R E P O R T

Environmental Assessment of Chullora Railway Workshops

Prepared for

Rail Corporation of NSW

Environmental Projects Unit
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Glossary

AC	Alternating Current
ANZECC	Australian and New Zealand Environment and Conservation Council
AST	Above-ground Storage Tank
BMC	Bogie Maintenance Centre
BRC	Ballast Recycling Facility
BTEX	Benzene, Toluene, Ethyl benzene, Xylene compounds
DC	Direct Current
DEMC	Diesel Engine Maintenance Centre
DO	Dissolved Oxygen
EC	Electrical Conductivity
EMC	Electrical Maintenance Centre
EMP	Environmental Management Plan
ESA	Environmental Site Assessment
HIL	Health Investigation Level
LMC	Locomotive Maintenance Centre
NATA	National Association of Testing Australia
NEHF	National Environment Health Forum
NEPC	National Environment Protection Council
OCPs	Organochlorine Pesticides
OPPs	Organophosphate Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PSH	Phase Separated Hydrocarbon
RSA	Rail Services Australia
SAQP	Sampling, Analytical and Quality Plan
SRA	State Rail Authority
SROH	Significant Risk of Harm
SSSP	Site Specific Safety Plan
SVOCs	Semi-volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tank
VCH	Volatile Chlorinated Hydrocarbons
VOCs	Volatile Organic Compounds
VPI	Vacuum Pressure Impregnation
XPT	eXpress Passenger Train

Executive Summary

This report presents an overview of the environmental assessments undertaken on the ~36 hectares of land that currently comprises the Chullora Railway Workshops, located at Worth Street, Chullora. Sixteen environmental assessments have been completed at the Site ranging from whole of Site assessments to localised assessments, heritage assessments and/or groundwater monitoring.

The objective of this report was to review and summarise the status of the assessments completed, and based on the current whole of Site understanding provide direction for the future assessment, management and remediation, as appropriate, for the Site.

In summary, the majority of the investigations, both soil and groundwater, have focused on identified potential sources of contamination. Therefore, although likely to have targeted the areas with a high potential to host contamination, there has been limited investigation in large, albeit less likely to host contamination, portions of the Site.

Common contaminants identified in source areas were total petroleum hydrocarbons (TPH) and volatile chlorinated hydrocarbons (VCHs). These contaminants were principally related to cleaning/degreasing of components prior to and/or during maintenance of rail rolling stock, and the subsequent management/disposal of the waste water. Often the extent of the contamination has not been fully delineated.

A major source of TPH contamination on the Site is the fuel storage and refuelling area, where leaks and/or spills associated with the facility have resulted in contamination of the soil and groundwater with petroleum hydrocarbons (principally diesel).

Based on the review of the available data collected from previous site assessment, including limited groundwater monitoring undertaken as part of this assessment, the identified contamination (and associated risks to human health and /or the environment) would not be likely preclude the on-going industrial land use at the Site. However, with respect to the whole of Site assessment URS recommends that a management strategy be adopted by RailCorp, and this may incorporate the following:

- Additional assessment of groundwater along the northern (down-gradient boundary) of the Site to allow adequate assessment of potential off-site migration of contaminants;
- Delineation of identified contamination, to ensure that the contamination has not migrated off-site. A monitoring program may be also required to confirm the understanding of the groundwater contamination;
- Assessment for the potential for VCH vapours to accumulate within work environments;
- Remediation of identified source and contaminated soil/groundwater. If the contamination has not been delineated, this may involve a staged remediation program. Remediation works should be undertaken using an appropriate Remedial Action Plan including a validation program; and/or
- Implement an Environmental Management Plan (EMP) to ensure that future workers on the Site are aware of the presence of identified and potentially unidentified contamination and the associated precautions that should be undertaken when undertaking sub-surface works. The EMP should also address mitigation of soil/sediments entering the stormwater system and potentially off-site.

Section 1 Introduction

URS Australia Pty Ltd (URS) was commissioned by Rail Corporation, NSW (RailCorp) to undertake a 'whole of Site' environmental assessment of the Chullora Railway Workshops Site, located at Worth Street, Chullora (the Site). The assessment primarily involved review and assessment of data collected from previous investigations.

1.1 Study Objective

The objectives of this Environmental Site Assessment (ESA) were to assess existing data and undertake relevant new works to:

- Develop a 'whole of Site' contamination profile for the Site;
- Draw conclusions as to the suitability of the Site for ongoing industrial land use; and
- Provide recommendations for Site management and/or remediation works necessary to mitigate identified or potential risk of harm to human health or the environment.

1.2 Background

Located in an industrial area, the Site, which covers an area of approximately 36 hectares and three local government areas. The Site is currently zoned Special Uses 5(b) Railways within the Bankstown City Council, Auburn Council and Strathfield City Council local government areas. The Site comprises land owned by RailCorp which has been used for rail maintenance since the early 1920s.

Sections of the Site are currently leased to a variety of rail services organisations, principally for rail related maintenance activities. Significant areas of the Site are vacant whilst other areas are occupied by large buildings and structures in varying states of repair. A corridor of Sydney Water land bisects the Site in an approximately east-west direction.

Numerous environmental assessments of the entire Site and selected parts of the Site have been conducted by a various environmental consultancies for various rail entities, lessees and operators in the period since 1990. These environmental assessments have presented various conclusions regarding the contamination status of the Site or parts of the Site. Several recommendations for remediation and/or management have been formulated, though it is uncertain whether these have been implemented. The significance of groundwater contamination, primarily by hydrocarbons, has not been fully assessed.

1.3 Scope of Work

The scope of work undertaken by URS, to address the objectives outlined in Section 1.1, is detailed below.

1.3.1 Phase 1

- Review and interpretation of existing information relating to the Site, including available ESA reports;
- Assessment of the reliability of the data from previous ESAs; and
- Undertake a detailed walkover inspection to allow the current condition of the Site to be fully documented.

1.3.2 Phase 2

- Preparation of a Site Specific Safety Plan (SSSP) for the Site walkover and sampling works;
- Preparation of an Environmental Management Plan (EMP) for Site sampling works;
- Preparation of a Sampling, Analysis and Quality Plan (SAQP);

Section 1 Introduction

- Undertake groundwater quality monitoring works in accordance with the RailCorp approved SAQP;
- Assess and describe the nature and extent of soil and groundwater contamination at the Site;
- Assess and determine the risk of Site contamination to the health of future uses within the context of the Site;
- Assess and determine whether the identified contamination has the potential to present a risk of harm to the environment;
- Determine whether sufficient reliable data exists to enable an assessment to be made regarding the suitability of the Site for ongoing industrial land use, and if not, identify data gaps and recommend a scope for further investigations;
- Should the ESA find the Site to be unsuitable for heavy industrial land use or that any identified contamination is considered to have the potential to present a risk of harm to human health or the environment, then assess and document the management and/or remediation works required to mitigate the risks; and
- Preparation of an Environmental Site Assessment report.

Section 2 Site Description

2.1 Facility Location and Ownership

The Site, which covers an area of approximately 36 hectares, is located across three local government areas. It is currently zoned Special Uses 5(b) Railways within the Bankstown City Council, Auburn Council and Strathfield City Council local government areas. The Site is approximately bounded by the Hume Highway south-east, Worth Street south-west and the Chullora rail line to the north.

The Site comprises land owned by RailCorp which has been used for rail maintenance since the early 1920s. Sections of the Site are currently leased to a variety of rail services organisations, principally for rail related maintenance activities.

Significant areas of the Site are vacant whilst others are occupied by large building/structures in varying states of repair. A corridor of Sydney Water land bisects the Site in an approximately east-west direction.

2.2 Adjoining Properties

The Site is located in an area predominantly used for commercial / industrial purposes. The surrounding land uses are identified in the following table:

Direction from Site	Land Use Description
North	Cooks River Canal, then Chullora Rail Line, Rookwood Cemetery and Lidcombe Hospital.
North-east	Commercial area in Marlene Crescent and Davidson Street with Dick Smith and a Garden Centre (approximately 400 metres from the Site) then the small Marlene Reserve which adjoins Strathfield Golf Course (approximately 600 metres from the Site). The Cooks River crosses Strathfield Golf Course approx 1 km from Site.
East	Hume Highway, then residential properties, shopping centre and Islamic school
South	Hume Highway, then a residential area opposite Hume Highway with Murray Street, Robinson Street and Glover Street being the closest residential streets.
South-west	Worth Street, then Fairfax Printers Warehouse.
West	Bushland Retention area, Remand Centre, RSPCA, then Potts Hill reservoir

2.3 Site Layout

The Site has been developed for rail infrastructure, including rail lines and maintenance work shops since the early 1920s. The detailed Site operations are discussed in Section 4.

For the purpose of this investigation the Site has been divided by URS into areas, based on Site operations, operational boundaries and identifying landmarks. The areas are outlined in the following table, and are also detailed on Figure 2.

