVESTIGATIONS .....</b>	<b>11</b>
3.1 POTENTIAL CONTAMINANT ISSUES.....	11
<b>4.0 CRITERIA DEVELOPMENT .....</b>	<b>13</b>
4.1 SOILS CRITERIA .....	13
4.2 COMPARISON OF SOIL ANALYTICAL RESULTS TO CRITERIA .....	14
4.3 GROUNDWATER ASSESSMENT CRITERIA .....	17
<b>5.0 INVESTIGATION STRATEGY .....</b>	<b>19</b>
5.1 SOIL SAMPLING METHODOLOGY .....	19
5.1.1 Sampling Strategy.....	19
5.1.2 Soil Sampling Methodology .....	20
5.1.3 Laboratory Analysis .....	21
5.2 GROUNDWATER MONITORING WELL INSTALLATION AND SAMPLING METHODOLOGY .....	23
<b>6.0 INVESTIGATION RESULTS.....</b>	<b>25</b>
6.1 GEOLOGICAL INFORMATION .....	25
6.2 SOIL ANALYTICAL RESULTS.....	25
6.2.1 Former Cleaning Shed Area .....	25
6.2.2 Former Gasworks Area.....	26
6.3 GROUNDWATER INVESTIGATION RESULTS .....	29

6.3.1	Groundwater Gauging.....	29
6.3.2	Chemical Results .....	31
6.4	POTENTIAL FOR NATURAL ATTENUATION .....	37
6.5	PERMEABILITY TESTING/TRANSMISSIVITY .....	39
<b>7.0</b>	<b>QA/QC PROGRAM.....</b>	<b>40</b>
7.1	GENERAL.....	40
7.2	DATA QUALITY OBJECTIVES .....	40
7.3	QUALITY CONTROL SAMPLES .....	40
7.3.1	Field Duplicates .....	40
7.3.2	Control Samples .....	40
7.3.3	Control Limits.....	41
7.3.4	Trip Blank Analysis .....	41
7.4	DATA VALIDATION RESULTS .....	41
7.4.1	Holding Times .....	41
7.4.2	Field Duplicates .....	42
7.4.3	Control Samples .....	42
7.4.4	QA Conclusion .....	42
<b>8.0</b>	<b>DISCUSSION .....</b>	<b>44</b>
8.1	FORMER CLEANING SHED AREA .....	44
8.2	FORMER GASWORKS AREA .....	45
8.2.1	Soils .....	45
8.2.2	Groundwater .....	45
<b>9.0</b>	<b>CONCLUSION.....</b>	<b>51</b>
9.1	FORMER CLEANING SHED AREA .....	51
9.2	FORMER GASWORKS AREA .....	51
9.2.1	Soil Investigation .....	51
9.2.2	Groundwater Investigation .....	52
<b>10.0</b>	<b>RECOMMENDATIONS.....</b>	<b>55</b>
10.1	GENERAL RECOMMENDATIONS: .....	55
10.2	ADDITIONAL INVESTIGATIONS .....	55
<b>11.0</b>	<b>LIMITATIONS .....</b>	<b>57</b>
<b>12.0</b>	<b>PRIMARY REFERENCES.....</b>	<b>59</b>

---

## FIGURES

Figure 1	Site Location
Figure 2	Site Layout and Sample Location Plan
Figure 3	Cross-Sections A-A' and B-B'
Figure 4	Hotspot Identification in the fill material of the Former Cleaning Shed Area
Figure 5	Hotspot Identification in the fill material of the Former Gasworks Area
Figure 6	Hotspot Identification in the natural material of the Former Gasworks Area
Figure 7	Inferred Potentiometric Contours for the Surficial Aquifer
Figure 8	Inferred Potentiometric Contours for the Ashfield Shale Aquifer

## PLATES

Plate 1	Elevation difference between the Former Gasworks Area and the adjacent residential properties. The open concrete drain is also visible.
Plate 2	Vegetable patches observed in the Former Gasworks Area of the site

## TABLES

Table 2.1	Site Identification
Table 2.2	Groundwater Bore Information
Table 2.3	Site History
Table 4.1	Investigation and Remediation Criteria
Table 4.2	Investigation and Remediation Criteria for Volatile Compounds
Table 4.3	Groundwater Guideline Criteria
Table 5.1	Soil Analytical Suite
Table 5.2	Groundwater Quality Information
Table 5.3	Groundwater Sample Register
Table 6.1	Former Cleaning Shed Soil Analytical Results
Table 6.2	Former Cleaning Shed Fill 95% UCL Calculations
Table 6.3	Former Gasworks Soil Analytical Results
Table 6.4	Former Gasworks Fill 95% UCL Calculations
Table 6.5	Former Gasworks Natural 95% UCL Calculations
Table 6.6	Groundwater Gauging Data
Table 6.7	Groundwater Laboratory Analytical Results
Table 6.8	Groundwater Heavy Metals Analytical Summary
Table 6.9	Summary of PAH Analytical Results – Surficial Aquifer
Table 6.10	Summary of BTEX Analytical Results – Surficial Aquifer
Table 6.11	Summary of TPH Analytical Results – Surficial Aquifer
Table 6.12	Summary of PAH Analytical Results – Ashfield Shale Aquifer
Table 6.13	Summary of BTEX Analytical Results – Ashfield Shale Aquifer
Table 6.14	Summary of TPH Analytical Results – Ashfield Shale Aquifer
Table 6.15	Summary of Natural Attenuation Data
Table 6.16	Summary of Dissolved Methane Data
Table 7.1	Soil Analytical RPD Calculations
Table 7.2	Groundwater Analytical RPD Calculations

## **APPENDICES**

Appendix A	Land Titles Information
Appendix B	Aerial Photographs
Appendix C	Statutory Notices
Appendix D	Standard CH2M HILL Fieldwork and Sampling Procedures
Appendix E	Borehole Logs
Appendix F	Laboratory Analytical Results and Chain of Custody
Appendix G	Natural Attenuation Background Information

## **EXECUTIVE SUMMARY**

### **BACKGROUND**

The State Rail Authority of NSW (SRA) commissioned CH2M HILL AUSTRALIA Pty Ltd (CH2M HILL) to complete a combined preliminary and detailed site investigation of the area known as the **Macdonaldtown Triangle**. The investigation was commissioned for due diligence purposes associated with the redevelopment of the site as stabling yards. The Macdonaldtown Triangle site is situated off Burren Street, Erskineville, NSW, at the western end of the Eveleigh Precinct, and is adjacent to residential properties (Figure 1). The site occupies a triangular area that is estimated to be 23,000 m<sup>2</sup>. The site comprises of Lot 50 DP 1001467 in the local government area of South Sydney, Parish of Petersham and County of Cumberland.

Based on the data collected as part of this investigation approximately 8,000 m<sup>2</sup> of the site was formerly used as a gasworks. The remaining 15,000 m<sup>2</sup> consisted of former cleaning sheds and rail sidings. Since the mid 1980's the site has been used as a staging depot for the storage and fabrication of materials for track upgrading and renewal projects. Three small vegetable patches (approximately three metres by two metres) were identified in the former gasworks area (shown on Figure 2).

### **Potential Environmental Issues**

Products such as tar, tarry oils, ammonia, sulphuretted hydrogen, native oxide of iron, coal gas and shale gas have been found on the site. These products represent potential chemical contaminants such as polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), benzene, toluene, ethylbenzene and total xylenes (BTEX), phenolics, ammonia, heavy metals (cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn)), arsenic (As), cyanide (CN), sulphide/sulphate (SO<sub>3</sub>/ SO<sub>4</sub>) and organochlorine pesticides (OCPs).

In addition, gas manufacturing process oils and lubricants from the maintenance of site facilities and the use of creosote treated sleepers have the potential to contaminate the site.

### **SITE INVESTIGATION**

The objectives of the site investigation were to:

- Delineate and define the contamination present on the site;
- Determine if the site is “fit for purpose”; and
- Provide sufficient information to prepare a remedial action plan (RAP) or environmental management plan (EMP), if required.



To this end, CH2M HILL has assessed whether the site may pose a “**significant risk of harm**” to human health or some other aspect of the environment as defined in the NSW EPA Contaminated Sites *Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report* (1999).

To achieve the above objectives the following scope of works was undertaken:

- Soil investigation of 50 locations across the site utilising a drill rig;
- Groundwater investigation of three shallow (up to 2m) and three deep (up to 10m) monitoring wells;
- Analysis of soil and groundwater samples for a broad selection of analytes; and
- Reporting and assessment.

The degree and extent of these investigative works is summarised on Figure 2.

### **Soil Investigation Conclusions**

#### ***Former Cleaning Shed Area (Yellow area on Figure 2)***

- Fill material consisting of sand, gravel, ballast, ash and coke breeze is widespread across the area and varies in depth between 0.20 to 2.50 metres (shown on Figure 3); and
- Analytical results reported for the soil samples collected during the investigation were generally below the site criteria. However, isolated contaminant concentrations exceeding the adopted soil “hot spots” criteria were identified. These contaminants include PAHs (including benzo(a)pyrene (B(a)P) ), benzene and toluene (shown on Figure 4).

#### ***Former Gasworks Area (Green area on Figure 2)***

- Fill material is widespread across the area and varies between 0.10 to 3.20 metres in depth (shown on Figure 3); and
- Contamination is widespread throughout the fill material but not underlying soils. The contaminants identified include TPH, PAH, and BTEX (shown on Figure 5 and 6).

### **Groundwater Investigation Conclusions**

Groundwater investigations of both the surficial and Ashfield Shale aquifer have only been undertaken in the area of the Former Gasworks and its immediate surrounds. No groundwater investigations were undertaken in the Former Cleaning Shed Area due to the thin nature of fill material and the extensive nature of the concrete slab identified below the surface.

### ***Surficial Aquifer (Figure 7)***

- Concentrations of total PAHs, TPH C<sub>10</sub>-C<sub>36</sub>, heavy metals, phenols and BTEX exceed by up to three orders of magnitude the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*. The groundwater quality in the surficial aquifer appears to have been adversely impacted by the above chemicals probably due to previous historical activities at the site;
- Based on the limited groundwater investigation undertaken to date, the general groundwater flow direction is likely to be towards the south south east, however, in the vicinity of the gas holders and any other localised structures (such as foundations, drains, tar pits, etc.) the local flow direction may vary; and
- There is a potential for surficial groundwater to seep out along the fill material into an open drain (adjacent to the south western boundary of the site) and/or onto residential properties through overflow mechanisms (ie. due to blockage and/or leakage from the drain). This potential needs to be verified using more detailed local groundwater surface and "drain invert" surveying work.

### ***Ashfield Shale Aquifer (Figure 8)***

- Concentrations of total PAHs, benzene, heavy metals and phenols identified in groundwater samples collected from the Ashfield Shale aquifer exceed the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*. The groundwater quality in the Ashfield Shale aquifer appears to have been impacted by a range of the above chemicals due to previous activities at the site; and
- Based on the limited groundwater investigation undertaken to date, the general Ashfield Shale groundwater flow direction is likely to be towards the south south east. However, if the foundations of the two gas holders and/or any others structures extend to depths that intersect the Ashfield Shale aquifer, there is a potential for localised disturbance of the general groundwater flow direction.

### **Potential Receptors (see Figure 2)**

- Workers conducting sub-surface excavation or entering underground manholes above or near an impacted groundwater plume in the surficial aquifer on the site may be exposed to impacted groundwater and/or contaminated soil as well as petroleum hydrocarbon vapours;
- Residential properties adjacent to the south western boundary of the site may be impacted by dusts, soil contact and possible groundwater if accessed;
- The environment in the vicinity of the site may be impacted by groundwater contaminant migration as well as from dust migration and surface water and sediment run-off; and

- Unregistered users of groundwater in the vicinity of the site may be impacted.

However;

- No sensitive environmental receptors have been identified in the immediate vicinity of the site; and
- No groundwater usage (ie. registered groundwater bores) has been identified within a two kilometres radius around the site.

### **Significant Risk of Harm**

- From the available information it is possible to conclude that the site may pose a “significant risk of harm” as defined by Clause 9 of the Contaminated Lands Management Act, 1997.

### **RECOMMENDATIONS**

- Notification to the New South Wales Environment Protection Authority (NSW EPA) with respect to the potential for the site to pose a “significant risk of harm”;
- Cessation of all activities on the Former Gasworks Area, including those which may be undertaken by personnel from SRA, RSA and RAC, especially activities which may result in the disturbance of the soil;
- Minimisation of activities on the Former Cleaning Shed Area for access purposes only;
- Cessation of public access and usage of the site by local residents (ie. activities involving unauthorised vegetable cultivation and chicken coop etc.);
- Development of an EMP, OH&S and RAP for the management of contamination on the site;
- Development of a community information strategy to inform all relevant stakeholders with the assistance of EPA, NSWHealth, Central Sydney Areas Health Service and Local Council;
- Undertake a soil gas survey, surface soil sampling and surficial groundwater sampling program within the residential properties bounding the south western portion of the site;
- Collection of samples from the vegetable gardens currently being used by local residents on-site;
- More detailed assessment of the groundwater quality of both the surficial and Ashfield Shale aquifers in both the Former Cleaning Shed and Former Gasworks Areas; and

- Prior to future development to the north east of the site, soil sampling should be undertaken in this area to assess whether the soil contamination identified in the Former Cleaning Shed Area extends across the investigation boundary. This soil sampling should be targeted along the proposed track alignment.

## **1.0 INTRODUCTION**

In March 2000, the State Rail Authority of New South Wales (SRA) engaged CH2M HILL AUSTRALIA Pty Ltd (CH2M HILL) to conduct both Phase I and Phase II Environmental Site Assessments (ESAs) of the Macdonaldtown Triangle, NSW. This report presents the findings of both ESAs. The format of this report is based on the New South Wales Environmental Protection Authority (NSW EPA) *Guidelines for Consultants Reporting on Contaminated Sites*, 1998.

The site is located off Burren Street, Erskineville, with the Macdonaldtown Railway Station adjacent to the northern boundary of the site as illustrated in Figure 1. The site is located at the western end of the Eveleigh Precinct adjacent to residential properties. The site area is estimated to be approximately 23,000m<sup>2</sup>. The site is bounded by the Illawarra and Western rail lines on the southern and northern edges of the site, respectively. Residential terrace housing is present adjacent to the western edge of the site.

### **1.1 PHASE I OBJECTIVE AND SCOPE OF WORKS**

The objective of the Phase I historical review and desktop study was to identify past activities that may have impacted upon the site. The collated site information was used to assist in the preparation of a site sampling plan for the Phase II investigation.

In order to achieve the objectives of the Phase I and Phase II Environmental Site Assessments, CH2M HILL undertook the following scope of work:

- review of historical archives, reports, maps and site plans provided by the Rail Estate Record office, including a Site History prepared by Rail Services Australia;
- interpretation of aerial photographs from the NSW Department of Land and Water Conservation. This provided a photographic history of both the natural and built environments on the site for the past 50 years, at approximate 10 year intervals;
- review of the NSW Land Titles Office records of ownership;
- review of NSW EPA records to assess if any statutory notices have been issued for the site under the Environmentally Hazardous Chemicals Act (1985), (now incorporated in The Contaminated Lands Management Act, 1997), or The Unhealthy Building Lands Act (1990);
- review of the Dangerous Goods Licenses held by WorkCover NSW;
- review of South Sydney Local Council records of the site; and
- review of previous reports relevant to the site.

## 1.2 PHASE II OBJECTIVE AND SCOPE OF WORKS

CH2M HILL understands that the objective of the combined Phase I and II Environmental Site Assessment is three fold:

- **To delineate and define the contamination present on the site.** The delineation and definition of the contamination present on the Macdonaldtown Triangle site will provide the necessary information for SRA to determine what works (if any) are required to fulfil SRA's management and due diligence requirements internally, and what will be required (if at all) with respect to state and federal legislation;
- **To determine if the site is "fit for purpose";**
- **To provide sufficient information** to prepare a remedial action plan (RAP) or environmental management plan (EMP), if required.

To this end, CH2M HILL has assessed whether the site is posing a **"significant risk of harm"** to human health or some other aspect of the environment as defined in the NSW EPA Contaminated Sites *Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report* (1999).

The above objectives may be expanded to include:

- Production of a report which takes into account the NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* (1998), SRA specifications noted in pages 2 to 9 of the tender brief, the DUAP document *Managing Land Contamination: Planning Guidelines SEPP 55 Remediation of Land* (1999), and the NSW EPA *Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report* (1999); and
- Satisfying stakeholders (ie. SRA, South Sydney Council, NSW EPA) of particular concern(s) relating to possible contamination.

The scope of this investigation included the following components:

- Soil investigation of 50 locations across the site using a drill rig and excavator to investigate the nature of the subsurface materials and collect samples for laboratory analysis. This sampling density is in excess of Table A in the NSW EPA *Sampling Design Guidelines* (1995);
- Analysis of soil samples for a selection of analytes as described in Section 5;
- Groundwater investigation of three shallow and three deep monitoring wells, to investigate the nature of both surficial groundwater and the Ashfield Shale aquifer in the area of the Former Gasworks;
- Analysis of groundwater samples for a selection of analytes as described in Section 5;

- Interpretation of the analytical results; and
- Preparation of this report.

## 2.0 PHASE I ASSESSMENT

### 2.1 SITE DESCRIPTION

The study area comprises the SRA property known as the Macdonaldtown Triangle. The site is located immediately to the south of Macdonaldtown Railway Station on the corner of Burren and Albert Streets, Erskineville, NSW and occupies an area of approximately 23,000 m<sup>2</sup>. The site is recorded as Lot 50 in Deposited Plan (DP) 1001467 and is currently used by Rail Services Australia (RSA) for the temporary storage of metal and other railway structures, under license from SRA.

The site is triangular in shape and is generally unsealed. All buildings and structures have been removed except for a disused gas holder in the south west of the site, and associated structures such as tar pits and building foundations.

Surrounding landuses include Macdonaldtown Railway Station and the Main Western railway line to the north, railway lines to the east, the Illawarra railway line to the south and residential properties to the west. The site location is illustrated in Figure 1.

<b>Table 2.1: Site Identification</b>	
<b><i>Street Address</i></b>	Corner of Burren and Albert Streets, Erskineville, NSW
<b><i>Lot and DP Number</i></b>	Lot 50 of DP 1001467
<b><i>Local Government Area</i></b>	South Sydney
<b><i>Parish</i></b>	Petersham
<b><i>County</i></b>	Cumberland
<b><i>Geographical Co-ordinates</i></b>	624700N 343200E
<b><i>Track Kilometres (Western Line)</i></b>	2.397km to 2.559km
<b><i>Track Kilometres (Illawarra/Inner West Line)</i></b>	2.375km to 2.618km

The site can be separated into two areas as defined by their historical uses; 1) Former Cleaning Shed Area, and 2) Former Gasworks Area. Both areas are shown on Figure 2.



## **2.2 TOPOGRAPHY**

The Former Cleaning Shed Area is generally flat with a slight slope towards the south.

The Former Gasworks Area has a surface topography that is locally variable as shown on Figure 2. The general slope of the Former Gasworks Area is towards the south east. Due to the elevation difference between the Former Gasworks Area and the residential properties adjacent to its western boundary the slope of the land in that area is towards the residential properties as shown in Plate 1.

## **2.3 SURFACE HYDROLOGY**

Surface water on the site is expected to generally flow towards the Illawarra rail line directly to the south of the site. However, as discussed in Section 2.2 the surface water flow will be locally variable. Any surface water that leaves the site through the south eastern boundary is expected to be intersected by the Illawarra railway line drainage system and flow towards the south west.

Surface water along the western boundary of the Former Gasworks Area will flow westerly towards the adjacent residential properties. This surface water runoff is expected to be captured by a concrete lined open drain along the boundary with the residential properties, Plate 1. This drain follows the line of the site boundary and directs surface water towards the Illawarra railway line to the south of the site, away from the residential properties. The alignment and direction of this drain after leaving the site is towards the south west, along the alignment of the Illawarra railway line.

## **2.4 SOILS**

Soils in the vicinity of the site are classified in the Soil Landscapes of Sydney 1:100 000 Sheet (Chapman and Murphy, 1989) as part of the Blacktown group. The Blacktown group is a residual landscape described as consisting of shallow to moderately deep red and brown podzolic soils on crests, upper slopes and well drained areas. Deep yellow podzolic soils are found on lower slopes and in areas of poor drainage. Dominant soil materials include loose, olive brown loamy sand, earthy, yellow clayey sand and yellow, earthy sandy clay loam. Limitations of soils within the Blacktown group are identified as moderately reactive highly plastic subsoil, low soil fertility and poor soil drainage.

## **2.5 SUBSURFACE CONDITIONS**

The geology of the area in the vicinity of the site is described in the Geology of the Sydney 1:100 000 Sheet (Ed. 1, Sheet 9130, 1983) as Ashfield Shale comprising black to dark-grey shale, siltstone, laminite, calcareous claystone and coal. Ashfield Shale belongs to the Middle Triassic Epoch and is part of the Wianamatta Group.

## **2.6 HYDROGEOLOGY**

No previous hydrogeological information was available for the site. However, the Department of Land and Water Conservation (DLWC) identified 35 registered groundwater bores within a three kilometre radius of the site. The nearest registered groundwater well to the site is approximately two kilometres to the south east.

It should be noted that all identified groundwater bores are located within quaternary sediments consisting of medium to fine grained marine sands (Geology of the Sydney 1:100 000 Sheet). These quaternary sediments constitute a separate geological unit to the Ashfield Shale located in the vicinity of the site (refer to Section 2.5). No groundwater bores constructed in Ashfield Shale were identified within a radius of three kilometres of the site. It is anticipated that interaction between these geological units is likely to consist of groundwater flow from the overlying quaternary sediments to the Ashfield Shale. Therefore, the potential for groundwater, impacted by former or current site activities, to affect any identified groundwater use in the vicinity of the site, is considered minimal.

Details provided by DLWC are summarised in Table 2.2 at the rear of this report.

## **2.7 VEGETATION**

The site is well vegetated except in access ways and gravelled areas. The vegetation consists predominantly of grasses and weeds. Some small to medium trees are located along the western boundary and within the Former Cleaning Shed Area. Recent landscaping work has been undertaken in the area of the Former Cleaning Shed with a number of small trees/shrubs recently planted in that area. Approximately three vegetable patches have been identified near the western boundary of the Former Gasworks Area. The extent of these vegetable patches is approximately two metres by three metres. The location of these vegetable patches are shown on Figure 2. An example of the vegetable patches is attached as Plate 2.

## **2.8 ZONING**

The site is zoned under South Sydney Council's Local Environment Plan 1998 as Zone No.5 - Special Uses (Railway).

## **2.9 ADJACENT LANDUSE**

Adjacent landuses to the site consist of:

- North - Macdonaldtown Railway Station and the operational, multi track, Main Western railway line;
- East - SRA land and the operational Illawarra and other southern railway lines are located to the east. Eveleigh Railyards and Australian Technology Park are located further east of the railway lines;

- South – The operational Illawarra and other southern railway lines are located directly to the south of the site. SRA land is located directly to the south of the railway lines followed by residential properties, approximately 100 metres to the south of the railway lines; and
- West – Residential properties are located adjacent to the western boundary of the site. Vegetable patches used by the residents have been observed near the western boundary of the Former Gasworks Area.

Potential for the immediate surrounding landuses to impact on the site is considered low.

## **2.10 SITE IDENTIFICATION**

During a search for ownership history of the site, the following details from the Land Title Office were identified:

1794	Original Crown Grant to Nicholas Devine.
1827	Title transferred from Nicholas Devine to Bernard Rochford.
1831	Title transferred from Bernard Rochford to David Chambers.
1843	Title transferred from David Chambers to Felix Wilson.
1887	Registered proprietors of title now John Hardy, John Houlding and Richard Holdsworth.
1888	Title transferred to the Commissioner for Railways (now State Rail Authority of NSW).

Land Titles information is provided in Appendix A.

## **2.11 SITE HISTORY**

The site was crown land until 1794 when it was acquired by Nicholas Devine by Crown Grant. The title was transferred to Bernard Rochford in 1827, David Chambers in 1831, Felix Wilson in 1843 and to John Hardy, John Houlding and Richard Holdsworth jointly in 1888. The “Railways” acquired the site in 1888. Although the registered proprietors of the site prior to SRA were identified during a search of land titles records, no documentation identifying site use prior to acquisition by the Railways has been identified. However, it has been noted (GHD, 1995) that a small gas producing plant was established during the construction of the workshops prior to 1891.

Construction of the Gasworks at the site was completed in 1892. The Gasworks were constructed in order to provide lighting for carriages, stations, signals and railyards. Gas used

for stations and signals was obtained from coal whereas gas used for carriage lighting was obtained from shale.

Two tar wells/pits were in use at the site (located west of the retort house) from at least 1943, and a connection of an aeration cylinder for wastewater to the sewer was proposed at this time. Only one tar well/pit was identified during the current investigation. Its location is shown on Figure 2. There is a possibility of other aboveground tar wells closer to the retort house, however, the presence of these have not been confirmed.

However, no record of the construction of these facilities have been identified. Minor modifications were made to the Gasworks during 1944, 1945, 1949, 1950, and 1952.

Damage was sustained to machinery during the 1950's due to the use of poor quality coal. Hence, the gasworks operations at the site were shut down. Plant and machinery used for gas production were demolished in approximately 1958. After closure, the site continued to be used for the storage of gas for use in carriages and railyards until the mid 1970's when the site finally closed. Gas used for this purpose was piped to the site from the Mortlake Gasworks.

Based on information provided by Rail Estate, the remainder of the site consisted of former cleaning sheds and rail sidings. Activities associated with these site uses ceased during the mid 1980's. The site was subsequently cleared and all buildings and railway tracks were removed to improve security and local amenity.

Since the mid 1980's the site has been used as a staging depot for the storage and fabrication of materials for track upgrading and renewal projects. Local residents also use the land adjacent to the gas holders for vegetable gardens. Three vegetable gardens have been identified as described in Section 2.7.

A summary of site activities is given in Table 2.3.

**Table 2.3: Site History**

<b>Date</b>	<b>Site Owner</b>	<b>Site Use</b>	<b>Potential Sources of Contamination</b>
1794	Mr Nicholas Devine.	Unknown	Not identified
1828	Mr Bernard Rochford.	Unknown	Not identified
1832	Mr Bernard Rochford.	Unknown	Not identified
1834	Mr Felix Wilson	Unknown	Not identified
1887	John Hardy, John Houlding and Richard Holdsworth.	Unknown	Not identified
1888-present	State Rail Authority of New South Wales	Southern Portion “Gasworks”	Operation of Gasworks, dumping of waste material, maintenance and operation of machinery
		Northern Portion “Cleaning Shed” and rail sidings	Cleaning of trains

## 2.12 AERIAL PHOTOGRAPHS

Aerial photographs of the site were available for the years 1951, 1961, 1970, 1978, 1986 and 1999. Due to the scale and resolution of the photographs small details have not been able to be determined. However, an interpretation of the photographs is as follows:

### *1951*

A large rectangular building is located in the area of the former train cleaning shed. Railway tracks are evident protruding from the eastern side of the building leading to the railway line to the east of the site. A number of trains/carriages are present on the tracks. A small rectangular building, possibly the former retort house or coal and shale storage buildings, is located adjacent to the southern side of the large building. Two gas holders are present along the south western edge of the site. A rectangular structure, orientated south west to north east, is located adjacent to the round structures. This building is possibly the former gas purifying facility. Rail lines are visible along the southern boundary of the site, adjacent to the Illawarra rail line. Little vegetation is visible on the site.

### *1961*

The site appears unchanged from the 1951 photograph.

### ***1970***

The building located to the south of the large rectangular structure identified in the 1951 aerial photograph has been removed. The building has been replaced by numerous small square structures. The northern circular structure, gas holder No. 2, located on the western boundary of the site and the adjacent rectangular structure have been removed. Trains are visible on the rail lines on site. No vegetation is visible on the site.

### ***1978***

The site appears relatively unchanged from the 1970 photograph. However, the area surrounding gas holder No. 1 appears grassed.

### ***1986***

The large rectangular building has been removed, however, the concrete floor of the building remains. In addition, rail lines are visible in the floor of the former building. The remainder of the site appears unchanged from the 1978 photograph.

### ***1999***

The site appears as present. All structures on the site, except gas holder No. 1, have been removed. No rail lines are visible on the site. The northern and eastern areas appear sealed and the remainder of the site appears grassed. Some vegetation is scattered across the site. A ramp has been constructed from the eastern end of Macdonaldtown Railway Station to the eastern end of the site.

Copies of the Aerial Photographs are provided in Appendix B.

## **2.13 EPA, COUNCIL AND WORKCOVER RECORDS**

No statutory notices have been issued on the site from the NSW EPA and no environmental notices have been issued from South Sydney Council. In addition, WorkCover reported no records of any license to keep dangerous goods at the premises.

All Statutory Notices issued by the NSW EPA, South Sydney Council and WorkCover are provided in Appendix C.

### 3.0 PREVIOUS INVESTIGATIONS

To the knowledge of CH2M HILL no previous environmental investigations have been conducted at the site. However, the following planning report has been prepared:

- In October 1995, GHD – Transmark Pty Ltd produced a planning report on the Macdonaldtown Triangle titled “*Development of Environmental Buffer Zone for the Local Residents*”.

The following environmental investigations have been conducted at adjacent sites:

- In July 1998, CH2M HILL AUSTRALIA Pty Ltd conducted a Stage II Field Investigation and Data Assessment study on the Eveleigh Workshops Site. The report identified heavy metal, TPH and PAH contamination within on-site soils and groundwater; and
- In April 1999 a drilling investigation and hazardous materials audit was conducted by IT Environmental (Australia) Pty Ltd on the 4GT Maintenance Facility at the Eveleigh Railyards. The report concluded that the site was underlain by fill of varying depth and identified lead contamination on the site.

### 3.1 POTENTIAL CONTAMINANT ISSUES

Based on CH2M HILL’s assessment of available site history and knowledge of previous activities, the following potential contamination issues have been identified

- **Former gasworks operations on site.** Gasworks operations potentially contaminate surrounding land due to activities such as disposal of coal tar, boiler ash and gas scrubber waste, spent oxides and leakage of tar storage facilities. Disposal of fill material may cause widespread contamination on the site, whereas leakage of storage facilities may cause isolated contamination in the vicinity of structures such as tar pits, gasholders etc. Contamination may also be derived from the operation and maintenance of machinery on-site. Potential contaminants of concern include polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), benzene, toluene, ethylbenzene and total xylenes (BTEX), phenolics, ammonia, heavy metals (cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn)), arsenic, asbestos, cyanide and sulphide/sulphate;
- **Former cleaning shed and rail sidings.** Cleaning processes may have impacted on the site through the disposal or leakage of oils and greases, solvents and degreasers. In addition, there is potential for the pre-treated railway sleepers to contain elevated concentrations of heavy metals (ie. chromium, copper, arsenic) and creosote, and therefore potential contaminants of concern include TPHs, PAHs, BTEX, chlorinated hydrocarbons, organochlorine pesticides (OCPs) and asbestos; and
- **Fill of unknown origin.** Investigations of nearby SRA sites of similar development periods have identified extensive use of fill on these sites. As the origin of the fill material

placed on the site (eg. above the former cleaning shed foundations) is unknown, there is the potential for a wide variety of contaminants to be present within the fill material as a result of activities conducted at the fill materials source site. Potential contaminants include heavy metals, asbestos, TPHs, PAHs, BTEX and OCPs.



---

## 4.0 CRITERIA DEVELOPMENT

### 4.1 SOILS CRITERIA

Criteria developed for the assessment of the site are based upon current management practices applied in NSW. The criteria are obtained from site investigation levels listed in the NSW EPA *Guidelines for the NSW Site Auditor Scheme* (1998). The NSW EPA *Guidelines for the NSW Site Auditor Scheme* (1998) guideline criteria provide health-based investigation levels considered to be appropriate for a range of generic land uses in Australia including low and medium density residential, and commercial/industrial use. The generic land uses for each set of criteria are described as:

- Column 1: Residential with gardens accessible soil (home grown produce contributing less than 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools and primary schools, or town houses or villas;
- Column 2: Residential with minimal access to soil including high rise apartments and flats;
- Column 3: Parks and recreational open space, playing fields including secondary schools; and
- Column 4: Commercial or Industrial.

The most appropriate criteria listed in the NSW EPA *Guidelines for the NSW Site Auditor Scheme* (1998) for the assessment of the site based on its current and potential future uses are those listed in Column 4 for Commercial/Industrial use. Environmental Investigation Levels (EIL's) have not been used for the comparison of the data as they are based on phytotoxicity values and the site has been prescribed for future commercial/industrial uses.

It has been noted that there is the presence of approximately three residential vegetable patches in the vicinity of the gas holders, Figure 2 and Plate 2. However, as the site is to be used for continuing commercial/industrial purposes a comparison of the soil data to residential criteria will be undertaken in a separate report.

In addition, criteria has also been obtained from the NSW EPA *Guidelines for Assessing Service Station Sites* (1994) for some parameters (BTEX and TPHs) not defined in the Guidelines for the NSW Site Auditor Scheme. Site criteria are presented in Table 4.1.

Australian criteria for some of the chemicals of concern identified during investigations at the site do not exist. In these cases, the 'B' value in the *Environmental Quality Objectives in the Netherlands*, (1994, Dutch Guidelines) has been used. If the Dutch Guidelines do not contain criteria for the chemical, then another appropriate source and criteria has been submitted for consideration. CH2M HILL has used criteria from the US EPA Region 9 Preliminary Remediation Goals for Industrial Soil where necessary. Table 4.2 lists the criteria for volatile organic compounds.

## 4.2 COMPARISON OF SOIL ANALYTICAL RESULTS TO CRITERIA

The methodology used for the comparison of analytical data for soils to the site criteria is based on the methods referred to in the NSW EPA's *Guidelines for the NSW Site Auditors Scheme* (1998), namely:

- comparison of the 95 percent upper confidence limit (UCL) of the arithmetic average concentration of each contaminant to the site criteria for the assessment of site wide contamination levels within appropriate data populations;
- comparison of individual analytical results to a 'hotspot' criteria of 2.5 times the respective analyte criteria to identify contamination hotspots. Results greater than 2.5 times the criteria are defined as not part of the general data population of the site, but rather as a 'hotspot' or a different population; and
- comparison of calculated standard deviations to a value of 50 percent of the respective criteria.

Analytical results reported above the hotspot criteria are removed from the respective data set and the 95 percent UCL recalculated. Such hotspots generally require remediation or management.

In addition, where the standard deviation exceeds a value of half the site criteria, the results are considered to contain an unacceptable degree of variation. Under these circumstances, the 95 percent UCL may be considered invalid. Where this occurs, hotspots (highest individual result) are progressively removed from the respective data set. Removal of hotspots are conducted until the calculated standard deviation is below 50 percent of the respective criteria. Hotspots removed from the data set generally need to be remediated or managed accordingly.

The methods used for calculating the 95 percent UCL of the arithmetic average concentration were derived from those contained in the NSW EPA *Sampling Design Guidelines* (1995), namely Procedure D and Procedure G. The NSW EPA *Sampling Design Guidelines* (1995) state that Procedure D is suitable for a range of concentration distributions and should generally be used for calculating the 95 percent UCL of a normal distribution. All concentrations are considered to be within a normal population unless the coefficient of the variation is calculated at greater than 1.2 (Gilbert, 1987) and statistical tests support the hypothesis of a lognormal distribution. Where the results display a lognormal distribution (ie. coefficient greater than 1.2), Procedure G be the method used for calculating the 95 percent UCL.

Therefore, the method outlined in Procedure D of the NSW EPA *Sampling Design Guidelines* (1995) has been used for calculating the 95 percent UCLs of the arithmetic average concentration in all cases except where the distribution is lognormal, where Procedure G has been used.

<b>Table 4.1: Investigation Criteria</b>	
<b>Parameter</b>	<b>Column 4 <sup>(a)</sup>: Health based investigation levels for commercial or industrial (mg/kg)</b>
Arsenic	500
Cadmium	100
Chromium (III)	60%
Chromium (VI)	500
Copper	5,000
Lead	1,500
Mercury (methyl)	50
Zinc	35,000
Nickel	3,000
Cyanide (complexed)	2500
TPHs (C <sub>6</sub> -C <sub>9</sub> )	65 <sup>(b)</sup>
TPHs (C <sub>10</sub> -C <sub>36</sub> )	1000 <sup>(b)</sup>
Benzene	1 <sup>(b)</sup>
Toluene	1.4 <sup>(b)</sup>
Ethyl Benzene	3.1 <sup>(b)</sup>
Xylene	14 <sup>(b)</sup>
PAHs (total)	100
Benzo(a) pyrene	5
Organochlorine Pesticides (total) <sup>f</sup>	40 <sup>(c)</sup>
Total Phenols	42500
Sulphide/Sulphate	2000 <sup>(g)</sup>
PCBs (total) <sup>f</sup>	50

**Footnotes:**

No guideline criteria exists for Ammonia or Asbestos in soil

(a) NSW EPA "Guidelines for the NSW Site Auditor Scheme".

(b) NSW EPA "Guidelines for Assessing Service Station Sites".

(c) Based on NSW EPA "Guidelines for the NSW Site Auditor Scheme", Health Based Investigation Level for Aldrin + Dieldrin.

(d) Environmental Quality Objectives in the Netherlands - B Values.