Section 2 Site Description

Label	Name	Description
Area A	Bogie Maintenance Centre (BMC)	Maintenance of bogies – removal, degreasing, major cleaning and repair of bogies.
Area B	Diesel Engine Maintenance Centre (DEMC)	Diesel engine disassembly and assembly; vehicle, wagon and engine component washing.
Area C	Locomotive Maintenance Centre (LMC)	Inspection / stripping / cleaning / rebuilding / testing / painting of the following: air brakes, bogies, locomotive, engines and components.
Area D	Electrical Maintenance Centre (EMC)	Overhaul, refurbishment and upgrade of electromechanical plant and associated equipment.
Area E	Locomotive Load Box, Weighbridge and Fuel/Oil Facility	Load box – to test locomotive diesel engines and generators after maintenance or construction. Fuel storage and distribution for locomotives and trucks
Area F	North Western Portion Including Ballast Recycling Depot	Recycling of spent ballast material.
Area G	North Eastern Portion, Including Former Rail Reclamation and Recycling Area	Open tract of land incorporating rail reclamation and recycling area
Area H	South Eastern Portion	Rail tracks, open space
Area I	Sydney Water Land Corridor	Land corridor carrying the trunk water main supply serving the Central Sydney area, extending from the Potts Hill Reservoir to the Hume Highway, the corridor of land runs through the Site on an east – west alignment

Section 2 Site Description

2.4 Environmental Setting

The information presented in this section is based on information published by, the Geological Survey of NSW and the Soil Conservation Service of NSW, including;

- NSW Topographic Map of Botany Bay Sheet 9130-3-S, 1:25,000 (1987);
- Sydney Soil Landscape Series Sheet 9130, 1:100,000 (1966); and
- Sydney Geological Series Sheet 9130, 1:100,000 (1983).

2.4.1 Topography

The Site is relatively flat with an approximate average elevation across the Site of 20 metres Australian Height Datum (AHD). An embankment rising approximately 5 – 7 metres above the average elevation of the Site forms the south-eastern boundary of the railway workshops area. The valley of the Cooks River influences the topography of the surrounding area with a gentle gradient to the east.

The Site was originally low lying wetlands, which were filled in during the 1940s to provide a level building surface.

2.4.2 Surface Drainage

The Site is located within the Cooks River catchment at the confluence of the Rookwood Road and Greenacre Branches, which converge north of the diesel engine maintenance centre (DEMC), before flowing north-east towards Strathfield Golf Course and ultimately becoming the Cooks River.

Within the Site the trunk drainage system consists of natural watercourses, open lined channels and box culverts before discharging to the natural watercourse Cooks River Canal at the northern edge of the Site. It is understood that some local flooding at the Site does occur.

A Sydney Water land corridor runs through the Site on an east-west alignment. In the 1980s, a retaining wall and drainage trench were constructed around the perimeter of the Electrical Maintenance Centre (EMC) (Area D) (south, west and north) to help prevent flooding on the Site from off-site run-on.

A small wetland area and creek, known as Freshwater Creek is located within 50 metres of the Electrical (EMC). Stormwater generated in this area generally flows east and discharges into an underground concrete storm water drainage channel (running north beneath the EMC and the Locomotive Maintenance Centre (LMC) (Area C), which discharges to Freshwater Creek, and ultimately to the Cooks River approximately 1.5 km to the north-east. The Cooks River flows south-east and discharges into Botany Bay. This is a heavily industrialised catchment with other potential contamination sources both up- and down-stream from the Site.

2.4.3 Geology

The Site is located on disturbed terrain, with fill (predominantly railway ballast and clay) present over the Site.

Soils underlying the Site are described, Sydney soil landscape series sheet (1966), as extensively disturbed by human activity, including complete disturbance and removal or burial of soil. The fill material is described as soil, rock, building and waste materials, with low permeability, poor drainage, and localised low fertility. The natural soil underneath the fill material is indicated as Residual Blacktown soil, comprising mottled, red brown, high plasticity clays. Alluvium could also be present overlying the residual soils in areas near current and former creeks and drainage lines.

The soils are indicated as overlying Wianamatta Group shales (Sydney Geological Series Sheet, 1983). The shale bedrock is further sub-divided as Bringelly Shale, an alluvial and estuarine shale and carbonaceous claystone, with fine to medium grained sandstone. The shales are orientated in a synclinal

feature with its axis crossing the Chullora Site west-northwest to east-southeast, which forms the Fairfield Basin. The Bringelly Shales overlie the Ashfield Shale in the Fairfield Basin.

The area known as the North Eastern Portion Including Former Rail Reclamation and Recycling Area (Area G) was apparently (anecdotally) a former swamp, backfilled with boiler ash from steam locomotives in the 1920s, prior to being used for its current use.

2.4.4 Hydrogeology

Surface water and shallow groundwater drainage, within the Site fill materials, is expected to follow topographic gradients and stormwater culverts towards the canalised section of the Cooks River to the north. A secondary drainage line bisects the Site east-west along the Sydney Water land corridor, which may have a local influence on shallow groundwater flow. Deeper groundwater is likely to be influenced by the catchment of the Cooks River and the orientation of bedrock, which in turn is influenced by the Fairfield Basin.

The Bringelly Shale thins to the southeast of the Site, resulting in the sub-cropping of Ashfield Shale. This feature, together with the Fairfield Basin, is likely to have influenced the origin of the Cooks River valley. The natural Cooks River is to the southeast of the Site and its catchment orientation is likely to influence deep groundwater flow northwest – southeast, given the direction of the river valley.

One licensed groundwater abstraction borehole has been identified within a 3 km radius search of the centre of the Site conducted by the Department of Land and Water Conservation (URS, 2002). The licence, for an abstraction borehole located 1.3 km to the southeast of the Site boundary, was issued in 1966 for general use purposes. The borehole was drilled to a depth of 6.1 metres below ground, with a standing water level 4.5 metres below ground. The water bearing zone was described as clay material and on the Geological Series Sheet (1983) the borehole is positioned in the alluvial deposits of the Cooks River Valley. As such, groundwater abstracted from the borehole is not likely to be influenced by deeper groundwater from the Site. In general, groundwater quality in the area is known to be naturally of poor quality. The natural poor groundwater quality is due to saline connate (ancient) waters entrapped with the Wianamatta Shale.

The static water levels recorded in previous investigations indicated that the Site was underlain by a discontinuous shallow perched groundwater aquifer within fill material overlying residual/alluvial clays and a deeper aquifer within the residual soils. The data does not indicate a uniform flow direction of the shallow groundwater. However it is likely that the water will flow towards the stormwater culvert, which bisects through the middle of the Site, or to the north.

The inferred (shallow) groundwater flow direction is generally to the north and north west.

Section 3 History of Site

3.1 Site History

The Site has been owned and used for railway activities by RailCorp since 1920. Prior to that, land use is unknown.

Development of facilities on the Site commenced in the mid 1920s. The Locomotive Maintenance Centre (LMC) building (Area C) was in its current location by the late 1920s. It is known that the LMC building was used for military aircraft assembly during WW II. A tank assembly annex was added in 1942 and this was converted to the present EMC (Area D) in the 1970s.

The weighbridge and turntable at the Site were constructed in the period 1929 – 1930 and the load box was constructed in the early 1950s to test locomotive diesel engines and generators after maintenance or construction. Each structure is listed on the Rail Infrastructure Corporation (RIC) Section 170 Heritage Conservation Register (Chullora Railway Workshop Items).

It is not known when the fuel storage and distribution infrastructure was installed at the Site, though anecdotal evidence indicates that steam locomotives were retired from use in the 1960s, hence construction of this infrastructure is likely to be around this time.

A wide variety of contaminating Site activities including metal working and machining, caustic washing, ash backfilling, degreasing and waste oil collection have taken place at the Site since the mid 1920s.

3.2 Previous Environmental Site Investigations

Provided below is a table summarising the author, date, title, area and type of previous environmental site investigations. In the following sections a summary of the previous investigations relevant to the scope of the current investigation is provided.

Author	Date	Title	Area of Site	Type of Investigation
Godden Mackay Pty Ltd	June 1990	Chullora Railway Workshops, Heritage Assessment	Whole Site	Heritage
Planning Workshop Australia	December 1990	Chullora SRA Workshops Site, An Environmental Assessment of Surplus Lands	Whole site plus additional lands railway lands not included in this study	Land use assessment, including environmental
Godden Mackay Pty Ltd	March 1991	Chullora Railway Workshops, History and Site Development	Whole Site	History
Godden Mackay Pty Ltd	March 1991	Chullora Railway Workshops, Site Recordings, A Description of the Building Fabric and Operations	Whole Site	History and Architectural
Dames and Moore Pty Ltd	September 1999	Preliminary Contamination Assessment, Chullora Railway Workshops	Whole Site	Soil and Groundwater
Dames and Moore Pty Ltd	June 2000	Supplementary Contamination Assessment, Chullora Railway Workshops	Whole Site	Soil and Groundwater
Dames and Moore Pty Ltd	July 2000	Chullora Railway Workshops, Revised Strategic Options	Whole Site	Remediation
Consulting Earth Sciences	January 2002	Groundwater Monitoring Programme, Rail Infrastructure Corporation Sites at Bathurst ,	Whole Site	Groundwater monitoring