(e) US EPA Region 9: Preliminary Remediation Goals for Soils- Industrial Land -Use.

(f) NOTE: Significant total mass of this contaminant may require management under the provisions of the NSW EPA Scheduled Chemical Waste Orders

(g) ANZECC (1992) Guidelines for the Assessment and Management of Contaminated Sites

Table 4.2: Investigation Criteria for Volatile Organic Compounds	
Parameter	Criteria (mg/kg)
Styrene	100 <sup>A</sup>
1,3,5-Trimethylbenzene	70 <sup>B</sup>
Chloromethane	2.7 <sup>B</sup>
Vinyl chloride	0.1 <sup>A</sup>
Bromomethane	13 <sup>B</sup>
Trichlorofluoromethane	2000 <sup>B</sup>
1,1-Dichloroethane	50 <sup>A</sup>
Dichloromethane (methylene chloride)	20 <sup>A</sup>
1,2-Dichloroethane (EDC)	4 <sup>A</sup>
1,1-Dichloroethene	0.12 <sup>B</sup>
cis 1,2-Dichloroethene	150 <sup>B</sup>
1,1,1-Trichloroethane	50 <sup>A</sup>
Carbon Tetrachloride	0.53 <sup>B</sup>
Trichloroethene	60 <sup>A</sup>
1,2-Dichloropropane	0.77 <sup>B</sup>
Dibromomethane	240 <sup>B</sup>
1,1,2-Trichloroethane	50 <sup>A</sup>
Tetrachloroethene	4 <sup>A</sup>
1,1,1,2-Tetrachloroethane	7 <sup>B</sup>
1,1,2,2-Tetrachloroethane	0.9 <sup>B</sup>
1,2,3-Trichloropropane	0.0031 <sup>B</sup>
1,2-Dibromo-3-chloropropane	4 <sup>B</sup>
Hexachlorobutadiene	32 <sup>B</sup>
Chlorobenzene	450 <sup>B</sup>
2-Chlorotoluene	570 <sup>B</sup>
1,3-Dichlorobenzene	52 <sup>B</sup>
1,4-Dichlorobenzene	8.1 <sup>B</sup>
1,2-Dichlorobenzene	370 <sup>B</sup>
1,2,4-Trichlorobenzene	3000 <sup>B</sup>
Chloroform (Trichloromethane)	10 <sup>A</sup>
Bromodichloromethane	2.4 <sup>B</sup>
Dibromochloromethane	2.7 <sup>B</sup>
Bromoform (Tribromomethane)	310 <sup>B</sup>

**Footnotes:**

- (a) Environmental Quality Objectives in the Netherlands, 1994 - Intervention Values  
 (b) US EPA Region 9: Preliminary Remediation Goals for Soils - Industrial Land Use

### 4.3 GROUNDWATER ASSESSMENT CRITERIA

Based on the groundwater bore search conducted as part of the Phase I Site History investigation, the reported background quality of the groundwater is fresh water as shown in Table 2.2. The adopted criteria for all groundwater analytical results are:

- The ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*; and
- The New South Wales Environment Protection Authority (NSW EPA) *Guidelines for the Assessment of Service Station Sites* (1994).

The NSW EPA *Guidelines for the Assessment of Service Station Sites* (1994) have been selected from ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* (benzene, toluene, ethylbenzene, phenols, PAHs and lead), the Netherlands (1994) Maximum Permissible Concentration for total xylenes and The NSW Clean Waters Act 1970 and Clean Waters Regulations (1972) for TPH C<sub>6</sub>-C<sub>9</sub> and TPH C<sub>10</sub>-C<sub>36</sub>.

The aim of this work was a targeted groundwater program and not a stand alone systematic assessment of the groundwater across the site.

The groundwater criteria are summarised in Table 4.3.

<b>Table 4.3: Groundwater Guideline Criteria</b>		
Analyte	ANZECC (1992)(µg/L)	NSW EPA (1994)(µg/L)
TPH C <sub>6</sub> -C <sub>9</sub>		10,000
TPH C <sub>10</sub> -C <sub>36</sub>		10,000
Benzene	300	
Toluene	300	
Ethylbenzene	140	
Xylene (total)		380
Phenols	50	
Total PAHs	3	
Copper	2-5	
Cadmium	0.2-2	
Chromium	10	
Lead	1-5	
Mercury	0.1	
Nickel	15-150	
Zinc	5-50	
Arsenic	50	

NOTE:

ANZECC (1992) - ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*

NSW EPA (1994) – NSW EPA *Guidelines for the Assessment of Service Station Sites* (1994)

## **5.0 INVESTIGATION STRATEGY**

### **5.1 SOIL SAMPLING METHODOLOGY**

The development of the soil sampling plan was based on targeting areas identified as being potentially contaminated during the Phase I Site History Investigation, as well as undertaking sampling on a systematic grid pattern across the site.

#### **5.1.1 Sampling Strategy**

The sampling strategy undertaken during the Phase II investigation was largely focused on a random grid-based approach, although targeted samples were also collected. Given the large size of the site, and the two separate historical uses of the site, CH2M HILL undertook this investigation using a combination of the systematic and judgemental sampling design.

The site has been split into two separate areas based on their historical uses:

- Former Cleaning Shed Area, comprising the northern portion of the site; and
- Former Gasworks Area, comprising the southern portion of the site.

These two areas are shown on Figure 2.

Soil sampling in the northern ‘Former Cleaning Shed Area’ (1.53 hectares), was based on the New South Wales Environment Protection Authority (NSW EPA) *Sampling Design Guidelines* (1995). The methodology employed in determining the number of sample locations was as follows:

- Calculate the area of investigation; and
- Allocate the minimum number of sample locations prescribed in the sampling guidelines for a grid based system.

Sampling points were located to provide sufficient coverage of the area by investigating non-targeted areas (without bias), on a 25 m by 25 m grid system. Sample locations were moved within the grid as required due to the presence of underground or aboveground structures or services within the area. The aim of the grid sampling was to enable the general environmental status of the area to be characterised.

Soil sampling in the remaining ‘Former Gasworks Area’ (0.79 hectares), was also based on the NSW EPA *Sampling Design Guidelines* (1995). The sample locations were determined using a combination of the systematic and judgemental sampling strategies as defined by the NSW EPA *Sampling Design Guidelines* (1995). The methodology employed in determining the location of the sampling points was as follows:

- Calculate the area of the investigation;

- Allocate the minimum number of sample locations prescribed in the sampling guidelines for a grid based system; and
- Allocate additional sample locations to target potential areas of concern and to provide a more comprehensive coverage of the area where necessary.

Sampling points were located to provide sufficient coverage of the area by investigating non-targeted and targeted areas, on a 25 m by 25 m grid system. Sample locations were moved within the grid as required due to the presence of underground or aboveground structures or services present within the area to enable the general environmental status of the area to be characterised. Additional targeted sampling locations were located at the probable location of potential chemicals of concern across the area.

This style of investigation was considered to be the most pragmatic approach to provide the greatest information to enable preliminary delineation of the extent of contamination across the Former Gasworks Area.

Figure 2 presents the location of all soil bores across the site.

Please note the following with regard to the soil investigation undertaken at the site:

- soil bore 5 was unable to be investigated due to the presence of Gas Holder No. 2 and the proximity of underground services in the area;
- sampling location 20 was replaced by sampling location 99;
- due to the extensive nature of the foundations of the former retort house identified in the vicinity of sample locations 9, 10 and 17 and the consistency of the fill material above the foundations between sample locations no soil samples were collected from sample location 17; and
- sample location 38 was not investigated.

### **5.1.2 Soil Sampling Methodology**

CH2M HILL conducted the soil sampling and groundwater monitoring well installation between Tuesday 18 April to Thursday 20 April, 2000.

Investigations at each targeted soil sampling location were extended vertically until the underlying natural soil was reached or to equipment refusal. Investigations were undertaken using an excavator and truck mounted drilling rig. Soil samples were collected either directly from the pushtube, excavator bucket or edge of test pit walls. In general, one surface sample (0-0.15m), one subsurface/fill sample (0.5-0.65m) and one sample from the top of the natural soil profile directly beneath the fill horizon were collected, or at the point of refusal. The actual depth from which the samples were collected was based on field observations.



All soil samples were labelled with a unique identifier consisting of sample location and depth of sample (eg. SB01 (sample location) 0.9-1.0 (depth in metres)).

Samples were screened for volatile organic compounds (e.g., BTEX) with a Photoionisation Detector (PID) where field observations indicated the potential for contamination (i.e. in fill material or where an odour was observed).

Field duplicate samples were collected for quality assurance purposes.

CH2M HILL standard fieldwork and decontamination procedures are outlined in Appendix D.

### **5.1.3 Laboratory Analysis**

All analyses were performed using analytical techniques that have been endorsed by the NSW EPA and accredited by the National Association of Testing Authorities (NATA). All of the analytical work was performed by AMDEL Analytical Laboratories, Asquith, New South Wales.

As detailed in the Sampling and Analysis Plan (SAP) submitted to Strategic Environmental Management (SRA Project Manager) in April 2000, the contaminants of concern for the soil investigation were defined as follows:

- Heavy metals (Cd, Cr, Cu, Pb, Hg, Ni and Zn) and arsenic;
- Polycyclic aromatic hydrocarbons (PAHs);
- Total petroleum hydrocarbons (TPHs);
- Benzene, toluene, ethylbenzene and total xylenes (BTEX);
- Volatile organic compounds (VOCs);
- Polychlorinated biphenyls (PCBs);
- Organochlorine pesticides (OCPs);
- Asbestos;
- Cyanide; and
- Speciated Phenolics.

Speciated Phenolics were only selected for analysis where the total PAH exceeded the nominated Commercial/Industrial guideline criteria.

The analytical suite conducted by CH2M HILL is summarised in Table 5.1 below. Laboratory QA procedures are outlined in Section 7.

**Table 5.1: Soil Analytical Suite**

Analyte	Units	PQL	Analytical Method Code	Preservation Requirement	Maximum Holding Time	No. Primary Sampled Analysed	No. Duplicate Samples Analysed
<b>Heavy Metals</b>	mg/kg*	5	E5910	Cool 4°C	6 months	94	13
<b>TPH</b>	mg/kg*	0.5	E1230/ E1221	Cool 4°C	14 days	31	8
<b>BTEX</b>	mg/kg*	5	E1010	Cool 4°C	14 days	67	13
<b>PAH</b>	mg/kg*	0.05	E1110	Cool 4°C	14 days	97	13
<b>OCPs</b>	mg/kg*	0.1	E1080	Cool 4°C	14 days	8	2
<b>VOCs</b>	mg/kg*	1	E1290	Cool 4°C	14 days	21	2
<b>PCBs</b>	mg/kg*	1	E1120	Cool 4°C	14 days	8	-
<b>Cyanide</b>	mg/kg*	0.5	E1120	Cool 4°C	14 days	22	5
<b>Phenolics</b>	mg/kg*	0.5	E1140	Cool 4°C	14 days	20	-
<b>Asbestos</b>	-	-	483	-	-	15	-

NOTE:

PQL = Practical Quantitation Limit

\* = mg/kg dry soil

## 5.2 GROUNDWATER MONITORING WELL INSTALLATION AND SAMPLING METHODOLOGY

A total of six (6) monitoring wells were installed across the Former Gasworks Area of the site. Three (3) of the monitoring wells were installed in the surficial aquifer (water table up to two metres below ground level) and three (3) monitoring wells were installed in the Ashfield Shale aquifer (water table approximately ten metres below ground level).

The three monitoring wells installed in the surficial aquifer have the monitoring well construction details presented on the appropriate borelogs in Appendix E.

The three monitoring wells installed in the Ashfield Shale aquifer were constructed between depths of approximately seven to 15 metres below ground surface. The top six metres was cased using an outer 100 mm blank PVC screen and cemented into place to ensure that no water from the surficial aquifer is able to penetrate the Ashfield Shale aquifer through the monitoring well. The monitoring wells construction details are presented on the appropriate borelogs presented in Appendix E.

- All of these monitoring wells were developed, purged and sampled during the investigation, Table 5.2 at the rear of this report.

Purging and sampling of the groundwater from each monitoring well was undertaken using dedicated teflon bailers with VOC sampling additions. Details of the laboratory analysis for the groundwater sampled are included in Table 5.3. Locations of the monitoring wells sampled are shown on Figure 2.

Due to the thin layer of fill material present in the Former Cleaning Shed Area, generally less than one metre, and the extensive nature of the concrete slab identified, approximately 3,500 m<sup>2</sup>, groundwater monitoring wells were only installed in the Former Gasworks Area. The placement of the monitoring wells was based on; 1) as near to the adjacent residents as available, due to the presence of underground services etc.; and 2) in the suspected down gradient direction of the potential contaminating sources (ie. gas holders, tar pits etc.).

One duplicate sample was collected from the six monitoring wells for quality assurance purposes. As dedicated bailers were used for the purging and sampling of the monitoring wells no equipment rinsate blank samples were collected. One trip blank sample was also transported with the bottles and samples to and from the laboratory. The trip blank sample was analysed only for relevant volatile compounds, i.e. TPH C<sub>6</sub>-C<sub>9</sub> and BTEX.

<b>Table 5.3: Groundwater Sample Register</b>		
Sample ID	Analyte	Duplicate Sample
MW03S	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO <sub>4</sub> , Nitrate as N, Dissolved Methane, pH, Conductivity	
MW03D	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO <sub>4</sub> , Nitrate as N, Dissolved Methane, pH, Conductivity	
MW04S	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO <sub>4</sub> , Nitrate as N, Dissolved Methane, pH, Conductivity	X
MW04D	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO <sub>4</sub> , Nitrate as N, Dissolved Methane, pH, Conductivity	
MW06S	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO <sub>4</sub> , Nitrate as N, Dissolved Methane, pH, Conductivity	
MW06D	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO <sub>4</sub> , Nitrate as N, Dissolved Methane, pH, Conductivity	

NOTE:

TPH – Total petroleum hydrocarbons

BTEX – Benzene, Toluene, Ethylbenzene, Total Xylenes

Heavy Metals – Cd, Cu, Cr, As, Pb, Ni, Hg, Zn

Phenols – Speciated Phenols

## **6.0 INVESTIGATION RESULTS**

### **6.1 GEOLOGICAL INFORMATION**

The general soil profile across the site comprises fill material composed of sand, gravel, ballast, ash and coke breeze varying in depths between 0.20 to 3.20 metres (SB01). The fill material overlies clay/weathered shale of unknown depth. The maximum depth of the soil investigation, was 5.10 metres (SB14), however, three monitoring wells were extended to 15 metres into the Ashfield Shale.

The generalised soil profile can be seen in the cross-sections shown in Figure 3. Cross-sections were drawn in a north west to south east direction (A – A') and south west to north east (B – B'). The locations of these cross-sections are shown on Figure 3.

Borehole logs are presented in Appendix E.

### **6.2 SOIL ANALYTICAL RESULTS**

All soil analytical results are shown in Table 6.1 at the rear of this report. The analytical results for both the fill and natural soils in the Former Cleaning Shed Area are discussed below.

#### **6.2.1 Former Cleaning Shed Area**

##### ***Fill Material***

Calculated 95 percent UCLs, refer to Table 6.2 for the calculated distributions, for samples collected from within the fill material in the Former Cleaning Shed Area were reported below the respective site criteria for all analytes except for the following:

- Benzo(a)pyrene – calculated as 13mg/kg, compared to the site criteria of 5mg/kg; and
- Total PAHs – calculated as 197mg/kg, compared to the site criteria of 100mg/kg.

In addition, the standard deviation for benzene (2.1mg/kg) and toluene (2.0mg/kg) were calculated to be greater than 50 percent of the nominated site criteria (1mg/kg and 1.4mg/kg respectively). Therefore, the calculated 95 percent UCLs for benzene and toluene are not considered valid for comparison to the site criteria due to high variability.

All individual results were reported below the respective hotspot criteria except for the following:

- Benzene – reported at 15mg/kg (TP44\_0.2-0.3) compared to the hotspot criteria of 2.5mg/kg;

- Toluene - reported at 16mg/kg (TP44\_0.2-0.3) compared to the hotspot criteria of 3.5mg/kg;
- Benzo(a)pyrene - reported at 150mg/kg (TP44\_0.2-0.3), 13mg/kg (BH43\_0.4), 14mg/kg (BH35\_0.2) and 15mg/kg (TP34\_0.4-0.5) compared to the hotspot criteria of 12.5mg/kg; and
- Total PAHs - reported at 2,500mg/kg (TP44\_0.2-0.3) and 260mg/kg (TP34\_0.4-0.5) compared to the hotspot criteria of 250mg/kg.

95 percent UCLs were subsequently recalculated following removal of all identified hotspots from the respective data sets. All recalculated 95 percent UCLs were below the respective site criteria and all standard deviations were below 50 percent of the respective site criteria.

The 95 percent UCLs are shown in Table 6.2 at the rear of this report. The hotspot areas identified are shown on Figure 4.

No asbestos was observed in the fill across the Former Cleaning Shed Area. No asbestos was reported in any of the samples selected for asbestos analysis.

### ***Clay/weathered Shale***

Calculated 95 percent UCLs for samples collected from within the underlying clay/weathered shale material in the Former Cleaning Shed Area were reported below the respective site criteria for all analytes. In addition, all calculated standard deviations were less than 50 percent of the respective site criteria and all individual results were reported below the respective hotspot criteria.

## **6.2.2 Former Gasworks Area**

All soil analytical results are shown in Table 6.3 at the rear of this report. A discussion of the analytical results for samples collected from the fill and natural material is given below.

### ***Fill Material***

Calculated 95 percent UCLs for samples collected from within the fill material in the Former Gasworks Area, refer to Table 6.4 for the calculated distributions, were reported below the respective site criteria for all analytes except for the following:

- TPH C<sub>10</sub>-C<sub>36</sub> – calculated as 11,913mg/kg, compared to the site criteria of 1,000mg/kg;
- Toluene – calculated as 3mg/kg, compared to the site criteria of 1.4mg/kg;
- Xylenes – calculated as 14mg/kg compared to the site criteria of 14mg/kg
- Benzo(a)pyrene – calculated as 51mg/kg, compared to the site criteria of 5mg/kg; and

- Total PAHs – calculated as 513mg/kg, compared to the site criteria of 100mg/kg.

In addition, the standard deviation for ethylbenzene (2.3 mg/kg) was calculated at greater than 50 percent of the site criteria (3.1 mg/kg). Therefore, the calculated 95 percent UCLs for ethylbenzene are not considered valid for comparison to the site criteria due to high variability.

All individual results were reported below the respective hotspot criteria except for the following:

- Toluene - reported at 5mg/kg (TPC\_1.00), 15mg/kg (TPA\_1.60) and 5mg/kg (BH13\_0.2-0.3) compared to the hotspot criteria of 3.5mg/kg;
- Ethylbenzene - reported at 9mg/kg (TPC\_1.00) compared to the hotspot criteria of 7.8mg/kg;
- Xylenes - reported at 65mg/kg (TPA\_1.60) and 48mg/kg (TPC\_1.00) compared to the hotspot criteria of 35mg/kg;
- TPH C<sub>10</sub>-C<sub>36</sub> – reported at 5,020mg/kg (SB03\_0.0-0.1), 12,100mg/kg (SB04\_0.7-0.8), 20,000mg/kg (SB06\_0.2-0.3), 14,400mg/kg (SB07\_0.0-0.1), 7,100mg/kg (BH13\_0.2-0.3), 4,390mg/kg (BH15\_0.2-0.3), 38,400mg/kg (SB18\_0.2-0.3) and 3,200mg/kg (TPA\_1.60) compared to the hotspot criteria of 2,500mg/kg;
- B(a)P – reported at 14mg/kg (SB02\_0.0-0.1), 35mg/kg (SB02\_0.2-0.3), 27mg/kg (SB03\_0.0-0.1), 140mg/kg (SB04\_0.7-0.8), 190mg/kg (SB06\_0.2-0.3), 200mg/kg (SB07\_0.0-0.1), 26mg/kg (SB07\_1.4-1.5), 39mg/kg (BH13\_0.2-0.3), 16mg/kg (BH15\_0.0-0.1), 58mg/kg (BH15\_0.2-0.3) and 220mg/kg (SB18\_0.2-0.3) compared to the hotspot criteria of 12.5mg/kg; and
- Total PAHs – reported at 290mg/kg (SB03\_0.0-0.1), 1,700mg/kg (SB04\_0.7-0.9), 410mg/kg (BH13\_0.2-0.3), 380mg/kg (BH15\_0.2-0.3), 4,000mg/kg (SB18\_0.2-0.3), 530mg/kg (TPA\_1.60) and 750mg/kg (TPC\_1.00) compared to the hotspot criteria of 250mg/kg.

95 percent UCLs and standard deviations were subsequently recalculated following removal of all identified hotspots from the respective data sets. All recalculated 95 percent UCLs were below the respective site criteria except for B(a)P. In addition, recalculated standard deviations were less than 50 percent of the respective site criteria for all the remaining analytes except for total PAHs. Therefore, the following individual results were identified as hotspots, due to a 95 percent UCL exceeding the respective site criteria or a calculated standard deviation exceeding 50 percent of the respective site criteria:

#### *95 percent UCL Hotspot*

- B(a)P – sample numbers BH16\_0.0-0.1 (11mg/kg), BH10\_0.0-0.1 (11mg/kg), TPA\_1.60 (8.4mg/kg) and TPC\_1.00 (8.4mg/kg); and

### *Standard Deviation Hotspot*

- Total PAHs – sample numbers SB02\_0.2-0.3 (200mg/kg).

The 95 percent UCL calculations are shown in Table 6.4 at the rear of the report.

All 95 percent UCLs and standard deviations were reported below the site criteria and 50 percent of the site criteria respectively following removal of the above hotspots.

All identified ‘hotspot’ boreholes are shown on Figure 5.

No asbestos was observed in the fill across the Former Gasworks Area. No asbestos was reported in any of the samples selected for asbestos analysis.

### *Clay/weathered Shale*

All calculated 95 percent UCLs were reported below the site criteria except for the following

- Benzene - calculated as 2mg/kg, compared to the site criteria of 1mg/kg;
- Toluene - calculated as 1.6mg/kg, compared to the site criteria of 1.4mg/kg;
- Ethylbenzene - calculated as 15mg/kg, compared to the site criteria of 3.1mg/kg;
- Xylenes - calculated as 40mg/kg, compared to the site criteria of 14mg/kg;
- Benzo(a)pyrene – calculated as 10mg/kg, compared to the site criteria of 5mg/kg; and
- Total PAHs – calculated as 339mg/kg, compared to the site criteria of 100mg/kg.

All calculated standard deviations for all remaining analytes were reported below 50 percent of the site criteria. However, the following individual analytical results were reported above the respective hotspot criteria

- Benzene – reported at 4.6mg/kg (BH14\_0.9-1.00), 7mg/kg (SB18\_1.7-1.8) and 4mg/kg (MW04\_2.00-2.10) compared to the hotspot criteria of 2.5mg/kg;
- Toluene - reported at 11mg/kg (SB18\_1.7-1.8) compared to the hotspot criteria of 3.5mg/kg;
- Ethylbenzene - reported at 8mg/kg (SB07\_1.40-1.50), 26mg/kg (BH14\_1.40-1.50) and 80mg/kg (SB18\_1.7-1.8) compared to the hotspot criteria of 7.8mg/kg;
- Xylenes - reported at 48mg/kg (BH14\_0.90-1.00) and 210 mg/kg (SB18\_1.7-1.8) compared to the hotspot criteria of 35mg/kg;



- Benzo(a)pyrene - reported at 30mg/kg (SB06\_0.3-0.4), 26mg/kg (SB07\_1.4-1.5) and 28mg/kg (SB18\_1.7-1.8) compared to the hotspot criteria of 12.5mg/kg; and
- Total PAHs - reported at 2,100mg/kg (SB18\_1.7-1.8) compared to the hotspot criteria of 250mg/kg.

95 percent UCLs and standard deviations were subsequently recalculated following removal of all identified hotspots from the respective data sets. All recalculated 95 percent UCLs were below the respective site criteria. In addition, all standard deviations were below 50 percent of the respective site criteria except for total PAHs. Therefore, total PAHs for sample number BH12\_4.4-4.5 (220mg/kg) was identified as a hotspot and removed from the data set. All recalculated standard deviations were subsequently below 50 percent of the respective site criteria.

All 95 percent UCL calculations reported for samples collected within the natural soils within the Former Gasworks Area are presented in Table 6.5 at the rear of the report. Figure 6 shows the sample locations identified as containing concentrations exceeding the 95 percent UCL criteria.

## **6.3 GROUNDWATER INVESTIGATION RESULTS**

### **6.3.1 Groundwater Gauging**

All six monitoring wells present on the site were gauged.

Free product was not identified on the surface of the groundwater in any of the six monitoring wells. Strong odours were observed from the groundwater collected from monitoring well MW06S.

All monitoring wells were developed one week prior to purging and sampling. The data obtained from the development, purging and sampling of the groundwater monitoring wells are shown in Table 5.2 at the rear of this report.

The recorded groundwater quality information indicates;

#### *Surficial Aquifer*

- that the groundwater is slightly acidic with pH values ranging between 4.71 to 5.81. This may be due to the contaminants identified in the groundwater; and
- that the groundwater is fresh with its conductivity ranging from 497 to 587  $\mu\text{S}/\text{cm}$ .

---

### *Ashfield Shale Aquifer*

- that the groundwater is slightly acidic with pH values ranging between 5.02 to 5.32. This may be due to the contaminants identified in the groundwater; and
- that the groundwater is brackish to slightly saline with its conductivity ranging from 1,163 to 3,028  $\mu\text{S}/\text{cm}$ .

From the calculation of the inferred potentiometric contours, Figures 7 and 8 indicate that the groundwater flow direction is towards the south south east for both the surficial and Ashfield Shale groundwater regimes. However, the specific groundwater flow patterns adjacent to the gas holders will vary due to the depth at which the annulus's of the gas holder will extend below ground surface. Based on observations made during the investigation the depth of the gas holders annulus's was estimated to be approximately five to six metres below ground surface. This annulus depth estimation is based on the telescoping nature of the gas holder observed on the site, with the height of the gas holder structure estimated to be approximately ten metres above ground level. Two partitions were observed to be connected to the gas holder. Each panel was assumed to be five metres in height.

The direction of groundwater flow on the western side of the gas holders may vary in relation to the groundwater flow directions calculated for the eastern side of the gas holders.

The measured water levels below the top of the PVC casing are shown in Table 6.6, along with each individual wells surveyed height to Australian Height Datum (AHD) and the reduced groundwater elevations to metres AHD. The hydraulic gradients for each of the two aquifers have been calculated as 0.0111 m/m for the surficial aquifer and 0.0444 m/m for the Ashfield Shale aquifer.

The hydraulic gradient difference observed between the surficial and Ashfield Shale aquifer may have resulted from a number of causes as noted below:

- I. The extent and nature of the confining layer at the base of the surficial aquifer;
- II. Lack of lateral connectivity of the groundwater in the Ashfield Shale aquifer;
- III. Potential disturbances to the geology around the gas holders due to their construction (ie. creation or expansion of fracture systems) causing a greater release of hydraulic pressure of the Ashfield Shale aquifer in monitoring well MW06D; and
- IV. Potential dewatering of the Ashfield Shale aquifer due to the presence of an underground railway line to the south east of the site, however, there does not appear to be a shift in the groundwater flow direction towards the underground railway line.

<b>Table 6.6: Groundwater Gauging Data</b>			
Well ID	Water Level (mbtoc)	Surveyed Height (mAHD)	Water Level (mAHD)
MW03S	2.31	18.38	16.07
MW03D	4.03	18.33	14.30
MW04S	2.29	18.40	16.11
MW04D	3.78	18.37	14.59
MW06S	2.33	18.96	16.63
MW06D	2.29	18.97	16.68

NOTE:

mbtoc – metres below top of pvc casing

mAHD – metres Australian Height Datum

### 6.3.2 Chemical Results

Groundwater collected from all of the monitoring wells was analysed for the range of parameters listed in Table 5.3.

The analytical results of the groundwater samples collected indicated the following:

#### *Inorganic Analyses*

The analytical results for the inorganic analysis are presented in Table 6.7 at the rear of this report. The laboratory results indicated the following:

#### *Surficial Aquifer*

- Concentrations of arsenic were reported above the laboratory limits of reporting (LOR) but less than the ANZECC (1992) guideline criteria of 50 µg/L in the groundwater collected from all of the monitoring wells. The highest reported concentration was from monitoring wells MW04S and MW06S with 2 µg/L;
- Concentrations of cadmium were only reported above the laboratory LOR of 0.1 µg/L and the ANZECC (1992) guideline criteria of 0.2 µg/L in the groundwater collected from MW06S, 0.4 µg/L. The groundwater collected from MW03S and MW04S reported cadmium concentrations less than the laboratory LOR;
- Concentrations of chromium were reported above the laboratory LOR of 1 µg/L in the groundwater collected from all of the monitoring wells. Groundwater collected from monitoring well MW04S (15 µg/L) was the only one to report a concentration above the ANZECC (1992) guideline criteria of 10 µg/L;
- Concentrations of copper were reported above the laboratory LOR of 1 µg/L in the groundwater collected from two monitoring wells (MW03S, 3 µg/L and MW06S, 2 µg/L).

Both concentrations reported from MW03S and MW06S are greater than the ANZECC (1992) guideline criteria of 2 µg/L;

- Concentrations of nickel were reported above the laboratory LOR of 1 µg/L but less than the ANZECC (1992) guideline criteria of 15 µg/L in the groundwater collected from all of the monitoring wells. The highest reported concentration was from monitoring well MW04S, 10 µg/L;
- Concentrations of lead were reported below the laboratory LOR of 1 µg/L for the groundwater collected from all of the monitoring wells;
- Concentrations of zinc were reported above the laboratory LOR of 2 µg/L and the ANZECC (1992) guideline criteria of 5 µg/L in all groundwater samples collected. The highest reported concentration was from monitoring well MW06S, 25 µg/L;
- Concentrations of mercury were reported below the laboratory LOR of 0.05 µg/L for the groundwater collected from all of the monitoring wells; and
- Concentrations of iron (II) were reported above the laboratory LOR of 5 µg/L and the ANZECC (1992) guideline criteria of 1000 µg/L in all groundwater samples collected. The highest reported concentration was from monitoring well MW03S, 55,600 µg/L.

#### *Ashfield Shale Aquifer*

- Concentrations of arsenic were reported above the laboratory limits of reporting (LOR) but less than the ANZECC (1992) guideline criteria of 50 µg/L in the groundwater collected from all of the monitoring wells. The highest reported concentration was from monitoring well MW03D, 9 µg/L;
- Concentrations of cadmium was only reported above the laboratory LOR of 0.1 µg/L but less than the ANZECC (1992) guideline criteria of 0.2 µg/L in the groundwater collected from MW06S, 0.1 µg/L. The groundwater collected from MW03S and MW04S reported cadmium concentrations less than the laboratory LOR;
- Concentrations of chromium were reported above the laboratory LOR of 1 µg/L in the groundwater collected from all of the monitoring wells. All reported concentrations were less than the ANZECC (1992) guideline criteria of 10 µg/L. The highest reported concentration was from monitoring well MW04D, 7 µg/L;
- Concentrations of copper were reported above the laboratory LOR of 1 µg/L and the ANZECC (1992) guideline criteria of 2 µg/L in the groundwater collected from all of the monitoring wells. The highest reported concentration was from monitoring well MW06D, 14 µg/L;
- Concentrations of nickel were reported above the laboratory LOR of 1 µg/L. Concentrations greater than the ANZECC (1992) guideline criteria of 15 µg/L were

reported in the groundwater collected from MW03D (19 µg/L) and MW06D (19 µg/L). The groundwater collected from MW04D (14 µg/L) reported a nickel concentration less than the ANZECC (1992) guideline criteria of 15 µg/L;

- Concentrations of lead was only reported above the laboratory LOR of 1 µg/L and the ANZECC (1992) guideline criteria of 1 µg/L in the groundwater collected from MW06D, 7 µg/L. The groundwater collected from MW03D and MW04D reported concentrations of lead less than the laboratory LOR of 1 µg/L.
- Concentrations of zinc were reported above the laboratory LOR of 2 µg/L and the ANZECC (1992) guideline criteria of 5 µg/L in all groundwater samples collected. The highest reported concentration was from monitoring well MW06D, 88 µg/L;
- Concentrations of mercury were reported below the laboratory LOR of 0.05 µg/L for the groundwater collected from all of the monitoring wells; and
- Concentrations of iron (II) were reported above the laboratory LOR of 5 µg/L and the ANZECC (1992) guideline criteria of 1000 µg/L in all groundwater samples collected. The highest reported concentration was from monitoring well MW03D, 36,500 µg/L.

### ***Organic Analyses***

The analytical results for the organic analysis are presented in Table 6.7 at the rear of this report. The laboratory results indicated the following:

#### ***Surficial Aquifer***

Speciated phenols were analysed in each of the groundwater samples collected from the monitoring wells installed in the surficial aquifer. Concentrations of total phenols exceeding the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* of 50 µg/L were reported from monitoring well MW06S (173 µg/L). The two remaining monitoring wells (MW03S and MW04S) did not report any speciated phenols greater than the laboratory limits of reporting (LOR).

Polycyclic aromatic hydrocarbons (PAHs) were selected for analysis on all of the groundwater samples collected from the surficial aquifer. All of the samples reported total PAH concentrations greater than the ANZECC (1992) *Guideline for the Protection of Fresh Water Ecosystems* of 3 µg/L. A summary of the surficial aquifer PAH analytical results are presented in Table 6.9 below:

<b>Table 6.9: Summary of PAH Analytical Results – Surficial Aquifer</b>			
Monitoring Well	Naphthalene (µg/L)	Total PAH (µg/L)	ANZECC (1992) (µg/L)
MW03S	86	89	3
MW04S	5	5	
MW06S	2600	2700	

NOTE:

ANZECC (1992) = ANZECC (1992) *Guideline for the Protection of Fresh Water Ecosystems*

As can be seen in Table 6.9, greater than 96 percent of all of the total PAH reported is comprised of naphthalene. The presence of naphthalene at this percentage of total PAH demonstrates that gasworks waste has been disposed of at the site and that as naphthalene has a high solubility and low half life this waste is still present in the soil.

Benzene, toluene, ethylbenzene and total xylene (BTEX) were selected for analysis in all samples collected from the surficial aquifer. The results of the laboratory analysis indicated that all of the samples reported concentrations of benzene, toluene and ethylbenzene compounds either less than the laboratory LOR or the relevant guideline criteria. A total xylene concentration of 460 µg/L was reported from monitoring well MW06S, which exceeds the guideline criteria of 380 µg/L. Total xylene concentrations reported from MW03S (15 µg/L) and MW04S (<3 µg/L) were below the adopted guideline criteria. The analytical results are presented in Table 6.10.

<b>Table 6.10: Summary of BTEX Results – Surficial Aquifer</b>				
Analyte	Guideline Criteria (µg/L)	MW03S (µg/L)	MW04S (µg/L)	MW06S (µg/L)
Benzene	300 <sup>1</sup>	74	<0.5	200
Toluene	300 <sup>1</sup>	<1	<1	170
Ethylbenzene	140 <sup>2</sup>	28	<1	130
Total Xylenes	380 <sup>2</sup>	15	<3	460

NOTE:

<sup>1</sup> = ANZECC (1992) Fresh Water Guideline Criteria

<sup>2</sup> = NSW EPA (1994) Guidelines for the Assessment of Service Station Sites (Fresh Waters)

nd = not reported above laboratory PQL

Total petroleum hydrocarbons (TPHs) were selected for analysis in all of the samples collected from the surficial aquifer. The results of the laboratory analysis indicated that the groundwater collected from monitoring well MW06S (TPH C<sub>10</sub>-C<sub>36</sub>; 21,796 µg/L) exceeds the NSW EPA *Guidelines for the Assessment of Service Station Sites* (1994) Protection of Fresh Water Ecosystems Threshold Concentration of 10,000 µg/L for TPH C<sub>10</sub>-C<sub>36</sub>.

All of the other samples selected for both TPH C<sub>6</sub>-C<sub>9</sub> and/or TPH C<sub>10</sub>-C<sub>36</sub> were reported either below the laboratory LOR or the NSW EPA *Guidelines for the Assessment of Service Station Sites* (1994) Protection of Fresh Water Ecosystems Threshold Concentrations of 10,000 µg/L each. A summary of the analytical results for TPH analysis on the surficial aquifer is presented in Table 6.11.



<b>Table 6.11: Summary of TPH Results – Surficial Aquifer</b>				
Analyte	Guideline Criteria (µg/L)	MW03S (µg/L)	MW04S (µg/L)	MW06S (µg/L)
TPH (C <sub>6</sub> -C <sub>9</sub> )	10,000	140	<20	980
TPH (C <sub>10</sub> -C <sub>36</sub> )	10,000	1,393	<220	21,796

NOTE:

The NSW EPA Guidelines for the Assessment of Service Station Sites (1994) indicate that for both TPH C<sub>6</sub>-C<sub>9</sub> and TPH C<sub>10</sub>-C<sub>36</sub> the NSW Clean Waters Act (1970) and Clean Waters Regulations (1972) prohibit the pollution of waters by unlicensed contaminated discharges and require licensed discharges to be visually free of oil and grease. Experience has demonstrated that the latter criterion is equivalent to an oil and grease concentration of approximately 10 mg/L.

nd = not reported above laboratory PQL

### *Ashfield Shale Aquifer*

Speciated phenols were analysed in each of the groundwater samples collected from the monitoring wells installed in the Ashfield Shale aquifer. Concentrations of total phenolics exceeding the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* of 50 µg/L were reported from monitoring well MW03D (82 µg/L). The two remaining monitoring wells (MW04D and MW06D) reported concentrations of total phenols greater than the laboratory LOR (11 µg/L and 35 µg/L respectively) but less than the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*.