Section 3 History of Site

Author	Date	Title	Area of Site	Type of Investigation
		Chullora, Clyde, Goulburn, Sydenham		
URS Australia Pty Ltd	December 2002	Supplementary Environmental Site Assessment, Chullora Railway Workshops Lots 1, 2 and 3 (DP883526)	EMC and western portion of the LMC	Soil and groundwater
Rail Infrastructure Corporation	February 2003	Environmental Assessment – Locomotive Load Box/Weighbridge/Fuel & Oil Facility (Area 4) leased to Rail Fleet Services, former Locomotive Maintenance Centre, Chullora	Locomotive Load Box / Weighbridge and Refuelling Facility	Assessment of risk based on existing soil and groundwater data
HLA-Envirosciences Pty Limited	February 2004	Environmental Management Plan for Old Railway Workshops Chullora, Sydney	Locomotive Load Box / Weighbridge and Refuelling Facility	Environmental Management Plan
Responsive Environmental Solutions	April 2004	Locomotive load Box/Weighbridge, Fuel & Oil Facility Area 4 – Environmental Assessment	Locomotive Load Box / Weighbridge and Refuelling Facility	Soil and groundwater
Environmental Resources Management Australia.	April 2005	Phase II Soil & Groundwater Contamination Assessment – Project Koala	EMC	Soil and Groundwater
Coffey Geosciences Pty Ltd.	June 2005	Groundwater Investigation, Chullora Railway Workshops, Locomotive Load Box / Weighbridge and Refuelling Facility, Chullora, NSW	Locomotive Load Box / Weighbridge and Refuelling Facility	Groundwater and soil
Coffey Geosciences Pty Ltd.	September 2005	September 2005 Groundwater Monitoring Round, Chullora Railway Workshops, Locomotive Load Box / Weighbridge and Refuelling Facility, Chullora, NSW	Locomotive Load Box / Weighbridge and Refuelling Facility	Groundwater
Coffey Geosciences Pty Ltd.	July 2006	Combined Additional Groundwater Investigations and February 2006 Groundwater Monitoring Round Report, Chullora Railway Workshops, Locomotive Load Box / Weighbridge and Refuelling Facility, Chullora, NSW	Locomotive Load Box / Weighbridge and Refuelling Facility	Groundwater and soil

3.2.1 Godden Mackay (June 1990) Heritage Assessment

Godden Mackay prepared a heritage and archaeological assessment on surplus State Rail Authority (SRA) lands and (former) railway land including the subject Site of this investigation and a large portion of land to the west and south-west (over 200 ha), to identify those buildings and relics which are part of the cultural heritage.

Section 3 History of Site

Godden Mackay concluded that no buildings in the study area (including the current subject Site) were of sufficient cultural significance to warrant conservation. The significance of the buildings at Chullora lie primarily within their historic association with the development of the railways and in particular with the development of electric traction.

A number of items were recommended for conservation, including a flagpole; a Boabab tree; cranes 2, 3 and 4 and associated equipment; a chain tester and bed; and one timber trolley.

Godden Mackay recommended that the workshops should be recorded and a detailed history complied. Further heritage assessment of non-surplus lands would be required in the future.

3.2.2 Planning Workshop (December 1990) Environmental Assessment of Surplus Lands

Planning Workshop examined environmental opportunities and constraints for development of approximately 240 hectares (ha) of land zoned Special Uses 5(b) (Railways) at Chullora.

Key findings of the Environmental Assessment are as follows:

- Rationalisation and increased use of external contractors have rendered certain SRA functions obsolete, thus enabling approximately 40 ha. of land (generally occupying the central eastern part of the Site) to be declared surplus.
- The immediate surrounding area is industrial.
- SRA lessees with industrial sidings at Chullora will be encouraged to close or extend those sidings currently accommodating less than full train loads.
- The heritage assessment recommended that a flag pole and Baobab tree be conserved in-situ, and nine selected plant items be conserved in-situ if possible, or else relocated and conserved.
- Vegetation at Chullora was overall considered to be of low significance by Ecotone, Ecological Consultants. However, two locations were deemed 'highly significant' by Ecotone and a survey by Bankstown Council.
- The drainage and stormwater assessment concluded that development of the Site must include provision of an upgraded stormwater system, required to retard flows and collect gross pollutants;
  - trunk drains within the Site should be within easements where not within public road reserves;
  - the trunk drain on Greenacre branch needs to provide adequate capacity to prevent flooding in adjacent residential areas and the Electrical Maintenance Workshop (EMC);
  - grease and oil interceptor traps should be incorporated within specific lot developments;
  - piped stormwater systems should comply with Council standards and should be designed in conjunction with the road system.
- A soil and groundwater contamination assessment by Johnstone Environmental Technology (JET) established 46 sampling points over the surplus lands. JET concluded that no contamination which would compromise the safe and satisfactory redevelopment of the area for Industrial or Business Park use had been identified. [URS has not received this report].
- A geotechnical assessment undertaken by Jeffery and Kautauskas, Consulting Engineers, found no overall geotechnical impediment to the development of the land for industrial purposes.
- A new Flexible Industrial zoning is considered appropriate for the SRA lands at Chullora within the City of Bankstown Council is preferred. Those minor parts of SRA lands which fall within the Municipality of Auburn should preferably be transferred to the Municipality of Bankstown. SRA lands within the Municipality of Strathfield (with exceptions) should be zoned General Industrial 4(a) pursuant to the Strathfield Planning Ordinance.

Section 3 History of Site

3.2.3 Godden Mackay (March 1991) History and Site Development

A condensed history of the establishment, development and operations at Chullora, with particular emphasis on the physical structures that have existed on the Site was reported by Godden Mackay.

The Chullora Workshops complex was established as a central maintenance facility which was planned to grow to become the single major centre for railway workshops for NSW.

Chullora represents four separate and independent workshops, each performing a necessary function within the operations of the system. Additional facilities were added in the post-war period and the complex reached its peak in the early 1960's. From that time, workshops have been closed, buildings removed and excess land sold into the private sector. The present complex remains an important facility within the system, but much of the work once carried out in the workshops is now supplied from outside the Railways.

3.2.4 Godden Mackay (March 1991) Description of Building Fabric and Operations

Godden Mackay outlined the history and architectural and engineering record of the buildings and fabric of the Signal Branch Workshops, Chain Testing Shop Area, buildings of the Per Way No. 2 Workshops, part of the Locomotive Maintenance Centre buildings and surplus vacant land within Chullora.

3.2.5 Blackwattle Environmental (1998)

Report was not available to URS, however, results were previously summarised by ERM (2005). Blackwattle prepared an environmental site audit for Transfield Tulk (Transfield currently operate the EMC) in June 1998. The audit involved a visual inspection as well as a soil and sludge (assumed to be sediment from stormwater drains however, it is not clear in the ERM report) investigation.

Elevated concentrations (above background) of copper, lead, cadmium, zinc and TPH were detected in various soil samples. Two stormwater samples indicated traces of mercury, lead and cadmium and an elevated level of zinc was also reported in soil on the adjacent area to the south of the EMC in one sample.

3.2.6 Dames & Moore (September 1999) Preliminary Contamination Assessment

A preliminary investigation was conducted by Dames & Moore to identify potential major environmental liabilities at the Site (equivalent to the current subject Site) in relation to soil and groundwater quality that may affect on-going management or redevelopment for a more sensitive land-use than at present.

The main identified contamination issues identified as part of the investigation were:

- Fill materials and naturals soils (including EMC (Area D), LMC (Area C) Load Box (Area E), North Eastern Portion (Area G), DEMC (Area B) and BMC (Area A)), contain selected heavy metals concentrations exceeding NEHF residential criteria (residential criteria were used to provide Rail Services Australia an indication of future land use at the time of the investigation). Site wide, elevated concentrations of metals exceed provisional phytotoxicity criteria (NEPC, 1999);
- Localised petroleum hydrocarbon contamination at the northwest of the BMC building (Area A), at the Pollution Control Plant (waste water treatment plant in Area C), adjacent to the wash bay annex (Area D), and adjacent to the diesel fuel above ground storage tank at the load box (Area E);
- In shallow groundwater, metals, in particular zinc, exceeded ANZECC (1992) criteria at all locations sampled;

- In shallow groundwater, mid range TPH compounds at the northwest of the BMC (Area A) building and to the east of the flammable goods store (located in the north-eastern corner of Area A adjacent the Maintenance Building), which was also impacted by benzene;
- PAH compounds in shallow groundwater to the northwest of the BMC building and to the east of the flammable goods store, and to the north and south of the LMC workshop; and
- Chlorinated solvents beneath the BMC and DEMC workshop areas, and north of the LMC workshop.

Further works were recommended to confirm whether the contamination on-site presents a Significant Risk of Harm (SROH) as defined by the Contaminated Land Management Act 1997.