PAHs were selected for analysis on all samples collected from the Ashfield Shale aquifer. All of the samples reported total PAHs greater than the laboratory. A summary of the Ashfield Shale aquifer PAH results are presented in Table 6.12 below:

<b>Table 6.12: Summary of PAH Analytical Results – Ashfield Shale Aquifer</b>			
Monitoring Well	Naphthalene (µg/L)	Total PAH (µg/L)	ANZECC (1992) (µg/L)
MW03D	210	210	3
MW04D	37	37	
MW06D	<1	1	

NOTE:

ANZECC (1992) = ANZECC (1992) *Guideline for the Protection of Fresh Water Ecosystems*

nd = not reported above laboratory PQL

As seen with the groundwater collected from the surficial aquifer, the majority of the total PAHs reported by the laboratory were comprised of naphthalene, except for the groundwater collected from MW06D where no naphthalene was reported above the laboratory LOR.

Groundwater collected from MW03D and MW04D reported total PAH concentrations greater than the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* criteria of 3 µg/L. Both of these locations are in the down hydraulic direction of the two gas holders and are adjacent to the south eastern boundary of the site. The groundwater collected from

monitoring well MW06D contains concentrations of total PAH less than the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*.

Benzene, toluene, ethylbenzene and total xylene (BTEX) were selected for analysis in all samples collected from the Ashfield Shale aquifer. The results of the laboratory analysis indicated that the sample collected from MW03D (430 µg/L) reported a benzene concentration greater than the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* of 300 µg/L. Concentrations of benzene were reported above the laboratory LOR but less than the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* for the groundwater collected from MW04D (16 µg/L) and MW06D (130 µg/L).

The analytical results reported for toluene, ethylbenzene and total xylenes were either below the laboratory LOR or their respective guideline criteria.

The analytical results are presented in Table 6.13.

<b>Table 6.13: Summary of BTEX Results – Ashfield Shale Aquifer</b>				
Analyte	Guideline Criteria (µg/L)	MW03D (µg/L)	MW04D (µg/L)	MW06D (µg/L)
Benzene	300 <sup>1</sup>	430	16	140
Toluene	300 <sup>1</sup>	9	<1	17
Ethylbenzene	140 <sup>2</sup>	25	<1	11
Total Xylenes	380 <sup>2</sup>	73	<3	39

NOTE:

<sup>1</sup> = ANZECC (1992) Fresh Water Guideline Criteria

<sup>2</sup> = NSW EPA (1994) Guidelines for the Assessment of Service Station Sites (Fresh Waters)

nd = not reported above laboratory PQL

Total petroleum hydrocarbons (TPHs) were selected for analysis in all of the samples collected from the Ashfield Shale aquifer. The results of the laboratory analysis indicated that all of the samples reported concentrations of TPH C<sub>6</sub>-C<sub>9</sub> and TPH C<sub>10</sub>-C<sub>36</sub> below the laboratory LOR or their respective guideline criteria.

A summary of the analytical results for TPH analysis on the Ashfield Shale aquifer is presented in Table 6.14.

<b>Table 6.14: Summary of TPH Results – Ashfield Shale Aquifer</b>				
Analyte	Guideline Criteria (µg/L)	MW03D (µg/L)	MW04D (µg/L)	MW06D (µg/L)
TPH (C <sub>6</sub> -C <sub>9</sub> )	10,000	580	20	200
TPH (C <sub>10</sub> -C <sub>36</sub> )	10,000	600	220	480

NOTE:

The NSW EPA Guidelines for the Assessment of Service Station Sites (1994) indicate that for both TPH C<sub>6</sub>-C<sub>9</sub> and TPH C<sub>10</sub>-C<sub>36</sub> the NSW Clean Waters Act (1970) and Clean Waters Regulations (1972) prohibit the pollution of waters by unlicensed contaminated discharges and require licensed discharges to be visually free of oil and grease. Experience has demonstrated that the latter criterion is equivalent to an oil and grease concentration of approximately 10 mg/L (ie. 10,000 µg/L).



## 6.4 POTENTIAL FOR NATURAL ATTENUATION

Table 6.15 presents the analytical and field measured natural attenuation parameters for the groundwater collected from the surficial and Ashfield Shale groundwater monitoring wells.

Concentrations of ferrous iron, dissolved oxygen and sulphide/sulphate were reported above the ANZECC (1992) guidelines of 1000 µg/L, >6 mg/L, and 2 µg/L respectively for all of the groundwater samples collected from both the surficial and Ashfield Shale aquifers. The presence of these compounds at concentrations greater than the ANZECC (1992) guideline values indicates that both the surficial and Ashfield Shale aquifers may provide mechanisms through which natural attenuation of the hydrocarbons may occur.

Table 6.15: Summary of Natural Attenuation Data				
Well	SO <sub>4</sub>	NO <sub>3</sub>	Diss O <sub>2</sub>	Ferrous Fe
<i>Surficial Aquifer</i>				
MW03S	240	<0.01	1.1	55.6
MW04S	41	<0.01	1.1	35.3
MW06S	130	1.42	3.9	1.5
<i>Ashfield Shale Aquifer</i>				
MW03D	580	0.01	3.1	36.5
MW04D	610	0.02	2.2	12.8
MW06D*	650	<0.01	3.1	6.8

NOTE:

\* - Background monitoring well

nd – not reported above laboratory PQL

All results in mg/L

### *Surficial Aquifer*

All monitoring wells in the surficial aquifer reported concentrations of hydrocarbons above the laboratory LORs and therefore none of these monitoring wells can be considered as representing background conditions for assimilative capacity considerations. However, the average concentrations are used to indicate an estimate of the potential for natural degradation of hydrocarbons.

The average dissolved oxygen concentration recorded in the aquifer at the site was 2.03 mg/L. Based on the equations provided in Appendix G, the aquifer at this dissolved oxygen concentration has the potential to degrade approximately 0.225 mg/L of C<sub>18</sub> chainlength hydrocarbon.

The average concentration of nitrate in the aquifer reported at the site is 0.476 mg/L. Therefore, based on the equations provided in Appendix G, the aquifer has the potential to degrade approximately 0.033 mg/L of C<sub>18</sub> chainlength hydrocarbon through denitrification.

The average sulphate concentration reported in the aquifer is 151 mg/L. Therefore, based on the equations provided in Appendix G, the aquifer has the potential to degrade approximately 10.94 mg/L of C<sub>18</sub> chainlength hydrocarbon through sulphate reduction.

Using the average concentration of ferrous iron reported by the laboratory, 30.8 mg/L, approximately 0.489 mg/L of C<sub>18</sub> chainlength hydrocarbon would be able to be degraded through iron reduction.

These concentrations suggest that the surficial aquifer has a potential assimilative capacity of 1.6 mg/L of hydrocarbons, which indicates a moderate potential for hydrocarbon degradation in the aquifer.

#### *Ashfield Shale Aquifer*

Monitoring well MW06D did not report any hydrocarbon concentrations above the laboratory LORs and is therefore considered to represent background conditions in the Ashfield Shale aquifer. The natural attenuation parameters reported from MW06D are also considered to represent the background concentrations present in the aquifer.

The dissolved oxygen concentrations in the Ashfield Shale aquifer suggest that oxidative degradation of hydrocarbons can occur in the aquifer. There is negligible concentrations of nitrate present (less than 0.02 mg/L) and it is unlikely that nitrate is a major contributor to hydrocarbon degradation in the aquifer. Sulphate concentrations are elevated in comparison to the concentrations reported in the surficial aquifer and, therefore, suggests a good potential for hydrocarbon breakdown under reducing conditions. Similarly, ferrous iron concentrations indicate that the aquifer has a good potential for hydrocarbon breakdown by anaerobic methods.

An estimate of the assimilative capacity of the Ashfield Shale aquifer, including both aerobic and anaerobic degradation pathways, through the average dissolved oxygen concentration reported, 2.8 mg/L, indicates that the aquifer has the potential to degrade approximately 0.311 mg/L of C<sub>18</sub> chainlength hydrocarbon by aerobic means.

The average nitrate concentration reported in the aquifer was 0.012 mg/L. Therefore, based on the equations provided in Appendix G, this aquifer has the potential to degrade approximately 0.00084 mg/L of C<sub>18</sub> chainlength hydrocarbon through denitrification.

The average sulphate concentration reported in the aquifer was 613.3 mg/L. Therefore, based on the equations provided in Appendix G, this aquifer has the potential to degrade approximately 44.4 mg/L of C<sub>18</sub> chainlength hydrocarbon through sulphate reduction.

Using both aerobic and anaerobic pathways these concentrations suggest that the Ashfield Shale aquifer has a potential assimilative capacity of 44.7 mg/L of hydrocarbons, which indicates a good potential for hydrocarbon degradation in the aquifer.

In addition, the presence of co-metabolite methane in both the surficial and Ashfield Shale aquifers, Table 6.16, suggests that the natural attenuation of hydrocarbons is actively occurring in the aquifers.

<b>Table 6.16: Summary of Dissolved Methane Data</b>	
<b>Well</b>	<b>Dissolved Methane</b>
<i>Surficial Aquifer</i>	
MW03S	230
MW04S	2500
MW06S	100
<i>Ashfield Shale Aquifer</i>	
MW03D	83
MW04D	22
MW06D	47

NOTE:

All results in µg/L @25°C

## 6.5 PERMEABILITY TESTING/TRANSMISSIVITY

Transmissivity is the rate at which the soil matrix has the ability to transport contaminants and is a function of a variety of parameters, primarily the soil physical properties. It is not in the scope of this report to include all soil physical properties, rather it is suffice to say that the larger the grainsize of the soil matrix, the larger the voids between them and therefore the faster the contaminant has the potential to move through the soil. Using this simple analogy, fill comprising building rubble will have a much greater potential to transport contaminants than a tightly packed clay.

In order to quantify the transmissivity of the soil on the site, a couple of slug tests were attempted on the surficial aquifer. A slug test involves the removal of a known volume of water from the monitoring well, either by the use of a pump or bailer. The time for the water level to recover to within 70 percent of its initial level is recorded. Water levels over time are also monitored. Generally, the larger the soil voids, the quicker the water can travel through the soil profile, and therefore the faster the water column in the well returns to its original level. During this investigation the water levels did not reduce to a satisfactory level to allow for permeability/transmissivity to be calculated.

## **7.0 QA/QC PROGRAM**

### **7.1 GENERAL**

Quality control samples were collected for the sampled media. Both QC and field sampling activities were documented in field logs, on the chain-of-custody record forms (which document the physical transfer of samples and requested analyses) and on sample labels (which show time, date, and location of sampling, the analytical parameters, and sample preservation techniques).

### **7.2 DATA QUALITY OBJECTIVES**

The quality assurance and quality control procedures that were used during this project included the collection of approximately 1 in 10 samples for field and laboratory QC purposes. Additional QA on these samples included:

- Matrix spikes and laboratory control samples to assess accuracy; and
- Field duplicate and field split samples to assess the quality of lab and field procedures.

Field duplicates and splits were required to fall within a 50 percent relative percentage difference (RPD) for soils and 20 percent RPD for water samples.

Laboratory accuracy was measured by the use of matrix spikes and surrogate compounds. The data quality objective (DQO) for these was set at 75-125 percent.

### **7.3 QUALITY CONTROL SAMPLES**

#### **7.3.1 Field Duplicates**

Field duplicates are taken primarily to check sampling and laboratory techniques. The samples are extra samples taken at the same sample location and time and submitted to the same laboratory as the primary samples using a unique identifier. Duplicate samples are collected using the same sampling techniques as the original samples, and analysed for the same parameters as the original sample.

Eleven field duplicate soil samples and one field duplicate water sample (MWDUP01\_11/05/00) were submitted to the laboratory with the primary samples.

#### **7.3.2 Control Samples**

Two forms of control samples (surrogate spikes and matrix spikes) were used by the laboratory to assess the affects of the medium (eg. soil) on the analytical techniques.

Surrogate spikes and matrix spikes were used for organic analysis and laboratory control samples; matrix spikes were used for inorganic analysis. For surrogate spikes, the sample is

spiked prior to extraction or analysis with surrogate compounds that are representative of the analysis. The recovery of the surrogate is recorded and used to assess the accuracy of the analysis. Matrix spikes are analysed by splitting a field sample and spiking each sub-sample with known quantities of the recommended spiking compound in order to assess the effects of the specific sample matrix on the recovery of analytes.

Laboratory control samples are prepared standards which are initially submitted for verification to an independent laboratory. Upon verification, the sample is then sent to the contract laboratory that is responsible for the analyses. Three forms of spike samples were prepared for this project by the contract laboratory. The samples were analysed at a frequency of 5 percent or once per analytical batch to meet frequency QC acceptance criteria.

### **7.3.3 Control Limits**

The control limits and laboratory data quality objectives specified in the laboratory certificates were met for all laboratory quality assurance samples.

### **7.3.4 Trip Blank Analysis**

One trip blank sample was analysed as part of the project quality objectives. The trip blank sample was provided by the laboratory and was transported with the bottles to site and then with the samples from the site to the laboratory. The trip blank sample was only analysed for relevant volatile components (ie. TPH C<sub>6</sub>-C<sub>9</sub> and BTEX). The analysis of the trip blank sample reported no concentrations of either TPH C<sub>6</sub>-C<sub>9</sub> or BTEX above the laboratory LOR. Therefore, no cross-contamination of the groundwater samples has occurred during sample handling and transport.

## **7.4 DATA VALIDATION RESULTS**

### **7.4.1 Holding Times**

The maximum holding time for the analytes requested as defined by current industry practice to be seven days for SVOCs, and 14 days for TPH, VOCs and Cyanide in water. Similarly, the maximum holding time for TPH, SVOCs, VOCs and Metals in soil prior to extraction is 14 days.

The soil samples were collected between 18 and 20 April 2000 inclusive with all of the samples received by the laboratory on 20 April 2000.

The laboratory reported that samples were received at the laboratory within the holding times and analysis undertaken within the required quality assurance requirements.

### **7.4.2 Field Duplicates**

Eleven soil field duplicate and one field duplicate water sample (MWDUP01\_11/05/00) were submitted to the laboratory for analysis.

No review criteria are established for the comparison of field duplicates to their original samples, however, the criteria discussed in Section 7.2 will be used for comparison. The difference between the original sample and the field duplicate is measured in terms of a Relative Percentage Difference (RPD).

#### *Soil:*

RPDs are compared to a 50 per cent level in soil for concentrations greater than 10 times the selected guideline level. Field duplicate results and RPDs are presented in Table 7.1 at the rear of this report. From the calculations shown in Table 7.1 the soil data shows good repeatability between the original field sample and the duplicate samples collected except for certain Heavy Metals and PAH analysis. The concentrations reported for Heavy Metals and PAHs should be considered as indicative only representing the range of concentrations that may be expected within the soil.

The high RPDs are believed to be due to the heterogeneous nature of the fill materials observed on the site.

#### *Groundwater:*

The groundwater field duplicate RPDs are provided in Table 7.2 at the rear of this report. As shown in the table, only the RPD for chromium exceeded the data quality objective (DQO) of 20 percent with the remainder of the analytes tested recording RPDs within the DQO. The origin of the high RPD between the original sample and the field duplicate is uncertain.

Therefore, chromium concentrations reported from this monitoring well should be considered as indicative only representing the range of concentrations that may be expected within the groundwater.

### **7.4.3 Control Samples**

Two forms of control samples (surrogate spikes and matrix spikes) were used during the field investigation as part of the Quality Assurance for organic analytes.

Laboratory accuracy was measured by the use of matrix spikes and surrogate compounds. The data quality objective (DQO) for these was set at 75-125 percent. The laboratory certificates indicate that the surrogate recoveries were all within these DQOs.

### **7.4.4 QA Conclusion**

The analysis of the soil field duplicate results indicate that the soil data should be considered as indicative, displaying the range of concentrations that are present in the soil.

The analysis of the surrogate recoveries and holding times indicate that the soil analytical results reported are a true and accurate representation of the concentrations of the identified chemicals present in the soil.

The analysis of the groundwater field duplicate results, surrogate recoveries, holding times and trip blank analysis indicate that the groundwater results are considered to be a true and accurate representation of the concentrations of the identified chemicals present in the groundwater.

## 8.0 DISCUSSION

The results from the analysis of soil and groundwater samples collected during the investigation have provided a current assessment of the soil and groundwater conditions across the site (excluding underneath the old cleaning shed foundation).

### 8.1 FORMER CLEANING SHED AREA

The results of the analysis of the soil samples collected from across the site indicated that there exists a number of 'hotspots' across the site within the shallow fill material. The compounds at these 'hotspots' are:

- Benzene, toluene; and
- Benzo(a)pyrene and total PAHs.

Based on the guidelines presented in the NSW EPA (1995) *Sampling Design Guidelines* three separate hotspot sizes have been calculated:

1. Adjacent to sampling location 34. An area of approximately 625 m<sup>2</sup> (25 m x 25 m) to a depth of approximately 0.50 metres;
2. Adjacent to sampling location 35. An area of approximately 625 m<sup>2</sup> (25 m x 25 m) to a depth of approximately 0.40 metres; and
3. Adjacent to sampling locations 43 and 44. An area of approximately 900 m<sup>2</sup> (45 m x 22 m) to an approximate depth of 0.40 metres.

The estimated total volume of soil in the identified hotspot areas, based on the above figures, is approximately 920 m<sup>3</sup>.

Potential exposure pathways for contaminated soil includes;

- exposure to contaminated soil due to generation of dust from the site;
- transport of sediment in surface water run-off generated from the site along track drainage systems;
- migration of surface contaminated soil due to erosion and movement through surface water run-off; and
- direct contact to surface and subsurface soil.



---

## 8.2 FORMER GASWORKS AREA

### 8.2.1 Soils

The results of the analysis of the soil samples collected from across the site indicated that there exists a number of 'hot spots' across the site within both the shallow and deep fill material and also within the natural soils. The compounds at these 'hotspots' are:

- TPHs C<sub>10</sub>-C<sub>36</sub>;
- Benzene, toluene, ethylbenzene, total xylene; and
- Benzo(a)pyrene and total PAHs.