3.2.7 Dames & Moore (June 2000) Supplementary Contamination Assessment

A Supplementary Contamination Assessment was conducted by Dames & Moore to confirm whether contamination identified in the preliminary assessment (D&M, 1999) presents a SROH and to refine the assessment of major environmental liabilities. Key findings of the investigation are as follows:

- Soil contamination was identified in excess of NEPM HIL “F” industrial land use criteria (NEPC, 1999) in land adjacent to the Pollution Control Plant (LMC – Area C) and to the north of the LMC building.
- Groundwater contained concentrations of analytes exceeding the adopted investigation guideline levels, however based on the soil conditions and anticipated slow groundwater flow rates the migration of contaminated groundwater was considered unlikely to adversely affect the Cooks River.
- Vapour diffusion modelling was undertaken to assess risks to human health from vapours emanating from volatile organic compounds identified in groundwater. The modelling indicated no risks to human health for commercial / industrial land use posed by volatile organic compounds identified in the Site groundwater.
- Dames & Moore concluded that the contamination identified on Site was unlikely to pose a significant risk of harm to human health or the environment for commercial / industrial land use and there was no duty to report to the EPA under the Contaminated Land Management Act 1997.

3.2.8 Dames & Moore (July 2000) Revised Strategic Options

Dames & Moore revised the strategic options listed in the Supplementary Assessment based on the on-going industrial land use and in the event NSW EPA concluded there is a significant risk of harm and orders control of off-site migration. Dames & Moore considered that the Site was unlikely to pose a significant risk of harm to either human health or the environment The following potential remedial options were however discussed as part of a long term site management strategy:

- The installation of a cut-off wall on the north Site perimeter and Sydney Water corridor to control off-site migration of groundwater;
- Annual groundwater monitoring;
- Review and development of runoff and sediment;
- Detailed contamination investigation;
- Hotspot remediation; and
- Testing / upgrading / remediation of effluent sumps, pipe work and treatment facilities.

Section 3 History of Site

Dames & Moore noted that Rail Services Australia (RSA) should consider submitting the assessment data to the NSW EPA (former title for the Department of Environment and Climate Change, NSW) for consideration as the NSW EPA are the final determiner of Significant Risk of Harm issues. It is unknown if RSA submitted reports to the NSW EPA for their consideration of Significant Risk of Harm.

3.2.9 CES (January 2002) Groundwater Monitoring Programme

Consulting Earth Scientists (CES) conducted four rounds of quarterly groundwater monitoring between February and November 2001, at existing groundwater wells located across the Site, predominantly in Areas A, B and C. Key findings of the investigation are as follows:

- Groundwater at a number of wells around the BMC (Area A) and DEMC (Area B) were contaminated with TPH and selected VCHs (predominantly trichloroethene and trichloroethane and break-down products). Likely sources of these chemicals include underground waste water holding tanks (based on information provided by Rail Infrastructure Corporation) used for the BMC workshops. These tanks received wastewater from degreasing operations undertaken as part of the former railway maintenance activities on the Site.
- Continued quarterly monitoring was recommended and the installation of additional wells in the vicinity of DEMC and the Sydney Water land corridor near the DEMC (Area B), in order to investigate the lateral and vertical extant of VCH-impacted groundwater in this area. Additional wells were also recommended to the north and east of BMC building, in order to investigate TPH impacted groundwater in this area.

3.2.10 URS (December 2002) Supplementary Environmental Site Assessment

A URS Environmental Site Assessment (ESA) was undertaken on the EMC (Area D) and the western portion of the LMC (Area C) immediately to the east of the Area D. URS reviewed previous data and completed a field program which comprised drilling 29 boreholes for assessment of subsurface soils and fill, and conversion to monitoring wells where groundwater was observed. Soil and groundwater samples were analysed.

The following findings were made based on the results of this assessment, as well as previous assessments of the subject area:

- Arsenic was identified in soil at one location exceeding industrial guidelines (NEPC, HIL “F”). This concentration was isolated, and in soils at depth;
- TPH (C_{10} – C_{36} fraction) was identified in soils at four locations exceeding the NSW EPA (1994) threshold concentrations for sensitive land use. From the results, the impact of TPH is noted to be localised around the area of the former boiler house on the north-western corner of the LMC Building;
- The highest concentrations of the VCH tetrachloroethene in soil were recorded at two locations at the northern boundary of the EMC and LMC workshops. The potential source of contamination is likely to be the previous use of solvents on the Site;
- Shallow groundwater was intersected at five locations. Elevated levels of copper were detected in all locations. Elevated concentrations of zinc were also detected in two locations. One location recorded concentrations of mercury above ANZECC (2000) guidelines at the western boundary of the LMC (Area C).
- Shallow groundwater copper and zinc concentrations are in the range of results previously recorded for deep groundwater on the Site and considered to be indicative of regional conditions; and
- Trace levels of VCHs (trichloroethene, tetrachloroethene and associated break-down products) were detected in shallow groundwater adjacent to the north-east corner of the EMC building (Area D) and

the north-west corner of the LMC building (Area C). The VCHs within groundwater (consistent with the VCHs identified within the soil) was considered likely to be from previous use of solvents in the workshops.

Based on the analytical results and previous investigations, URS concluded that the Site is suitable for continued industrial use without requirements to undertake remediation. However, URS recommended that a Site management plan be developed to continue to monitor and assess the conditions of the Site.

3.2.11 RIC (February 2003) Environmental Site Assessment

The Property Unit of the Rail Infrastructure Corporation (RIC) conducted a Site inspection and data review in August 2002 in order to document the condition of an area of the former LMC (Area C) and determine environmental risk areas requiring further management.

Based on the available information, the following conclusions were drawn:

- With the exception of some petroleum hydrocarbons in shallow road base fill beneath the concrete pavement at one location to the south of the fuel/storage facility (in Area E), concentrations of chemical residues found in the subsurface filling material from past investigations at locations near the Load Box (Area E) have been within the acceptable range for industrial sites;
- Shallow groundwater present underneath the Load Box (Area E) has been impacted to a slight degree by heavy metals most likely from contact with fill materials (this conclusion is contrary to previous conclusions with respect to heavy metals in the shallow groundwater, that concluded that concentrations of heavy metals in the groundwater were representative of background conditions);
- The configuration and construction of the fuel / oil facility appears inconsistent with the requirements of Australian Standard in particular:
  - the volume of the bulk fuel and oil tank compounds is likely to be insufficient to contain leakage to the maximum capacity of the tanks for materials as labelled on the side of the tanks;
  - the road tanker transfer point from the diesel fuel tank has no collision protection or adequate spillage control;
  - the spill kit stationed at the fuel / oil facility may be inadequate to control all potential incidents that could occur during bulk liquid handling to / from tankers;
- It would appear that spills have occurred during the transfer of oil at two main locations, as evidenced by the observation of staining of concrete pavement;
- At the weighbridge, damage has been occasioned to the shed housing the measuring equipment; and
- No structures or facilities for containing leaks that could arise from operation and testing of locomotives were observed to be in place at the Load Box; therefore, there is some potential for stormwater to become contaminated from such leaks via entry to drainage pits.

The configuration and management of the entire fuel / oil facility (Area E) was identified as an environmental risk area requiring particular consideration in the ongoing management of activities, based on operational procedures understood to be in place at that time, within the Load Box area (Area E). This is due not only to the potential for off-site contaminant migration via drains of any spills or leaks from tanks, transfer to / from tankers, etc due to the lack of adequate spill containment facilities, but also to the need to ensure that all legal requirements relating the storage and handling of dangerous goods are observed.

The Load Box would also be an environmental risk area if locomotives are operated or tested in the facility, due to the lack of spill containment facilities.

RIC recommended that consideration be given to reviewing the ongoing need to operate the fuel / oil facility and the Load Box.

Section 3 History of Site

3.2.12 HLA (February 2004) Environmental Management Plan

HLA prepared an Environmental Management Plan (EMP) in response to a surface water pollution incident reported by Strathfield Council in July 2003 to the NSW EPA for a tributary of the Cooks River. The potential source of the pollution was suggested as being the Old Railway Workshops Site. The NSW EPA conducted an inspection of facilities on the Site and the neighbouring downstream creek, a tributary of the Cooks River. RIC later identified seepages of oily wastewater escaping from the Load Box (Area E) refuelling area, leased to Rail Fleet Services (RFS), which had graduated into a maintenance pit between the refuelling area and the Load Box. This pit contains a ball valve that connects to the on-site stormwater drainage system, which diverts stormwater in this part of the Site into the creek to the north.

The principal objectives of the EMP are to:

- Conform with EMP industry best practice standards;
- Maintain a primary focus on the prevention of water pollution from the Site;
- Prioritise other environmental risks of the Site;
- Enable implementation by Site based staff;
- Identify clear, practical and prioritised management actions;
- Provide for staged and / or recurring implementation of management actions;
- Identify triggers for corrective action and management intervention; and
- Identify all / any issues pertaining to the refuelling point, Locomotive Load Box Service Area, Locomotive Turntable, surface and subsurface drainage systems and Oil Treatment Works.

3.2.13 RES (April 2004) Environmental Site Assessment Locomotive Load Box

Responsive Environmental Solutions (RES) prepared an Environmental Assessment of the area around the Locomotive Load Box, Weighbridge and Fuel/Oil Facility (Area E), based on new and existing soil and groundwater data. Four new boreholes were installed and three were converted into monitoring wells. The following conclusions were made:

- Concentrations of TPH in soil exceeded the NSW EPA (1994) guidelines appeared to be confined to the upper fill profile. TPH contaminations did not extend to the residual clayey soils or shale bedrock;
- Petroleum hydrocarbons were detected in groundwater in monitoring wells MW1 and MW3, and phase separated hydrocarbon (PSH) (apparent thickness of 10 mm) was detected in MW1;
- The source of heavy metal (predominantly copper and zinc) concentrations in groundwater may be from leaching of the overlying fill material (this conclusion is contrary to previous conclusions with respect to heavy metals in the shallow groundwater, that concluded that concentrations of heavy metals in the groundwater were representative of background conditions); and
- Analytical results indicated that petroleum hydrocarbons capable of producing PSH were located near the weighbridge (MW1) and closer to the turntable (MW3).

3.2.14 ERM (April 2005) Phase 2 Soil & Groundwater Environmental Site Assessment, EMC Facility

Environmental Resources Management (ERM) undertook a Phase 2 soil and groundwater assessment of the EMC (Area D) at Chullora. A sampling and analysis plan was developed to target potential source areas of contamination. A total of 14 monitoring wells were installed; 15 boreholes were drilled and sediment samples from the stormwater drainage sumps were collected. Key findings of the investigation are as follows:

- Hydrocarbons and organic solvents were detected in shallow fill adjacent to and below the footprint of the wash bay annex (north east corner of Area D). TPH and VCHs (tetrachloroethene, trichloroethene, trichloroethane and associated break-down products) were detected in groundwater samples immediately down-gradient of this area and at the investigation area boundary. TPH and VOC contaminated wash water from the wash bay annex may be entering the underlying aquifer through current and historical cracks / leaks in the wash water collection system; and
- Elevated concentrations of TPH and heavy metals in sediment (sludge) samples collected from the accessible stormwater drainage sumps across the EMC area represents an off-site contamination / compliance issue and highlights a need for remediation / industrial cleaning and improved management practices.

ERM recommended further assessment of the potential for bio-accumulation and / or ecotoxicity with respect to off-site contaminant migration to potential sensitive receptors.

3.2.15 Coffey (June 2005) Groundwater Investigation, Loading Box

A groundwater investigation of the Load Box, Weighbridge and Fuel/Oil Facility (Area E) at Chullora was completed by Coffey in 2005. Key findings of the investigation are as follows:

- Decommissioning of existing monitoring wells MW1 and MW3 to remove a potential migration pathway for deeper groundwater contamination at the Site was completed. MW4 was not able to be located for decommission and could still provide an ongoing pathway;
- Concentrations of petroleum hydrocarbons were detected exceeding site adopted acceptance criteria (NSW EPA, 1994) in fill material and the upper part of the underlying alluvium in the vicinity of the fuel dispensing area, as well as in fill material to the south of the ASTs and the south east of the load box / weighbridge structure. The lateral extent of petroleum hydrocarbon contamination has not been well defined;
- Petroleum hydrocarbon contamination was detected in groundwater exceeding the site adopted acceptance criteria (Dutch, 2000 (325 µg/L)) in monitoring wells MWCS1 and MWCS4;
- Petroleum hydrocarbon contamination was mainly limited to perched groundwater in the fill material and the upper part of the alluvial soils and widespread petroleum hydrocarbon contamination was not present in the deeper aquifer within the natural soils;
- Substantial dilution and attenuation of hydrocarbon contamination would be likely to occur prior to the shallow groundwater discharging to the Cooks River (URS notes that discharge via stormwater lines was not, however, considered in the report);
- Soil and groundwater would not pose a significant risk of harm to the health of Site users in its current condition given the low sensitivity land use (railway yards). To be considered suitable for industrial land use, at a minimum a Site management plan would need to be implemented.

Coffey recommended implementation of the EMP, a bi-annual monitoring program and additional investigations, including a fate and transport assessment, to assess the extent of TPH and PAH contamination in soil and shallow groundwater and to assess the potential for preferential contamination migration pathways.

Section 3 History of Site

3.2.16 Coffey (October 2005) Groundwater Investigation, Loading Box

Coffey undertook the first bi-annual groundwater monitoring program (in Area E) in accordance with the Sampling, Analysis and Quality Plan (SAQP) prepared by Coffey in June 2005. Based on the investigations, Coffey concluded:

- Petroleum hydrocarbon contamination exceeded the adopted groundwater investigation levels (Dutch, 2000 (325 µg/L)) in shallow monitoring well MWCS1 and deep monitoring well MWCD1;
- The shallow aquifer at the Site contains significantly higher TPH contamination than the deep aquifer;
- Low concentrations of TPH were detected for the first time in two deeper wells, and one shallow well with previously moderate TPH concentrations had non-detect concentrations during this round;
- Substantial dilution and attenuation of the hydrocarbon contamination is considered likely to occur prior to groundwater discharge to the Cooks River, however the extent of and preferential pathways for contamination has not been well defined; and
- The results of this monitoring round support the conclusions of the previous investigation that it is considered unlikely that the NSW EPA would consider the groundwater contamination at the Site to pose a significant risk of harm to human health or the environment based on the available data.

Coffey again recommended implementation of the EMP, a bi-annual monitoring program and additional investigations, including a fate and transport assessment, to assess the extent of TPH and PAH contamination in soil and shallow groundwater and to assess the potential for preferential contamination migration pathways.

3.2.17 Coffey (July 2006) Groundwater Investigation, Loading Box

Additional groundwater investigations and the second bi-annual groundwater monitoring program of the Locomotive Load Box / Weighbridge and Refuelling Facility (Area E) were completed by Coffey. Key findings of the investigation are as follows:

- Attempts to locate monitoring well MW4 for decommission were undertaken to the extent practicable;
- TPH (C_{10}-C_{36}) contamination exceeded acceptance criteria (NSW EPA, 1994) in shallow fill material to the south of the ASTs and to the south east of the weighbridge shelter building, the extent of which has not been defined;
- TPH (C_{10}-C_{36}) contamination exceeded acceptance criteria (NSW EPA, 1994) in shallow soils and localised PSH was present in groundwater approximately 2 m north of the refuelling area;
- Concentrations of VCHs (trichloroethene and tetrachloroethene) exceeded ANZECC (2000) guideline levels to the southwest (10 m) and west (15 m) of the refuelling area (within Area E). The lateral extent of the contamination was not defined and it is unknown whether this contamination is localised, or forms part of a greater plume. It is also unknown whether these compounds are present in the shallow aquifer (as not analysed);
- Based on groundwater flow and velocity calculations, identified contamination is likely to have undergone significant attenuation to below ANZECC (2000) guideline levels by the time it discharges to the Site boundary;
- Underground services in shallow soils (identified by geophysical survey) may be potential preferential flow paths which may lead to faster transport velocities; and
- It is considered unlikely that the NSW EPA would consider the groundwater contamination at the Site to pose a significant risk of harm to human health or the environment. However further assessment of the source, extent and significance of VCH contamination is required followed by a reassessment

of whether the contamination poses a significant risk to human health and/or the environment, through either migration of the groundwater or through vapours.

- Based on the assessment of natural attenuation parameters, Coffey's were unable to conclusively state whether biodegradation of petroleum hydrocarbons was occurring in the groundwater in Area E.

Section 4 Site Operations

RailCorp (and leaseholders) generally use the Site for rail maintenance and associated activities. It is noted that in some areas of the Site non-rail activities are undertaken. These activities are, however, related to the activities undertaken historically for rail related activities. For example, the EMC is currently used for the reconditioning of electrical motors, however, the motors are not currently from rail rolling stock or infrastructure.

For the purpose of this investigation, the Site infrastructure is divided into Areas (Figure 2) based on site main historical operational activities, landmarks, and natural boundaries bounding those operations. In general, the Site infrastructure present on site is discussed below with reference to the activities which may present the potential to contaminate the Site, rather than detailing the production processes. The following sections include information from historic reports, Site inspections (including a Site inspection completed by URS personnel on 26 April 2007) and discussions with Site employees with knowledge of the current and historical activities.

4.1 Area A: Bogie Maintenance Centre (BMC)

4.1.1 Main Activities

Development of the complex, which included levelling with boiler bottom ash (which could also be Site wide), commenced in the mid 1920s. The initial building constructed by 1925 was the Boiler Shop, predominantly occupying the BMC, however, now vacant. Activities in the Boiler Shop included fabrication of steel parts in the northern bay, fabrication of copper parts in the southern bay; coal and coke storage in external areas adjacent to furnaces and blacksmith's fires at the eastern end of the building; numerous electrically powered drills, milling machines and screwing machines were operated in the building, presumably with oil utilised to remove metallic swarf; and disposal and filling of surrounding areas with boiler ash.

Boiler test pits in an unsurfaced earth floor at the western end of the BMC building were backfilled in the 1940s with unknown fill material and were not concreted over until 1988. Boreholes beneath the BMC building apparently indicated 15 m of backfill which included rock cuttings from construction of the Sydney underground railway.

Conversion of the Boiler Shop to the BMC took place in the 1960s and activities have remained largely unchanged since then. Activities at the BMC consisted of removing, cleaning and repairs to rail bogies. Cleaning would have involved removing of dirt and grease and is likely to have involved caustic washing and solvent use. Waste oils and solvent from the BMC workshops were disposed of via a collection pit in the west of the building either to the waste water treatment plant located in Area C (formerly known as the Pollution Control Plant) or through licensed contractors.