Due to the extensive nature of the contamination identified in the soil no hotspot size calculations have been undertaken. However, an estimated volume of fill material across the area is approximately 12,800 m<sup>3</sup>. This volume is based on an approximate size of 8,000 m<sup>2</sup> to an average depth of approximately 1.60 metres.

Potential exposure pathways for contaminated soil include;

- exposure to contaminated soil due to generation of dust from the site;
- transport of sediment in surface water run-off generated from the site along track drainage systems;
- migration of surface contaminated soil due to erosion and movement through surface water run-off; and
- direct contact to surface and subsurface soil.

### 8.2.2 Groundwater

#### *Fate and Transport*

Generally, analysis of the fate and transport of chemicals in subsurface environments consists of identification of the following elements in a chemical compound transport model:

- Primary Sources; consisting of man-made structures and facilities from which chemicals are released (eg. tar pits, gas holders etc.).
- Secondary Sources; consisting of residual hydrocarbon such as impacted soil above the uppermost water table.
- Pathways; consisting of high permeability natural formations, backfill in underground service trenches, soil gas migration and groundwater migration.

- Receptors; consisting of areas of potential impacts such as beneficial use of aquifers, surface water bodies, excavations on adjacent properties and vapour emissions into buildings and structures.

#### *Sources*

Potential primary sources of chemicals of concern were identified as follows:

- Underground tar pits, gas pipework and associated structures;
- The foundations of the gas holders and retort house present on the site; and
- Fill material.

#### *Pathways*

Potential pathways for migration of impacted water across the site boundary were identified as follows:

- Migration of impacted surface water in the surficial aquifer;
- Migration of hydrocarbon vapours by volatilisation from groundwater into the unsaturated zone;
- Migration of impacted surficial groundwater into the Ashfield Shale aquifer;
- Surface water run-off onto the surrounding environment and residential properties from the decrease in elevation between the fill material and residential properties; and
- Run-off along the open drain adjacent to the south western boundary of the site.

#### *Receptors*

The observed groundwater flow direction is towards the south south east. Specific receptors of the groundwater contamination might include:

- Workers conducting sub-surface excavation or entering underground manholes above or near an impacted groundwater plume in the surficial aquifer on the site may be exposed to petroleum hydrocarbon vapours or impacted groundwater;
- Residential properties adjacent to the south western boundary of the site;
- The environment in the vicinity of the site; and
- Unregistered users of the groundwater in the vicinity of the site.

## *Contaminant Distribution*

### *Surficial Aquifer*

Groundwater present in the surficial aquifer across the southern Former Gasworks Area of the site has been shown to be impacted by a number of different compounds. The greatest distribution of contaminants is total PAH where guideline exceedences were reported in each of the three shallow monitoring wells (MW03S, MW04S and MW06S). The highest concentration reported was in the groundwater collected from MW06S (2,700 µg/L). MW06S is located approximately 15 metres to the west of the tar pits.

Monitoring wells MW03S and MW04S are located in the approximate down hydraulic gradient direction of the two gas holders and associated structures (ie. tar pits, retort house etc) and adjacent to the south eastern boundary of the site.

Of the total PAH concentrations reported from each monitoring well greater than 96 percent was comprised of naphthalene. The presence of naphthalene at this percentage demonstrates that gasworks waste has been disposed of at the site and that as naphthalene has a high solubility and low half life this waste is still present in the soil.

The distribution of phenols and TPH C<sub>10</sub>-C<sub>36</sub> reported in the groundwater collected from the shallow monitoring wells indicated that there were guideline exceedences at sampling location MW06S (173 µg/L and 21,796 µg/L respectively). These concentrations can be typical of historical industrial sites where hydrocarbon products have been used. The distribution of these compounds is not as widespread as that seen for total PAH. No exceedences were reported for phenols and TPH C<sub>10</sub>-C<sub>36</sub> in the samples collected from MW03S or MW04S. This reported distribution of phenols and TPH C<sub>10</sub>-C<sub>36</sub> in the surficial aquifer indicates that these compounds do not appear to have reached the extent of the south eastern site boundary monitoring locations.

Concentrations of ferrous iron and zinc were reported above the ANZECC (1992) guideline criteria at all monitoring wells. Concentrations of copper, chromium and cadmium were also reported above the ANZECC (1992) guideline criteria, however, at a smaller distribution than zinc and ferrous iron. The concentrations and extent of heavy metals reported indicates that there is migration of the compounds from the overlying fill material into the surficial aquifer.

### *Ashfield Shale Aquifer*

Groundwater present in the Ashfield Shale aquifer across the Former Gasworks Area of the site has been shown to be impacted by total PAH, phenols and benzene. The degree and extent of impact identified in the Ashfield Shale aquifer is lower than those impacts identified in the surficial aquifer.

Total PAHs were reported in all of the monitoring wells sampled, however, guideline exceedences were only reported in monitoring wells MW03D (210 µg/L) and MW04D (37 µg/L) located in the down hydraulic gradient of the two gas holders and adjacent to the

south eastern boundary of the site. Monitoring well MW06D did not contain concentrations of total PAH (1 µg/L) above the guideline criteria of 3 µg/L.

Based on the concentrations of sulphate, nitrate, dissolved oxygen and ferrous iron reported for each of the aquifers, Table 6.15, it can be assumed that the groundwater present in each of the two aquifers belong to separate groundwater regimes.

Naphthalene comprised 100 percent of the total PAH concentrations reported from monitoring wells MW03D and MW04D. The mechanism for the contamination in the Ashfield Shale aquifer is likely to have been leaks, spills and uses of structures containing deeper foundations on the site, eg. the two gas holders.

The distribution of phenol and benzene contamination above the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems* was only reported in the groundwater collected from monitoring well MW03D (82 µg/L and 430 µg/L respectively).

### ***Significant Risk of Harm***

The New South Wales Environment Protection Authority (NSW EPA) has recently released “Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report (EPA, 1999). These guidelines discuss the definitions of “contamination”, “harm”, “risk of harm” and “significant risk of harm”. The guidelines seek to set out a range of considerations regarding contamination, and set out a process of assessing whether contamination presents a significant risk of harm and determining whether reporting under S.60 of the Contaminated Land Management Act, 1997 is required.

The guidelines describe the likely evaluation by EPA as to whether contamination presents a significant risk of harm as follows:

- where the contaminant concentrations in soil are analysed (in a statistically sound way) and are greater than the relevant guideline values for the current or approved land use, and/or the contaminants occur over a relatively large area, and
- where humans either on or off site are exposed to these contaminants.

In cases of contamination of groundwater or surface water, sediment, air, flora or fauna, or any other aspect of the environment either on or off site, the EPA would be likely to consider that contamination presents a significant risk of harm;

- where the contaminant concentration is greater than the relevant guideline values, and
- where the contamination in these media can be reasonably linked to the contamination in question (EPA, 1999).

Sometimes an assessment of whether contamination presents a risk of harm will be clear-cut; however it may often be a question of degree, dependent on consideration of all relevant matters listed in Section 9 of the Contaminated Land Management Act, 1997. A detailed

consideration of these matters is beyond the currently available information and further confirmatory studies would be required before the “duty to report” has been triggered. However, from the information available it is possible to conclude that the site may pose a “significant risk of harm” due to:

- the identification of toxic and persistent contaminants in high concentrations in the site’s soils and groundwaters;
- the presence of exposure pathways that may allow the identified contaminants to impact on human receptors on adjoining lands;
- the presence of sensitive land uses on adjacent lands that increase the risk of potential human health impacts (ie. domestic vegetable gardens);
- the potential for identified contamination to migrate from the site in both the surficial and Ashfield Shale aquifer; and
- the presence of contaminants above EPA approved groundwater quality guidelines.

However, it is less clear as to whether the site poses a “significant risk of harm” to other aspects of the environment as the site is within a highly urbanised environment and any potential environmental receptors are remote.

From the available information it is possible to conclude that the site may pose a “significant risk of harm” due to:

- the identification of toxic and persistent contaminants in high concentrations in the site’s soils and groundwaters;
- the presence of exposure pathways that may allow the identified contaminants to impact on human receptors on adjoining lands;
- the presence of sensitive land uses on adjacent lands that increase the risk of potential human health impact (ie. domestic vegetable gardens);
- the potential for identified contamination to migrate from the site in both the surficial and Ashfield Shale aquifer; and
- the presence of contaminants above EPA approved water quality guidelines.

However, due to the implications of such an assessment, the potential for the site to be considered to pose a “significant risk of harm” cannot be adequately confirmed from the current environmental data. Recommendations to enable clear determination of the need for the site to be reported under Section 60 of the Contaminated Land Management Act, 1997 are provided in Section 10. When this further information is obtained a detailed review of the

potential for significant risk of harm will be possible, using the conditions outlined in Section 9 of the Contaminated Land Management Act, 1997.

---

## 9.0 CONCLUSION

### 9.1 FORMER CLEANING SHED AREA

Based on field observations and analytical results for soil samples collected during the Phase II Environmental Site Assessment, the following points may be concluded with respect to the subsurface conditions and soil contamination within the Former Cleaning Shed Area:

- Fill material consisting of sand, gravel, ballast, ash and coke breeze is widespread across the area and varies in depth between 0.20 to 2.50 metres. The fill material is limited to less than one metre in depth above a large concrete slab, remnant from the former cleaning shed, which covers a large portion of the area. Fill material is also limited to less than 0.50 metres in the area north of the concrete slab.

However, the fill material extends up to a depth of approximately 2.50 metres to the east of the concrete slab. The fill material overlies clay/weathered shale of unknown depth, and field observations could not identify if this material was of natural or anthropogenic origin;

- Analytical results reported for the soil samples collected during the investigation were generally below the site criteria for the majority of analytes using the 95 percent UCL calculations and statistical methods discussed in Section 4. However “hot spots” were identified within the shallow fill material at sample locations BH34 (benzo(a)pyrene and total PAHs), BH44 (benzene, toluene, benzo(a)pyrene and total PAHs), BH43 (benzo(a)pyrene) and BH35 (benzo(a)pyrene);
- It should be noted that no samples were collected from beneath the remnant concrete slab of the former Cleaning Shed. There is a potential for localised (TPH, BTEX, PAH, heavy metals, phenols and chlorinated hydrocarbons) contamination in the vicinity of drains and sumps beneath the slab, associated with the past use of the shed as a train cleaning facility; and
- Groundwater was not encountered during the soil investigation conducted in the Former Cleaning Shed Area and therefore, no groundwater monitoring wells were installed.

### 9.2 FORMER GASWORKS AREA

#### 9.2.1 Soil Investigation

Based on field observations and analytical results reported for soil samples collected during the Phase II Environmental Site Assessment, the following points may be concluded with respect to the subsurface conditions and soil contamination within the Former Gasworks Area:

- Fill material is widespread across the area and varies between 0.10 to 3.20 metres in depth. This fill material consists of sand, gravel, ballast, ash and coke breeze. The fill material overlies clay/weathered shale of unknown depth;

- Analytical results reported for soil samples collected during the investigation indicate that contamination is widespread throughout the fill material. Concentrations of BTEX, TPHs and PAHs were reported above the respective site criteria at a number of locations within the Former Gasworks Area;
- In addition to contamination identified within the fill material, isolated contaminant concentrations exceeding the respective site criteria were identified within the underlying clay material at sample locations SB12 (total PAHs), SB14 (benzene, ethylbenzene, total xylenes, benzo(a)pyrene, total PAHs) and MW04 (benzene); and
- The contamination within the Former Gasworks Area is more widespread and extends deeper (ie. within the clay/weathered shale) than contamination within the Former Cleaning Shed Area. Therefore, former site activities associated with the gasworks operations may have impacted upon the site's soil quality.

### **9.2.2 Groundwater Investigation**

#### *Surficial Aquifer*

- Concentrations of total PAH, TPH C<sub>10</sub>-C<sub>36</sub>, heavy metals and phenols exceed (up to three orders of magnitude) the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*. Therefore, the groundwater quality in the surficial aquifer has been impacted by a range of contaminants due to previous activities at the site;
- The highest concentration of total PAH was recorded from monitoring well MW06S (2,700 µg/L) which is located in the vicinity of the residential properties at the south western boundary of the site;
- Based on the limited groundwater investigation undertaken to date, the general groundwater flow direction is likely to be towards the south south east, however, in the vicinity of the gas holders and any other localised structures (such as foundations, drains, tar pits, etc.) the flow direction may vary locally;
- There is the potential for the surficial groundwater to seep out along the fill material into an open drain (adjacent to the south western boundary of the site) and/or onto residential properties through overflow mechanisms (ie. due to blockage and/or leakage from the drain). This interpretation is based on the observed elevation difference (up to two to three metres) which exists between the fill material on site and the adjacent residential properties;
- There is the potential for the surficial groundwater to migrate towards the properties if the general groundwater directions have been impacted locally due to the presence of the above mentioned structures;
- No free phase hydrocarbon product was observed during the field investigation;



- The mechanism for the contamination of the surficial groundwater is likely to have been the downward migration of contaminants through surface water infiltrating through the fill material and/or from leaks within the tar pits, gas pipes and other associated structures; and
- Concentrations of heavy metals were reported either below the laboratory limits of reporting (LOR) or the respective analytes ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*.

#### *Ashfield Shale Aquifer*

- Concentrations of total PAH, benzene, heavy metals and phenols identified in the groundwater samples collected from the Ashfield Shale aquifer exceed the ANZECC (1992) *Guidelines for the Protection of Fresh Water Ecosystems*. Therefore, the groundwater quality in the Ashfield Shale aquifer appears to have been impacted by a range of contaminants probably due to previous activities at the site. The degree and extent of impact is lower than those impacts identified in the surficial aquifer;
- The highest concentration of total PAH was recorded from monitoring well MW03D (210 µg/L) which is located down hydraulic gradient of the two gas holders adjacent to the south eastern boundary of the site;
- Based on the limited groundwater investigation undertaken to date, the general groundwater flow direction is likely to be towards the south south east, however, if the foundations of the two gas holders and/or any others structures extend to depths that intersect the Ashfield Shale aquifer there is a potential for local disturbance of the general groundwater flow direction;
- No sensitive environmental receptors have been identified in the immediate vicinity of the site;
- No groundwater usage (ie. registered groundwater bores) has been identified within two kilometres radius around the site;
- No free phase hydrocarbon product was observed during the field investigation;
- The potential mechanism for the impact on the groundwater quality of the Ashfield Shale aquifer may have been from leaks, spills and uses of structures containing deeper foundations on the site; and
- Concentrations of heavy metals were reported either below the laboratory limits of reporting (LOR) or the respective analytes ANZECC (1992) fresh water guideline criteria.

### **Significant Risk of Harm**

- From the available information it is possible to conclude that the site may pose a “significant risk of harm” due to:
  - the identification of toxic and persistent contaminants in high concentrations in the site’s soils and groundwaters;
  - the presence of exposure pathways that may allow the identified contaminants to impact on human receptors on adjoining lands;
  - the presence of sensitive land uses on adjacent lands that increase the risk of potential human health impact (ie. domestic vegetable gardens);
  - the potential for identified contamination to migrate from the site in both the upper and Ashfield Shale aquifer; and
  - the presence of contaminants above EPA approved water quality guidelines.

## **10.0 RECOMMENDATIONS**

Based on the conclusions given above CH2M HILL present the following staged recommendations.

The below approach has been adopted based on contamination characteristics, potential adverse impact which may arise from contamination identified on the site as well as management actions which are required to further minimise the risk to the environment and human health on the site.

These recommendations are provided in two groups: general recommendations and additional investigations.

### **10.1 GENERAL RECOMMENDATIONS:**

- Notification of the New South Wales Environment Protection Authority (NSW EPA) with respect to the potential for “significant risk of harm” and implementation of meetings with the NSW EPA to seek the EPA’s direction/advise with respect to the management of the identified contamination;
- Cessation of all activities on the Former Gasworks Area, including those which may be undertaken by personnel from SRA, RSA and RAC, especially activities which may result in the disturbance of the soil;
- Minimisation of activities on the Former Cleaning Shed Area for access purposes only;
- Cessation of public access and use of the site by residents living in the vicinity of the site (ie. activities involving unauthorised vegetable cultivation and chicken coop etc.);
- Development of an EMP, OH&S and RAP for the management of remediation and presentation of the RAP to the NSW EPA. This RAP may require management of the site over both the short and long terms; and
- Development of a communications strategy to inform all relevant stakeholders.

### **10.2 ADDITIONAL INVESTIGATIONS**

Two stages of investigations have been recommended allowing for the review and interpretation of the data collected.

The first stage of works comprises the following and should be undertaken within the next two months:

- Undertake a soil gas survey, surface soil sampling and surficial groundwater sampling program within the residential properties bounding the south western portion of the site, after receiving written approval from the residents;

- If SRA is unable to obtain written approval for the implementation of the above investigation, the investigation should be undertaken as close as practicable to the site boundary, soil gas survey (up to 20 locations), surface soil sampling from up to 20 locations (surface to 0.15 metres depth) and surficial groundwater investigation including the installation of up to five groundwater monitoring wells as well as sediment sampling from the exit end of the open drain;
- In addition it may be prudent to collect samples of the vegetable garden currently being used by residents on the site. Vegetable samples should be tested for those contaminants which have the potential for uptake and accumulation by plants; and
- Surveying to Australian Height Datum (AHD) and Australian Magnetic Grid (AMG) of selected locations of the residential properties, open concrete drain and the site to determine the elevation difference between the site and the adjacent properties.

The second stage of works comprises the following and should be completed between two to six months:

- More detailed assessment of the groundwater quality of the surficial and Ashfield Shale aquifers on site including an assessment of the groundwater quality of the groundwater entering and leaving the site;
- An assessment of the potential for contamination of soil/fill below the concrete slab in the Former Cleaning Shed Area of the site. If soil/fill contamination is identified beneath the concrete slab an assessment of the groundwater quality in this area should be undertaken; and
- Prior to future development to the north east of the site boundary, soil sampling should be undertaken to assess whether the soil contamination identified in the Former Cleaning Shed Area extends across the site boundary. This soil sampling should be targeted along the proposed track alignment.

## **11.0 LIMITATIONS**

The investigations by CH2M HILL identified actual surface and subsurface conditions only at those locations where and when samples were taken and analysed. These data have been interpreted and an opinion rendered regarding the overall environmental conditions.

The advice tendered in this report is based on information obtained from the investigation locations, test points and sample points and is not warranted in respect to the conditions that may be encountered across the site at other than these locations (eg. the location of unidentified underground storage tanks etc.). Although CH2M HILL uses all means at its disposal to collect representative samples it is emphasised that the actual characteristics of the subsurface and surface materials may vary significantly between adjacent test points and sample intervals and at locations other than where observations, explorations and investigations have been made. Sub-surface conditions, including groundwater levels and contaminant concentrations can change in a limited time. However, it is our opinion that the test points chosen are representative of conditions on the site at the time of the investigation. To limit the occurrence of errors, CH2M HILL follows the NSW EPA Guidelines when performing sampling investigations. Additional soil contamination information can be obtained by collecting additional samples from locations in between those locations already sampled.

It should be noted that because of the inherent uncertainties in sub-surface evaluations, changed or unanticipated sub-surface conditions might occur that could affect total project cost and/or execution. CH2M HILL does not accept responsibility for the consequences of significant variances in the conditions. To limit changes to the site conditions it is recommended that access to the site be limited to minimise the potential for dumping, spills etc., which could change the site conditions and further, that materials which may cause further contamination be removed from the site.

An understanding of the site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure-specific and some experienced-based. This report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by CH2M HILL. CH2M HILL accepts no responsibility for any circumstances, which arise from the issue of the report that has been modified in any way as outlined above.

This report has not been prepared for the purposes of assessing the suitability of soil and fill on the site for foundations or establishment of gardens and lawns.

## 12.0 PRIMARY REFERENCES

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

ANZECC (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*. Australian and New Zealand Environment and Conservation Council.

Australian Standard (1997) *Guide to Sampling and Investigation of Potentially Contaminated Soil*

Chapman, G.A. and Murphy, C.L. (1989) *Soil Landscapes of the Sydney 1:100,00 Sheet*. Soil Conservation Service of New South Wales.

Department of Urban Affairs and Planning (1999) *Managing Land Contamination: Planning Guidelines SEPP 55 Remediation of Land*.

Geological Survey of New South Wales (1983) *Geology of the Sydney 1:100,00 Sheet* (9130 Ed.1).

GHD – Tranmark Pty Ltd (1995) *Macdonaldtown Rail Yard – Development of Environmental Buffer Zone for the Local Residents* (Report: R5103).

Imray, P & Langley, A (1996) *Health-based Soil Investigation Levels*, National Environmental Health Forum Monographs, Soil Series No. 1, SA Health Commission, Adelaide

Netherlands Ministry of Housing, Environment etc. (1994). *Environmental Quality Objectives in the Netherlands – A Review of Environmental Quality Objectives and Their Policy Framework in the Netherlands*. Risk Assessment and Environmental Quality Division, Directorate for Chemicals, External Safety and Radiation Protection, Ministry of Housing, Spatial Planning and the Environment, Netherlands.

NSW EPA (1994) *Guidelines for the Assessment of Service Station Sites*, New South Wales Environment Protection Authority, Sydney

NSW EPA (1995) *Contaminated Sites Sampling Design Guidelines*, New South Wales Environment Protection Authority, Sydney

NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*, New South Wales Environment Protection Authority, Sydney

NSW EPA (1998) *Guidelines for the NSW Site Auditor Scheme*, New South Wales Environment Protection Authority, Sydney

NSW EPA (1999) *Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report*, New South Wales Environment Protection Authority, Sydney

United States Environmental Protection Agency (1998) *Region IX Preliminary Remediation Goals*

## **TABLES**

---



**Table 2.2: Groundwater Bore Information**

Bore ID	Approximate Distance From Site	Direction From Site	Depth to GW (m)	Date Installed	Status	Authorised Purpose	Intended Use
GW013331	2.5km	South	7.90	1-8-54	Unknown	Not noted	Industrial
GW013514	2.5km	South East	7.30	1-3-58	Unknown	Industrial	Industrial
GW015954	2.5km	South	6.70	1-5-57	Unknown	Not noted	Industrial
GW017340	2.5km	South East	15.20	1-6-58	Supply Obtained	Not noted	Industrial
GW017342	2.5km	South East	7.30	1-12-46	Unknown	Not noted	Industrial
GW017345	2.5km	South East	7.90	1-10-54	Unknown	Not noted	Industrial
GW017354	2.5km	South East	No GW identified (total depth = 16.40m)	1-1-39	Unknown	Not noted	Industrial
GW017684	2km	South East	2.40	1-9-47	Unknown	Not noted	Industrial
GW017782	2.5km	South East	No GW identified (total depth = 15.50m)	1-9-59	Unknown	Not noted	Industrial
GW017834	2.5km	South East	6.00	1-11-55	Unknown	Not noted	Industrial
GW017869	2.5km	South East	3.60	1-1-55	Unknown	Not noted	Industrial
GW017870	2.5km	East	6.70	1-3-55	Unknown	Not noted	Industrial
GW023168	2.5km	South East	4.50	1-1-66	Unknown	Not noted	General Use
GW023275	2.5km	South East	3.90	1-9-65	Unknown	Not noted	General Use
GW023585	2.5km	South East	No GW identified (total depth = 4.50m)	1-3-66	Unknown	Not noted	General Use
GW024118	2.5km	South East	2.10	1-1-66	Unknown	Not noted	General Use
GW024374	2.5km	South East	5.10	1-12-65	Unknown	Not noted	General Use
GW025717	2.5km	South East	1.70	1-10-65	Unknown	Not noted	General Use

**Table 2.2 con't: Groundwater Bore Information**

GW026142	2.5km	South East	9.40	1-2-67	Unknown	Not noted	General Use
GW027248	2.5km	South East	3.00	1-11-65	Unknown	Not noted	Industrial
GW028844	2.5km	South East	6.00	1-11-68	Unknown	Not noted	Industrial
GW037956	2.5km	East	7.90	1-4-72	Unknown	Not noted	Industrial
GW040219	2.5km	South	No GW identified (total depth = 6.30m)	None Available	Unknown	Not noted	Industrial
GW042179	2.5km	South East	No GW identified (total depth = 24.00m)	None Available	Unknown	Not noted	Not known
GW048937	2.5km	East	12.20	1-6-74	Test hole	Test Bore	Recreation
GW051725	2.5km	South East	No GW identified (total depth = 8.00m)	1-2-80	Unknown	Not noted	Monitoring Bore
GW051726	2.5km	South East	No GW identified (total depth = 8.00m)	1-2-80	Unknown	Not noted	Monitoring Bore
GW051727	2.5km	South East	No GW identified (total depth = 8.00m)	1-12-80	Unknown	Not noted	Monitoring Bore
GW051728	2.5km	South East	No GW identified (total depth = 8.30m)	1-12-80	Unknown	Not noted	Monitoring Bore

**Table 2.2 con't: Groundwater Bore Information**

GW051729	2.5km	South East	No GW identified (total depth = 8.50m)	1-12-80	Unknown	Not noted	Monitoring Bore
GW051730	2.5km	South East	No GW identified (total depth = 8.30m)	1-12-80	Unknown	Not noted	Monitoring Bore
GW051731	2.5km	South East	No GW identified (total depth = 8.00m)	1-12-80	Test Hole	Not noted	Monitoring Bore
GW065460	2.5km	South East	4.00	9-1-92	Unknown	Not noted	Industrial
GW065532	2.5km	South East	No GW identified (total depth = 18.00m)	1-11-90	Unknown	Not noted	Industrial
GW071907	2.5km	East	2.00	5-3-93	Unknown	Recreation	Not noted

**TABLE 5.2**  
**Groundwater Quality Information**

Groundwater Purging and Sampling Data							
Monitoring Well	Volume Purged (L)	Temperature (°C)	pH	Conductivity µS/cm	Dissolved Oxygen (mg/L)	ORP (mV)	Comments
MW03S	13	20.15	5.07	587	1.1	-10	Dark brown, odour
MW03D	20	20.38	5.12	2068	3.7	67	Clear, Fine Suspended
	40	19.79	5.02	3002	3.3	34	Solids, TPH/sulfate odour
	65	19.75	5.08	3028	3.1	32	
MW04S	9	20.74	5.81	497	1.1	-50	Dark brown, odour
MW04D	10	20.19	5.21	1163	3.3	83	
	20	19.88	5.21	1486	2.9	65	Clear, Fine Suspended
	30	19.51	5.21	2312	2.4	57	Solids, TPH/sulfate odour
	40	19.58	5.21	2322	2.4	43	
	53	19.5	5.21	2357	2.2	40	
MW06S	13	20.74	4.71	515	3.9	138	Dark brown, odour
MW06D	40	20.52	5.32	2171	3.5	80	Clear, Fine Suspended
	80	20.18	5.31	2183	3.1	129	Solids, TPH/sulfate odour

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		TP19	BH21	BH22	BH22	BH22	BH22	BH23	BH23
Sample Depth (metres)		0.00-0.10	0.2	0.2	0.2	0.6	0.6	0.2	0.6

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
HEAVY METALS									
Arsenic	mg/kg	5	500		86	16	20	na	63
Cadmium	mg/kg	0.5	100		2	0.6	0.7	na	0.7
Chromium	mg/kg	5	500		27	8	25	na	19
Copper	mg/kg	5	5000		310	130	140	na	230
Nickel	mg/kg	2	3000		18	8	28	na	17
Lead	mg/kg	5	1500	300	230	100	97	na	140
Zinc	mg/kg	5	35000		350	83	970	na	140
Mercury	mg/kg	0.05	75		0.25	0.52	0.1	na	0.13
Total Cyanide	mg/kg	0.5	2500		na	na	na	na	na
VOCs									
Benzene	mg/kg	0.5		1	nd	nd	na	nd	nd
Bromobenzene	mg/kg	1			nd	nd	na	nd	nd
Bromochloromethane	mg/kg	1			nd	nd	na	nd	nd
Bromodichloromethane	mg/kg	1			nd	nd	na	nd	nd
Bromoform	mg/kg	1			nd	nd	na	nd	nd
Bromomethane	mg/kg	1			nd	nd	na	nd	nd
n-Butylbenzene	mg/kg	1			nd	nd	na	nd	nd
sec-Butylbenzene	mg/kg	1			nd	nd	na	nd	nd
tert-Butylbenzene	mg/kg	1			nd	nd	na	nd	nd
Carbon Tetrachloride	mg/kg	1			nd	nd	na	nd	nd
cis-1,2-Dichloroethene	mg/kg	1			nd	nd	na	nd	nd
Chlorobenzene	mg/kg	1			nd	nd	na	nd	nd
Chloroethane	mg/kg	1			nd	nd	na	nd	nd
Chloroform	mg/kg	1			nd	nd	na	nd	nd
Chloromethane	mg/kg	1			nd	nd	na	nd	nd
2-Chlorotoluene	mg/kg	1			nd	nd	na	nd	nd

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location				CLEANING SHED AREA							
Consultant				CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location				TP19	BH21	BH22	BH22	BH23	BH23	BH23	BH23
Sample Depth (metres)				0.00-0.10	0.2	0.2	0.6	0.2	0.2	0.6	0.6

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)							
4-Chlorotoluene	mg/kg	1			nd	nd	na	nd	na	nd	nd
Dibromochloromethane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,2-Dibromo-3-Chloropropane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,2-Dibromomethane (EDB)	mg/kg	1			nd	nd	na	nd	na	nd	nd
Dibromomethane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,2-Dichlorobenzene	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,3-Dichlorobenzene	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,4-Dichlorobenzene	mg/kg	1			nd	nd	na	nd	na	nd	nd
Dichlorodifluoromethane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,1-Dichloroethene	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,2-Dichloroethane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,1-Dichloroethane	mg/kg	1			nd	nd	na	nd	na	nd	nd
cis-1,2-Dichloroethene	mg/kg	1			nd	nd	na	nd	na	nd	nd
trans-1,2-Dichloroethene	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,2-Dichloropropane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,3-Dichloropropane	mg/kg	1			nd	nd	na	nd	na	nd	nd
2,2-Dichloropropane	mg/kg	1			nd	nd	na	nd	na	nd	nd
1,1-Dichloropropylene	mg/kg	1			nd	nd	na	nd	na	nd	nd
cis-1,3-Dichloropropylene	mg/kg	1			nd	nd	na	nd	na	nd	nd
trans-1,3-Dichloropropylene	mg/kg	1			nd	nd	na	nd	na	nd	nd
Ethylbenzene	mg/kg	1		3.1	nd	nd	na	nd	na	nd	nd
Hexachlorobutadiene	mg/kg	1			nd	nd	na	nd	na	nd	nd
Isopropylene	mg/kg	1			nd	nd	na	nd	na	nd	nd
p-Isopropyltoluene	mg/kg	1			nd	nd	na	nd	na	nd	nd
Methylene chloride	mg/kg	1			nd	nd	na	nd	na	nd	nd
Naphthalene	mg/kg	1			nd	nd	na	nd	na	nd	nd
n-Propylbenzene	mg/kg	1			nd	nd	na	nd	na	nd	nd

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		TP19	BH21	BH22	BH22	BH23			BH23
Sample Depth (metres)		0.00-0.10	0.2	0.2	0.6	0.2			0.6

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
Styrene	mg/kg	1			nd	nd	na	nd	na
1.1.1.2-Tetrachloroethane	mg/kg	1			nd	nd	na	na	nd
1.1.2.2-Tetrachloroethane	mg/kg	1			nd	nd	na	na	nd
Tetrachloroethene	mg/kg	1			nd	nd	na	na	nd
Toluene	mg/kg	1		1.4	nd	nd	na	na	nd
1.2.3-Trichlorobenzene	mg/kg	1			nd	nd	na	na	nd
1.2.4-Trichlorobenzene	mg/kg	1			nd	nd	na	na	nd
1.1.1-Trichloroethane	mg/kg	1			nd	nd	na	na	nd
1.1.2-Trichloroethane	mg/kg	1			nd	nd	na	na	nd
Trichloroethene	mg/kg	1			nd	nd	na	na	nd
Trichlorofluoromethane	mg/kg	1			nd	nd	na	na	nd
1.2.3-Trichloropropane	mg/kg	1			nd	nd	na	na	nd
1.2.4-Trimethylbenzene	mg/kg	1			nd	nd	na	na	nd
1.3.5-Trimethylbenzene	mg/kg	1			nd	nd	na	na	nd
Vinyl chloride	mg/kg	1			nd	nd	na	na	nd
ortho-Xylene	mg/kg	1			nd	nd	na	na	nd
meta- & para-Xylene	mg/kg	1		14	nd	nd	na	na	nd
TPH									
C6-C9	mg/kg	10		65	na	na	na	na	na
C10-C14	mg/kg	10			na	na	na	na	na
C15-C28	mg/kg	50			na	na	na	na	na
C29-C36	mg/kg	50			na	na	na	na	na
Total C10-C36	mg/kg			1000	na	na	na	na	na
BTEX									
Benzene	mg/kg	0.5		1	nd	na	nd	na	na
Toluene	mg/kg	1		1.4	nd	na	nd	na	na
Ethylbenzene	mg/kg	1		3.1	nd	na	nd	na	na

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		TP19	BH21	BH22	BH22	BH22	BH23	BH23	BH23
Sample Depth (metres)		0.00-0.10	0.2	0.2	0.2	0.6	0.2	0.2	0.6

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
Total Xylenes	mg/kg	3		14	nd	na	nd	na	
PAHs									
Naphthalene	mg/kg	0.5			nd	nd	na	nd	nd
Acenaphthylene	mg/kg	0.5			nd	nd	na	nd	nd
Acenaphthene	mg/kg	0.5			nd	nd	na	nd	nd
Fluorene	mg/kg	0.5			nd	nd	na	nd	nd
Phenanthrene	mg/kg	0.5			nd	0.5	na	0.7	nd
Anthracene	mg/kg	0.5			nd	nd	na	nd	nd
Fluoranthene	mg/kg	0.5			0.6	1	na	1	nd
Pyrene	mg/kg	0.5			0.6	1	na	1	nd
Benzo(a)anthracene	mg/kg	0.5			nd	0.6	na	0.6	nd
Chrysene	mg/kg	0.5			nd	0.6	na	0.5	nd
Benzo(b)&(k)fluoranthene	mg/kg	1			nd	1	na	2	nd
Benzo(a)pyrene	mg/kg	0.5	5	1	nd	0.5	na	0.6	nd
Indeno(1,2,3-cd)pyrene	mg/kg	0.5			nd	nd	na	nd	nd
Dibenz(a,h)anthracene	mg/kg	0.5			nd	nd	na	nd	nd
Benzo(g,h,i)perylene	mg/kg	0.5			nd	nd	na	nd	nd
Total PAHs	mg/kg		100	20	1.2	5.2	0	na	6.4
Phenols									
Phenol	mg/kg	0.5	42500		na	na	na	na	na
2-Chlorophenol	mg/kg	0.5			na	na	na	na	na
2-Methylphenol	mg/kg	0.5			na	na	na	na	na
3-Methylphenol & 4-Methylphenol	mg/kg	0.5			na	na	na	na	na
2-Nitrophenol	mg/kg	0.5			na	na	na	na	na
2,4-Dimethylphenol	mg/kg	0.5			na	na	na	na	na
2,4-Dichlorophenol	mg/kg	0.5			na	na	na	na	na
2,6-Dichlorophenol	mg/kg	0.5			na	na	na	na	na



TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		TP19	BH21	BH22	BH22	BH23			BH23
Sample Depth (metres)		0.00-0.10	0.2	0.2	0.6	0.2			0.6

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)
4-Chloro-3-methylphenol	mg/kg	0.5		
2,4,5-Trichlorophenol	mg/kg	0.5		
2,4,6-Trichlorophenol	mg/kg	0.5		
2,4-Dinitrophenol	mg/kg	2		
4-Nitrophenol	mg/kg	1		
2,3,4,6-Tetrachlorophenol	mg/kg	1		
4,6-Dinitro-2-methylphenol	mg/kg	2		
Pentachlorophenol	mg/kg	1		
4,6-Dinitro-2-sec-butyphenol	mg/kg	2		
<b>Total Phenols</b>	mg/kg			
<b>OCP's</b>				
HCB	mg/kg	0.1		
alpha-BHC	mg/kg	0.1		
gamma-BHC	mg/kg	0.1		
Heptachlor	mg/kg	0.1	50	
Aldrin	mg/kg	0.1	50	
Dieldrin	mg/kg	0.1		
beta-BHC	mg/kg	0.1		
delta-BHC	mg/kg	0.1		
Oxychlordan	mg/kg	0.1		
Heptachlor epoxide	mg/kg	0.1		
Endosulphan I	mg/kg	0.1		
Chlordane-trans	mg/kg	0.1	250	
Chlordane-cis	mg/kg	0.1		
trans-Nonachlor	mg/kg	0.1		
4,4'-DDE	mg/kg	0.1		
Endrin	mg/kg	0.1		

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA					
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		TP19	BH21	BH22	BH23	BH23	BH23
Sample Depth (metres)		0.00-0.10	0.2	0.2	0.6	0.2	0.6

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)			
4,4'-DDD	mg/kg	0.1			na	na	na
Endosulphan II	mg/kg	0.1			na	na	na
4,4'-DDT	mg/kg	0.1	1000		na	na	na
Endosulphan sulphate	mg/kg	0.1			na	na	na
Methoxychlor	mg/kg	0.1			na	na	na
<b>PCBs</b>							
Arochlor 1016	mg/kg	1			na	na	na
Arochlor 1221	mg/kg	1			na	na	na
Arochlor 1232	mg/kg	1			na	na	na
Arochlor 1242	mg/kg	1			na	na	na
Arochlor 1248	mg/kg	1			na	na	na
Arochlor 1254	mg/kg	1			na	na	na
Arochlor 1260	mg/kg	1			na	na	na
<b>Total PCBs</b>			50		na	na	na