At the time of the recent URS Site walkover inspection (April, 2007) entry to the BMC building was prohibited due to reports of lead dust inside. No inspection of internal building areas was undertaken as part of this investigation. The most recent use of the BMC building was for storing transformers, wire and electrical parts by Warehouse Logistics Group, who provide track maintenance of electrical infrastructure.

The building was reclad over 5 years ago and a transformer is located between the Area A BMC and Area B DEMC buildings. Area A also includes the former eXpress Passenger Train (XPT) building (now demolished) and cafeteria, to the east of the BMC building. Diesel and petrol have been stored in a 5 KL AST and 240 L drums respectively at the south east side of the XPT building adjacent to the BMC.

A former flammable goods store was located in the north-eastern corner of Area A adjacent the rail lines to the north, adjacent the former Maintenance Buildings. The location of these storage facilities was not confirmed during the URS 2007 site walkover.

Section 4 Site Operations

4.1.2 Identified Potential Sources and Chemicals of Concern

From the review of available information, the following potential sources and contaminants of concern have been identified for the Area A:

- Boiler bottom ash used to level the Site – heavy metals, TPH, BTEX, PAHs;
- Coal and coke storage by the external northern wall of the BMC building) – PAHs, total cyanide;
- Waste oil and solvent from the BMC workshops – TPH, BTEX, volatile chlorinated hydrocarbons (VCHs);
- Diesel AST and petrol drums at the south east side of the XPT building adjacent to the BMC – TPH, BTEX, PAHs, phenols, lead;
- Unknown fill material materials located at the western end of the BMC building from backfilling boiler test pits in the 1940s – heavy metals, TPH, BTEX, PAHs, VCHs;
- Rail brakes - asbestos
- Component caustic washing, with the addition of hydroxides and phenolic agents – PAHs, phenols, VCHs, VOCs, TPH; and
- Vehicle, wagon and engine component washing with the addition of emulsifiers and detergents – VOCs, TPH, BTEX, VCHs.

4.1.3 Previously Identified Contamination

Previous investigations have identified the following contamination in Area A:

- Localised petroleum hydrocarbon contamination of the soil (C_{10}-C_{28} TPH fraction) has been identified in the western end of the BMC building and to the north west of the BMC building, sources unconfirmed.
- TPH (C_6-C_{36}) and/or VCHs in groundwater have been identified in the western end in the vicinity of the degreasing pit, to the north west of the BMC building and adjacent to the former flammable goods store located in the north-eastern corner of Area A.
- Heavy metals were identified in groundwater within Area A that exceeded the superseded (1992) and current (2000) ANZECC water quality guideline levels.

4.2 Area B: Diesel Engine Maintenance Centre (DEMC) and Associated Buildings

4.2.1 Main Activities

During the 1950s the introduction of diesel locomotives led to the construction of the DEMC originally as an annex to the boiler shop (now occupied by the BMC). Details of activities within the locomotive erecting shop are not well documented. Activities in the DEMC included diesel engine disassembly and assembly; vehicle, wagon and engine component washing with the addition of emulsifiers and detergents; and component caustic washing with the addition of hydroxides and phenolic agents.

Waste was pumped to the waste water treatment plant (formerly the Pollution Control Plant) located in Area C, for treatment. The waste water treatment plant is operated by the LMC. The DEMC was decommissioned in 2000 and the connection to the waste water treatment plant has been disconnected.

Section 4 Site Operations

A second, smaller building in DEMC area is currently used by United Rail Group as a tube store, and test cell. The test cell houses a dynometer (used to check whether compressors are up to power). The test cell for the dynometer has an asbestos roof. The test cell was historically used for this purpose.

Infrastructure surrounding the DEMC includes: a transformer, located between the DEMC and BMC buildings; an above ground diesel tank; a Dangerous Goods store; 2 underground storage tanks (USTs) (neither of which are in use, and at least one of which is abandoned with sand) and a potential fuel dispenser in a grassed garden area. The USTs were observed to still be present during the URS 2007 Site inspection undertaken as part of this investigation. Showers and amenities are located east of the DEMC, and a heritage listed air compressor beyond.

The former XPT building (now demolished), used to operate as a blacksmith forge, the operation has since moved to Sydenham workshops.

4.2.2 Identified Potential Sources and Chemicals of Concern

From the review of available information, the following potential contaminants of concern have been identified for the subject area:

- Diesel engine disassembly, paint store, compressor, former external storage tank, radiator testing, waste oil pit, chemical store – TPH, BTEX, VCHs, heavy metals;
- Component caustic washing (degreasing) - hydroxides, PAHs, phenols, VCHs, TPH;
- Vehicle, wagon and engine component washing – emulsifiers, detergents, BTEX and VCHs;
- Stores building and test cell – chemical storage, fuel USTs – TPH, BTEX, VCHs, heavy metals and cyanide; and
- Site wide issues – pesticides (OCPs and OPPs) and asbestos.

4.2.3 Previously Identified Contamination

Previous investigations have identified the following soil and groundwater contamination in Area B:

- Dieldrin was detected in the surface fill at three locations around the DEMC. Dieldrin may be from surface spraying, rather than imported fill;
- Significant TPH (C_{10}-C_{28}) (17 mg/L) was detected in groundwater at one location, although lower concentrations were detected in a subsequent monitoring round; and
- Heavy metals/metalloids (arsenic, chromium, copper, mercury, nickel and zinc) were identified in groundwater within the DEMC area that exceeded the superseded (1992) and current (2000) ANZECC guideline levels.

4.3 Area C: Locomotive Maintenance Centre (LMC)

4.3.1 Main Activities

Construction of the Locomotive Erecting Shop occurred in the late 1920s and 1930s and included levelling of the Site area with boiler bottom ash. Details of activities within the erecting shop are not well documented. The Shop was turned over for military manufacture during WWII and used for the fabrication and assembly of aircraft. Details of the precise locations of the military manufacturing activities are not well documented.

Section 4 Site Operations

Amalgamation of the Locomotive Erecting Shop and associated machine shops into the LMC took place in the 1960s. Activities in those buildings have remained largely unchanged since then. Inside the main building are concrete lined sub-surface inspection pits. Some oil staining has been observed on the concrete, particularly within the pits. Activities carried out in this area are generally the stripping and maintenance of rolling stock, including 'large' scale engineering works.

The LMC has been leased by United Rail Group since 2000. Current activities comprise inspection / stripping / cleaning / rebuilding / testing / painting of the following: air brakes, bogies, locomotives, engines, project work (ie reconditioning old trains) and components. Work is conducted on the diesel fleet only (not electric). New and waste oil is stored in 200 L drums on pallets around the Area. Waste oil is collected for off-site disposal by a licensed waste contractor from the Pollution Control Plant (now known as the waste water treatment plant), the Load Box area (Area E) and from LMC adhoc storage areas.

The buildings house boilers and caustic tanks, battery storage, a flammable goods store, two spray booths, an engineering workshop and cleaning bays. A transformer is also located on the Site.

There is a cleaning bay, which uses 'Sparticus' a caustic degreasing agent. The bay is located in a bunded area near the waste water treatment plant. Here items are sprayed with cleaning (degreasing) agent and washed using gurneys. Collected effluent from the washing bay is pumped to the waste water treatment plant, which is located on the boundary of the Sydney Water land. Small components are cleaned in a "dishwasher" type turbo wash machine.

Historically, the waste water treatment plant has received and treated waste from across the Site, until requested to cease by the NSW EPA. The waste water treatment plant is licensed with the EPA and has a Trade Waste Agreement (for discharge of treated effluent to sewer) with Sydney Water. The plant includes an oil separator, pH adjustment and flocculation to remove suspended solids. Waste sludge's are collected for off-site disposal by a waste contractor. An overflow at the waste water treatment plant occurred in 2003, caused by stormwater entry into the treatment tank.

A stormwater canal runs north-south underneath the LMC building. The width of the canal is approximately 6 metres. The base of the canal is approximately 2.5 m below ground level.

Other companies leasing buildings/facilities within Area C included Argus and Skyreach. Until late 2006, Skyreach rented a small building in the southern end of Area C. This building was used for administration for renting of boom lifts. Batteries were handled and pressure cleaning in a bunded area with a separator occurred. Argus telecommunication exchange handled batteries used as backup for communication systems.

Over the last four years general demolition of small buildings located within Areas C, with asbestos containing building materials and termite damage, has been conducted.

4.3.2 Identified Potential Sources and Chemicals of Concern

From the review of available information, the following potential sources and contaminants of concern have been identified for the Area C:

- Paint and fibreglass spraying, waste oil and battery storage, former aircraft manufacture, transformer, flammable goods store,– petroleum hydrocarbons (measured as TPH), BTEX, PAHs, phenols, hydroxides, asbestos, VCHs, heavy metals and PCBs;
- Hazardous building materials – asbestos and lead;
- Pesticide use for termite control – OCPs;
- Boiler bottom ash used to level the Site – heavy metals, TPH, BTEX, PAHs;
- Component caustic washing – hydroxides (pH), PAHs, phenols, VCHs, TPH;

- Vehicle, wagon and engine component washing and degreasing – emulsifiers, detergents, TPH, BTEX and VCHs; and
- Pollution Control Plant (waste water treatment plant) – Hydroxides/acids (pH) TPH, BTEX, VCHs.

4.3.3 Previously Identified Contamination

Previous investigations have identified the following contamination in Area C:

- TPH (C_{10}-C_{36}) identified in soil indicated that there is localised contamination within the vicinity of the former gas-fired boiler facility, and may be related to previous use of fuel oil in this area. Results of the deeper soil samples indicated that the contamination is likely to be confined to the surface fill layer and is unlikely to infiltrate to the underlying in-situ clay.
- The likely potential source of VCH contamination in soil in the north-western corner of the LMC area was attributed to potential leaks associated with the wash bay adjacent to the old boiler house, approximately 25m east of the borehole.
- Concentrations of heavy metals/metalloids (arsenic, cadmium, chromium, copper, mercury, zinc) in groundwater were above the superseded and current ANZECC water quality guideline levels.
- Elevated concentrations of TPH (C_{10}-C_{36}) in groundwater were recorded in the north-western corner of the LMC area (MW01 and MW02). TPH detected at MW01 was likely to be weathered diesel. The TPH detected at MW02 was likely to be a mixture of weathered oil and diesel.
- The elevated levels of VCHs in groundwater were measured in the north-western corner of the LMC area (MW02 and MW06). Contamination at MW02 may be associated with the elevated concentrations of VCH detected in the surface soils of the borehole. Soil results from MW06 indicate trace concentrations of tetrachloroethane within the fill material and/or degreasing operations undertaken in the north-western corner of the LMC building.
- Localised petroleum hydrocarbon contamination (predominantly in the C_{10}-C_{14} fraction) in soil (up to 66,000 mg/kg) has been identified at the Pollution Control Plant, possibly due to leaks from the plant.
- Arsenic, lead and copper have been detected in fill at concentrations above site adopted guideline levels for industrial land use (HIL “F”).

4.4 Area D: Electrical Maintenance Centre (EMC)

4.4.1 Main Activities

A tank assembly annex was added to the Site in 1942 during WWII for the production of tanks. This building became the Tender Maintenance Repair Shop in 1944, and was converted to its current use as the EMC by the mid 1970s. Area D consists of three main buildings: the EMC Workshop, the EMC store and the Main Office. Transfield-RSA Electromechanical Services has leased the property from RIC since 1998 for electrical and mechanical component repair.

Specific activities occurring prior to Transfield-RSA’s tenancy include:

- Prior to 1940 General rail yard usage
- 1940 – 1945 Assembly of military tanks
- 1945 – 1960 Repair of locomotives
- 1960 – 1974 Repair of bogies for rolling stock and electrical components of engines
- 1974 – 1998 Electrical component repair.

Section 4 Site Operations

Main activities at the Site currently include overhaul, refurbishment and upgrade of electromechanical plant and associated equipment used in the rail, mining, power generation, oil and gas, defence and other heavy industries. Specific services include coil manufacture, dynamic balancing to 20 tonne, vibration analysis, laser alignment, thermography, vacuum pressure impregnation (VPI), dielectrical loss angle testing and spin seasoning. Specific types of equipment serviced includes motors, transformers and generators, AC and DC high low voltage, gearboxes, auxiliary control equipment, off-highway vehicle motors and generators and explosion protected equipment. A small fabrication workshop is also located within the EMC workshop.

The VPI facility includes two in ground pits with 3000 litre and greater than 4000 litre capacities respectively. The larger pit was noted to contain groundwater during URS' site inspection in 2007. Apparently when groundwater reaches a certain level it triggers a pump which removes the water to a holding tank. The VPI process involves impregnation of components with an epoxy-based varnish. The facility would have used xylene. The smaller pit is still used.

A wash bay used for degreasing of small components is located outside the north-east corner of the EMC workshop. Wastes from the wash bay are stored in holding tanks which are pumped out and removed off-site by a licensed waste contractor every 6 to 8 weeks. Approximately 15,000 litres are removed each time they are emptied.

Located to the north of the EMC workshop building (western end) former caustic tanks, settling tanks and an oil/water separator were formerly located, these have been removed.

The EMC store building is used as a coil store and workshop. Copper coils are refurbished in here. The building includes an oven which was used to bake the coils but this is no longer in use. A small shed is located outside the eastern entrance to the EMC store building. This shed is used to store surplus tools.

A flammable goods store is located on the western Area D boundary behind the EMS store. The flammable goods store contains oils and greases, solvents containing xylene, methylated spirits as well as various other goods.

A transformer compound is located on the northern boundary of the EMC building, which is unsealed. The transformers have been present at this location for a long period and were recently removed (URS 2002).

A car park is located to the south of the EMC buildings, this car park is currently not used and is not leased by Transfield.

4.4.2 Identified Potential Sources and Chemicals of Concern

Based on the findings of previous investigations, the following areas are areas of concern:

- The former caustic tanks and enclosure to the north (western end) of the Main Workshop – hydroxides (pH);
- The former settling tanks to the north (western end) of the Main Workshop – heavy metals, pH, TPH/BTEX;
- The former oil/water separator to the north (western end) of the Main Workshop – TPH, BTEX.
- The area of hazardous waste storage in the south-west of the Main Workshop; the former chemical storage area adjacent to the tank ramp to the south-west of the Main Workshop and the chemical storage compound in the south-west of the Site – TPH, BTEX, heavy metals, VOCs;
- The former paint booth in the south-east of the Main Workshop and the paint booth adjacent to the tank ramp in the south-west of the Main Workshop – heavy metals, BTEX, VCHs;
- The wastewater sumps to the east of the Main Workshop – TPH, BTEX, VCHs;

- The large and small resin vacuum pressure impregnation tanks in the north west of the main building - xylenes;
- The wash bay outside the north east corner of the Main Workshop – TPH, BTEX, VCHs;
- The surface drainage leading to the wastewater treatment area – heavy metals, TPH;
- The former wash bay in the eastern end of the Main Workshop – TPH, BTEX, VCHs; and
- Areas of petroleum tank wash water in the north-east corner of the Site, that migrate across the Site boundary from the LMC (Area C) located to the east; the oil / water separator to the north-west of the Main Workshop; the diesel AST in the north east of the Site; and potential oil leakages to ground from the two main transformer facilities – TPH, BTEX, VCHs.

4.4.3 Previously Identified Contamination

Previous investigations have identified the following contamination in Area D:

- Elevated heavy metals (lead, cadmium and nickel), BTEX and TPH (C_{10}-C_{36}) concentrations in stormwater drain sediments from Area D;
- Concentrations of TPH (C_{10}-C_{36}) were detected in groundwater samples located immediately down-gradient (north-east) of the wash bay annex;
- VCHs (1.1-dichloroethene, cis-1.2-dichloroethene, tetrachloroethene) have been reported in the groundwater samples collected from the north eastern portion of Area D, around the wash bay annex;
- Concentrations of TPH (C_{10} – C_{36}) in fill material adjacent to / within the wash bay exceeded the site adopted guideline (NSW EPA, 1994) (BH12 (0.2 m) 4570 mg/kg). Fill samples from two other boreholes (BH11 and MW12) in the vicinity of the wash bay annex contained TPH (C_{10}-C_{36}) (110 to 220 mg/kg), but at concentrations below the site adopted guideline (NSW EPA, 1994). Sample BH01 (0.5-0.7m) collected in shallow weathered shale contained arsenic (1200 mg/kg) at a concentration in excess of the HIL “F” (NEPC, 1999) guideline. The arsenic concentration was less than the HIL “F” guideline level in a sample of the overlying fill at this location;
- Elevated concentrations of VCHs in groundwater (predominantly trichloroethene and tetrachloroethene and their associated break-down products) below guidelines (where available) have been detected in the north eastern portion of Area D; and
- Tetrachloroethene was detected in soil at BH07 (1.4-1.6 m), located adjacent to the effluent collection pits at the north-east corner of the EMC building. It is probable that impact to soils in this region is related to leakage and/or spills from the wash bay.

4.5 Area E: Locomotive Load Box / Weighbridge Refuelling Facility

4.6 Main Activities

The Locomotive Load Box / Weighbridge and Refuelling Facility were established from 1929 onwards and are still operational today. The main components are:

- Load Box, constructed in the early 1950’s, to test locomotive diesel engines and generators after maintenance or construction;
- Weighbridge and shed: the weighbridge was constructed in 1929 – 1930 with measuring equipment located in the timber framed shed;
- Inspection pits to allow inspection and maintenance of the undercarriage of train carriages; and

- Refuelling facility, which includes:
  - A fuel dispensing arrangement, with awning and concrete pad believed to drain to an underground sump;
  - One above ground storage tank (AST) labelled 'diesel fuel' (approximately 55 KL capacity) with a pipe for connection for bulk road tankers;
  - Pump arrangement;
  - Two 28 KL ASTs, one labelled 'diesel lube oil' and the other 'used oil'.