NOTE:

Exceeds NEHF- Level F (1996)
Exceeds NSW EPA Guidelines for the Assessment of Service Station Sites (1995)

n/a = not applicable  
LOR = Laboratory Limits of Reporting  
na = not selected for analysis  
nd = not detected above laboratory LOR  
\* = sample required dilution

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB23	SB23	SB23	SB23	SB24	SB24	SB24	SB24
Sample Depth (metres)		0.00-0.10	0.50-0.60	DUP2	2.00-2.10	0.00-0.10	0.00-0.10	0.20-0.30	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
HEAVY METALS									
Arsenic	mg/kg	5	500		19	8	7	15	21
Cadmium	mg/kg	0.5	100		0.5	nd	nd	nd	0.6
Chromium	mg/kg	5	500		14	7	8	49	14
Copper	mg/kg	5	5000		140	140	110	nd	200
Nickel	mg/kg	2	3000		52	18	16	nd	17
Lead	mg/kg	5	1500	300	85	140	150	26	180
Zinc	mg/kg	5	35000		91	93	110	nd	150
Mercury	mg/kg	0.05	75		0.08	0.16	0.09	nd	0.2
Total Cyanide	mg/kg	0.5	2500		na	nd	nd	nd	na
VOCs									
Benzene	mg/kg	0.5		1	na	na	na	na	na
Bromobenzene	mg/kg	1			na	na	na	na	na
Bromochloromethane	mg/kg	1			na	na	na	na	na
Bromodichloromethane	mg/kg	1			na	na	na	na	na
Bromoform	mg/kg	1			na	na	na	na	na
Bromomethane	mg/kg	1			na	na	na	na	na
n-Butylbenzene	mg/kg	1			na	na	na	na	na
sec-Butylbenzene	mg/kg	1			na	na	na	na	na
tert-Butylbenzene	mg/kg	1			na	na	na	na	na
Carbon Tetrachloride	mg/kg	1			na	na	na	na	na
cis-1,2-Dichloroethene	mg/kg	1			na	na	na	na	na
Chlorobenzene	mg/kg	1			na	na	na	na	na
Chloroethane	mg/kg	1			na	na	na	na	na
Chloroform	mg/kg	1			na	na	na	na	na
Chloromethane	mg/kg	1			na	na	na	na	na
2-Chlorotoluene	mg/kg	1			na	na	na	na	na

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB23	SB23	SB23	SB23	SB24	SB24	SB24	SB24
Sample Depth (metres)		0.00-0.10	0.50-0.60	DUP2	2.00-2.10	0.00-0.10	0.00-0.10	0.20-0.30	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)								
					na	na	na	na	na	na	na	na
4-Chlorotoluene	mg/kg	1			na	na	na	na	na	na	na	na
Dibromochloromethane	mg/kg	1			na	na	na	na	na	na	na	na
1,2-Dibromo-3-Chloropropane	mg/kg	1			na	na	na	na	na	na	na	na
1,2-Dibromomethane (EDB)	mg/kg	1			na	na	na	na	na	na	na	na
Dibromomethane	mg/kg	1			na	na	na	na	na	na	na	na
1,2-Dichlorobenzene	mg/kg	1			na	na	na	na	na	na	na	na
1,3-Dichlorobenzene	mg/kg	1			na	na	na	na	na	na	na	na
1,4-Dichlorobenzene	mg/kg	1			na	na	na	na	na	na	na	na
Dichlorodifluoromethane	mg/kg	1			na	na	na	na	na	na	na	na
1,1-Dichloroethene	mg/kg	1			na	na	na	na	na	na	na	na
1,2-Dichloroethane	mg/kg	1			na	na	na	na	na	na	na	na
1,1-Dichloroethane	mg/kg	1			na	na	na	na	na	na	na	na
cis-1,2-Dichloroethene	mg/kg	1			na	na	na	na	na	na	na	na
trans-1,2-Dichloroethene	mg/kg	1			na	na	na	na	na	na	na	na
1,2-Dichloropropane	mg/kg	1			na	na	na	na	na	na	na	na
1,3-Dichloropropane	mg/kg	1			na	na	na	na	na	na	na	na
2,2-Dichloropropane	mg/kg	1			na	na	na	na	na	na	na	na
1,1-Dichloropropylene	mg/kg	1			na	na	na	na	na	na	na	na
cis-1,3-Dichloropropylene	mg/kg	1			na	na	na	na	na	na	na	na
trans-1,3-Dichloropropylene	mg/kg	1			na	na	na	na	na	na	na	na
Ethylbenzene	mg/kg	1		3.1	na	na	na	na	na	na	na	na
Hexachlorobutadiene	mg/kg	1			na	na	na	na	na	na	na	na
Isopropylene	mg/kg	1			na	na	na	na	na	na	na	na
p-Isopropyltoluene	mg/kg	1			na	na	na	na	na	na	na	na
Methylene chloride	mg/kg	1			na	na	na	na	na	na	na	na
Naphthalene	mg/kg	1			na	na	na	na	na	na	na	na
n-Propylbenzene	mg/kg	1			na	na	na	na	na	na	na	na

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB23	SB23	SB23	SB23	SB24	SB24	SB24	SB24
Sample Depth (metres)		0.00-0.10	0.50-0.60	DUP2	2.00-2.10	0.00-0.10	0.00-0.10	0.20-0.30	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
					na	na	na	na	na
Styrene	mg/kg	1			na	na	na	na	na
1.1.1.2-Tetrachloroethane	mg/kg	1			na	na	na	na	na
1.1.2.2-Tetrachloroethane	mg/kg	1			na	na	na	na	na
Tetrachloroethene	mg/kg	1			na	na	na	na	na
Toluene	mg/kg	1		1.4	na	na	na	na	na
1.2.3-Trichlorobenzene	mg/kg	1			na	na	na	na	na
1.2.4-Trichlorobenzene	mg/kg	1			na	na	na	na	na
1.1.1.1-Trichloroethane	mg/kg	1			na	na	na	na	na
1.1.2-Trichloroethane	mg/kg	1			na	na	na	na	na
Trichloroethene	mg/kg	1			na	na	na	na	na
Trichlorofluoromethane	mg/kg	1			na	na	na	na	na
1.2.3-Trichloropropane	mg/kg	1			na	na	na	na	na
1.2.4-Trimethylbenzene	mg/kg	1			na	na	na	na	na
1.3.5-Trimethylbenzene	mg/kg	1			na	na	na	na	na
Vinyl chloride	mg/kg	1			na	na	na	na	na
ortho-Xylene	mg/kg	1			na	na	na	na	na
meta- & para-Xylene	mg/kg	1		14	na	na	na	na	na
TPH									
C6-C9	mg/kg	10		65	na	nd	na	na	nd
C10-C14	mg/kg	10			na	nd	na	na	nd
C15-C28	mg/kg	50			na	100	na	na	340
C29-C36	mg/kg	50			na	60	na	na	220
Total C10-C36	mg/kg			1000	na	160	220	na	560
BTEX									
Benzene	mg/kg	0.5		1	na	nd	nd	na	nd
Toluene	mg/kg	1		1.4	na	nd	nd	na	nd
Ethylbenzene	mg/kg	1		3.1	na	nd	nd	na	nd

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB23	SB23	SB23	SB23	SB24	SB24	SB24	SB24
Sample Depth (metres)		0.00-0.10	0.50-0.60	DUP2	2.00-2.10	0.00-0.10	0.00-0.10	0.20-0.30	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)	na	nd	nd	nd	na	nd
Total Xylenes	mg/kg	3		14						
PAHs										
Naphthalene	mg/kg	0.5			nd	nd	nd	nd	nd	nd
Acenaphthylene	mg/kg	0.5			nd	nd	nd	nd	nd	nd
Acenaphthene	mg/kg	0.5			nd	nd	nd	nd	nd	nd
Fluorene	mg/kg	0.5			nd	nd	nd	nd	nd	nd
Phenanthrene	mg/kg	0.5			nd	0.6	nd	nd	1	2.8
Anthracene	mg/kg	0.5			nd	nd	nd	nd	nd	0.9
Fluoranthene	mg/kg	0.5			nd	0.7	nd	nd	1.4	4.6
Pyrene	mg/kg	0.5			nd	0.8	nd	nd	1.6	5.4
Benzo(a)anthracene	mg/kg	0.5			nd	0.6	nd	nd	0.9	5
Chrysene	mg/kg	0.5			nd	0.6	nd	nd	0.7	3.6
Benzo(b) & (k) fluoranthene	mg/kg	1			nd	nd	nd	nd	1	8
Benzo(a)pyrene	mg/kg	0.5	5	1	nd	0.6	nd	nd	0.8	6.4
Indeno(1,2,3-cd)pyrene	mg/kg	0.5			nd	nd	nd	nd	0.7	4.6
Dibenz(a,h)anthracene	mg/kg	0.5			nd	nd	nd	nd	nd	0.8
Benzo(g,h,i)perylene	mg/kg	0.5			nd	nd	nd	nd	nd	3
Total PAHs	mg/kg		100	20	0	3.9	0	0	8.1	45.1
Phenols										
Phenol	mg/kg	0.5	42500		na	na	na	na	na	na
2-Chlorophenol	mg/kg	0.5			na	na	na	na	na	na
2-Methylphenol	mg/kg	0.5			na	na	na	na	na	na
3-Methylphenol & 4-Methylphenol	mg/kg	0.5			na	na	na	na	na	na
2-Nitrophenol	mg/kg	0.5			na	na	na	na	na	na
2,4-Dimethylphenol	mg/kg	0.5			na	na	na	na	na	na
2,4-Dichlorophenol	mg/kg	0.5			na	na	na	na	na	na
2,6-Dichlorophenol	mg/kg	0.5			na	na	na	na	na	na

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB23	SB23	SB23	SB23	SB24	SB24	SB24	SB24
Sample Depth (metres)		0.00-0.10	0.50-0.60	DUP2	2.00-2.10	0.00-0.10	0.00-0.10	0.20-0.30	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)								
					na	na	na	na	na	na	na	na
4-Chloro-3-methylphenol	mg/kg	0.5			na	na	na	na	na	na	na	na
2,4,5-Trichlorophenol	mg/kg	0.5			na	na	na	na	na	na	na	na
2,4,6-Trichlorophenol	mg/kg	0.5			na	na	na	na	na	na	na	na
2,4-Dinitrophenol	mg/kg	2			na	na	na	na	na	na	na	na
4-Nitrophenol	mg/kg	1			na	na	na	na	na	na	na	na
2,3,4,6-Tetrachlorophenol	mg/kg	1			na	na	na	na	na	na	na	na
4,6-Dinitro-2-methylphenol	mg/kg	2			na	na	na	na	na	na	na	na
Pentachlorophenol	mg/kg	1			na	na	na	na	na	na	na	na
4,6-Dinitro-2-sec-butyphenol	mg/kg	2			na	na	na	na	na	na	na	na
Total Phenols	mg/kg				na	na	na	na	na	na	na	na
OCP's												
HCB	mg/kg	0.1			na	na	na	na	na	na	na	na
alpha-BHC	mg/kg	0.1			na	na	na	na	na	na	na	na
gamma-BHC	mg/kg	0.1			na	na	na	na	na	na	na	na
Heptachlor	mg/kg	0.1	50		na	na	na	na	na	na	na	na
Aldrin	mg/kg	0.1	50		na	na	na	na	na	na	na	na
Dieldrin	mg/kg	0.1			na	na	na	na	na	na	na	na
beta-BHC	mg/kg	0.1			na	na	na	na	na	na	na	na
delta-BHC	mg/kg	0.1			na	na	na	na	na	na	na	na
Oxychlordan	mg/kg	0.1			na	na	na	na	na	na	na	na
Heptachlor epoxide	mg/kg	0.1			na	na	na	na	na	na	na	na
Endosulphan I	mg/kg	0.1			na	na	na	na	na	na	na	na
Chlordane-trans	mg/kg	0.1	250		na	na	na	na	na	na	na	na
Chlordane-cis	mg/kg	0.1			na	na	na	na	na	na	na	na
trans-Nonachlor	mg/kg	0.1			na	na	na	na	na	na	na	na
4,4'-DDE	mg/kg	0.1			na	na	na	na	na	na	na	na
Endrin	mg/kg	0.1			na	na	na	na	na	na	na	na

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB23	SB23	SB23	SB23	SB24	SB24	SB24	SB24
Sample Depth (metres)		0.00-0.10	0.50-0.60	DUP2	2.00-2.10	0.00-0.10	0.00-0.10	0.20-0.30	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
4,4'-DDD	mg/kg	0.1			na	na	na	na	na
Endosulphan II	mg/kg	0.1			na	na	na	na	na
4,4'-DDT	mg/kg	0.1	1000		na	na	na	na	na
Endosulphan sulphate	mg/kg	0.1			na	na	na	na	na
Methoxychlor	mg/kg	0.1			na	na	na	na	na
<b>PCBs</b>									
Arochlor 1016	mg/kg	1			na	na	na	na	na
Arochlor 1221	mg/kg	1			na	na	na	na	na
Arochlor 1232	mg/kg	1			na	na	na	na	na
Arochlor 1242	mg/kg	1			na	na	na	na	na
Arochlor 1248	mg/kg	1			na	na	na	na	na
Arochlor 1254	mg/kg	1			na	na	na	na	na
Arochlor 1260	mg/kg	1			na	na	na	na	na
<b>Total PCBs</b>			50		na	na	na	na	na

NOTE:

<b>Exceeds NEHF- Level F (1996)</b>
<b>Exceeds NSW EPA Guidelines for the Assessment of Service Station Sites (1995)</b>

n/a = not applicable  
LOR = Laboratory Limits of Reporting  
na = not selected for analysis  
nd = not detected above laboratory LOR  
\* = sample required dilution



TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA							
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB24	SB24	BH26	BH26	BH26	BH27	BH28	
Sample Depth (metres)		1.0-1.1	DUP3	0.2	0.2	0.8	0.2	0.30-0.40	

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)					
HEAVY METALS									
Arsenic	mg/kg	5	500		5	9	31	na	43
Cadmium	mg/kg	0.5	100		nd	nd	nd	na	1.2
Chromium	mg/kg	5	500		9	8	18	na	23
Copper	mg/kg	5	5000		20	430	120	na	62
Nickel	mg/kg	2	3000		nd	15	21	na	2
Lead	mg/kg	5	1500	300	14	300	100	na	36
Zinc	mg/kg	5	35000		nd	170	140	na	17
Mercury	mg/kg	0.05	75		nd	0.17	0.09	na	nd
Total Cyanide	mg/kg	0.5	2500		na	nd	na	na	na
VOCs									
Benzene	mg/kg	0.5		1	na	na	na	nd	na
Bromobenzene	mg/kg	1			na	na	na	nd	na
Bromochloromethane	mg/kg	1			na	na	na	nd	na
Bromodichloromethane	mg/kg	1			na	na	na	nd	na
Bromoform	mg/kg	1			na	na	na	nd	na
Bromomethane	mg/kg	1			na	na	na	nd	na
n-Butylbenzene	mg/kg	1			na	na	na	nd	na
sec-Butylbenzene	mg/kg	1			na	na	na	nd	na
tert-Butylbenzene	mg/kg	1			na	na	na	nd	na
Carbon Tetrachloride	mg/kg	1			na	na	na	nd	na
cis-1,2-Dichloroethene	mg/kg	1			na	na	na	nd	na
Chlorobenzene	mg/kg	1			na	na	na	nd	na
Chloroethane	mg/kg	1			na	na	na	nd	na
Chloroform	mg/kg	1			na	na	na	nd	na
Chloromethane	mg/kg	1			na	na	na	nd	na
2-Chlorotoluene	mg/kg	1			na	na	na	nd	na

TABLE 6.1  
SOIL ANALYTICAL RESULTS - FORMER CLEANING SHED AREA

Location		CLEANING SHED AREA					
Consultant		CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL	CH2M HILL
Sample Location		SB24	SB24	BH26	BH26	BH27	BH28
Sample Depth (metres)		1.0-1.1	DUP3	0.2	0.8	0.2	0.30-0.40

Analyte	Units	LOR	NEHF - Level F Monographs (1996)	NSW EPA Guidelines for the Assessment of Service Station Sites (1994)						
4-Chlorotoluene	mg/kg	1			na	na	na	nd	na	nd
Dibromochloromethane	mg/kg	1			na	na	na	nd	na	nd
1,2-Dibromo-3-Chloropropane	mg/kg	1			na	na	na	nd	na	nd
1,2-Dibromomethane (EDB)	mg/kg	1			na	na	na	nd	na	nd
Dibromomethane	mg/kg	1			na	na	na	nd	na	nd
1,2-Dichlorobenzene	mg/kg	1			na	na	na	nd	na	nd
1,3-Dichlorobenzene	mg/kg	1			na	na	na	nd	na	nd
1,4-Dichlorobenzene	mg/kg	1			na	na	na	nd	na	nd
Dichlorodifluoromethane	mg/kg	1			na	na	na	nd	na	nd
1,1-Dichloroethene	mg/kg	1			na	na	na	nd	na	nd
1,2-Dichloroethane	mg/kg	1			na	na	na	nd	na	nd
1,1-Dichloroethane	mg/kg	1			na	na	na	nd	na	nd
cis-1,2-Dichloroethene	mg/kg	1			na	na	na	nd	na	nd
trans-1,2-Dichloroethene	mg/kg	1			na	na	na	nd	na	nd
1,2-Dichloropropane	mg/kg	1			na	na	na	nd	na	nd
1,3-Dichloropropane	mg/kg	1			na	na	na	nd	na	nd
2,2-Dichloropropane	mg/kg	1			na	na	na	nd	na	nd
1,1-Dichloropropylene	mg/kg	1			na	na	na	nd	na	nd
cis-1,3-Dichloropropylene	mg/kg	1			na	na	na	nd	na	nd
trans-1,3-Dichloropropylene	mg/kg	1			na	na	na	nd	na	nd
Ethylbenzene	mg/kg	1		3.1	na	na	na	nd	na	nd
Hexachlorobutadiene	mg/kg	1			na	na	na	nd	na	nd
Isopropylene	mg/kg	1			na	na	na	nd	na	nd
p-Isopropyltoluene	mg/kg	1			na	na	na	nd	na	nd
Methylene chloride	mg/kg	1			na	na	na	nd	na	nd
Naphthalene	mg/kg	1			na	na	na	nd	na	nd
n-Propylbenzene	mg/kg	1			na	na	na	nd	na	nd