The Site is currently leased to United Group Limited and operated for the maintenance and refuelling of locomotives.

4.6.1 Identified Potential Sources and Chemicals of Concern

Substantial oil staining has been noted at the Site surface in previous investigations in the vicinity of the fuel dispensing area and maintenance pits. The following areas have been identified as potential contamination sources and chemicals of concern:

- AST Area and / or Maintenance Pits – TPH, BTEX, VCHs, PAHs, phenols and heavy metals;
- Load box / Weighbridge Area – TPH;
- Refuelling Area – TPH, BTEX, PAHs, phenols, heavy metals; and
- Lube oil storage and dispensing, diesel fuel storage and dispensing – TPH, BTEX, PAHs, phenols and heavy metals.

4.6.2 Previously Identified Contamination

Previous investigations have identified the following contamination in Area E:

- PSH - Localised PSH on groundwater at MWCS1 (severely weathered diesel) is most likely related to historic diesel spills / leaks;
- PAHs – Phenanthrene and fluorene contamination in groundwater is most likely attributable to diesel contamination ;
- TPH (C_{10}-C_{36}) - in shallow fill soil south of the ASTs (borehole 151) and south-east of the weighbridge shelter building (BH2). Most likely associated with leaks and / or spills of diesel from the adjacent AST area and / or maintenance pits. Extent undefined. In groundwater, approximately 2 m north of refuelling area (MWCS1 / D1);
- VCHs in groundwater most likely from solvent degreaser currently and / or previously used at the Site. Located west and south west of the refuelling area. Lateral extent undefined. Trichloroethene and tetrachloroethene at concentrations above (ANZECC, 2000) guideline concentrations, but many others above laboratory limits of reporting (LORs) including:
  - 1.1-dichloroethene;
  - 1.1-dichloroethane;
  - cis-1.2-dichloroethene;
  - vinyl chloride; and
  - trans-1.2-dichloroethene.

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4.7 Area F: North Western Portion Including Ballast Recycling Centre (BRC)

4.7.1 Main Activities

Activities in and around the north western portion of the Site have not been well documented. The main current use of this area of the Site is to recycle spent ballast recovered from routine track reconditioning and ballast cleaning works..

The BRC occupies approximately 2.4 hectares, although anecdotal evidence suggests it formerly comprised bushland areas to the west that are no longer owned by RailCorp. Approximately 200,000 tonnes of spent ballast is received by the BRC per year for recycling, 70% of the ballast arrives by rail. Four rail sidings run into the facility to load and unload ballast as part of routine track reconditioning and ballast cleaning works..

The BRC holds and environmental protection licence for it's operations, and is licensed to accept materials for recycling classified as "Solid Waste" (as defined by the NSW EPA "Waste Guidelines", 2004). It is understood that prior to transportation of materials to the BRC for recycling, RailCorp undertakes in-situ classification of the ballast to determine whether it is acceptable for receipt by the BRC. The BRC also routinely screens the ballast to ensure compliance with the EPA licence.

Upon receipt of ballast for recycling, the BRC temporarily stores the spent ballast in stockpiles (up to 20 metres high) pending processing. The ballast is processed by screening and sorting the ballast based on aggregate size. Depending on the aggregate size, the recycled ballast is either reused as track ballast or for other purposes such as track formation construction, road construction or embankment widening. Waste products, such as soil, concrete and general rubbish, which are separated from the ballast are disposed to landfill.

All Site plant is refuelled using mobile fuel tankers and no fuel is stored at the facility. No other chemicals are known to be used or stored at the facility.

The ballast is from track maintenance and/or repair programs and ballast cleaning programs conducted within the rail system in NSW. Recycled ballast is used by RailCorp within the network, there are no external sales of ballast.

The facility is surrounded by a perimeter drain which connects to a surface water detention basin located along the southern boundary of Area F. Every 2-3 years the detention pond is excavated and the sediment reused on Area F.

Two buildings are also located in the northern western portion of Area F. One building is of nissen hut construction and was built during WWII and is understood to have been associated with the tank construction activities. The nissen hut is currently occupied by Transport Infrastructure Development Corporation (TIDIC) and used for storage of equipment associated with railway infrastructure upgrades. The other building is constructed of colour bond steel and is approximately 20 years old. This building is used for storage (archiving) and distribution of paper documents and office furniture.

4.7.2 Identified Potential Sources and Chemicals of Concern

From the review of available information, the following potential sources and contaminants of concern have been identified for the subject area:

- Ballast, ash fill - heavy metals, TPH, PAHs, phenols.
- Rail brakes - asbestos; and
- Rail line and vegetation maintenance – arsenic and herbicides.

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4.7.3 Previously Identified Contamination

Limited investigations have been undertaken in Area F. Ballast material has been analysed and has been found to contain elevated copper and arsenic concentrations and high pH, with respect to the guidelines (ANZECC and NMHRC, 1992) applicable at the time of the investigation.

4.8 Area G: North Eastern Portion Including Former Rail Reclamation and Recycling Area

4.8.1 Main Activities

The area known as the former rail reclamation and recycling area was apparently a former swamp, backfilled with boiler ash from steam locomotives in the 1920s. The area has remained relatively inactive over the years, and has primarily been used for the recycling of steel rail lines, including welding, grinding and scraping rail tracks as well as storage of sleepers, rail and spoil (soil and ballast). A stockpile of ballast was temporarily stored in this area. The stockpile had been classified as Solid Waste and was awaiting processing by the BRC.

A petrol driven grinding machine (which required the use of oils and degreasing equipment) has historically been used in the welding depot of the Rail and Recycling Centre to the south; and sumps were reportedly utilised in the Rail and Recycling Area for storage of coolant water.

4.8.2 Identified Potential Sources and Chemicals of Concern

From the review of available information, the following potential sources and contaminants of concern have been identified for the subject area:

- Spent ballast material stockpiled – TPH, PAHs, heavy metals and arsenic and asbestos;
- Historic compressor plant (compressors) – TPH and PAHs;
- Timber storage (possible treatment), ash fill, waste ballast – heavy metals and arsenic, TPH, phenols and PAHs;
- Degreasing, minor fuel storage, water sumps – TPH, BTEX, PAHs, VCHs and heavy metals.

4.8.3 Previously Identified Contamination

Based on the investigation completed, concentrations of contaminants assessed, with the exception of metals in groundwater (Site wide issue), did not exceed relevant Site adopted guideline levels.

4.9 Area H: South Eastern Portion

4.9.1 Main Activities

The south eastern portion of the Site consists of multiple rail tracks. No previous investigations have been conducted on this portion of the Site, with the exception of the installation of groundwater monitoring well 153 (D&M, 1999).

Similar to operations in Area G, rail recycling has been undertaken in this portion of the Site which included welding, grinding and scraping of steel which was brought in by road. This has occurred in this portion of the Site for approximately 80 years, ceasing operation in 2000.

Section 4 Site Operations

4.9.2 Identified Potential Sources and Chemicals of Concern

From the review of available information, the following potential sources and contaminants of concern have been identified for the subject area:

- Boiler bottom ash used to level the Site – heavy metals, TPH, BTEX, PAHs; and
- Rail recycling – heavy metals.

4.9.3 Previously Identified Contamination

Limited investigations have been undertaken in Area H. Concentrations of contaminants assessed, with the exception of metals in groundwater (Site wide issue) did not exceed relevant Site adopted guideline levels.

4.10 Area I: Sydney Water Land

4.10.1 Main Activities

This area is not part of the Site or this investigation, but is discussed for completeness, as it bisects the Site in an east-west orientation. The Sydney Water land contains the trunk water main supply serving the Central Sydney area, extending from the Potts Hill Reservoir to the Hume Highway.

At the time of URS' Site inspection (April, 2007), Sydney Water was engaged in excavation works to modify the existing pipeline. A number of small excavated soil stockpiles were located on the land.

4.10.2 Identified Potential Sources and Chemicals of Concern

This area was not included in previous investigations undertaken for the railway lands at the Chullora Site.

4.10.3 Previously Identified Contamination

No investigations have been completed the Sydney Water Land (Area I) to target potential sources on the Sydney Water Land. Some investigation locations have, however, been located on the Sydney Water Land for assessing potential chemicals of concern on the adjacent RailCorp Site. This analytical data is included and assessed as part of the associated adjacent RailCorp land use as described above.

Section 5 Potential Source of Contamination

5.1 Areas and Chemicals of Environmental Concern

Area of Concern	Chemicals of Concern
Area A: Bogie Maintenance Centre	TPH, BTEX, PAHs, phenols, cyanide, VCHs, asbestos
Area B: Diesel Engine Maintenance Centre	TPH, BTEX,, heavy metals, emulsifiers, PAHs, phenols, VCHs, asbestos, OCPs, OPPs, cyanide
Area C: Locomotive Maintenance Centre (encompasses the Pollution Control Plant)	TPH, BTEX, PAHs, phenols, caustic (pH), VCHs, heavy metals, OCPs, PCBs, emulsifiers, detergents, asbestos, caustic (pH)
Area D: Electrical Maintenance Centre	TPH, BTEX (particularly xylenes), VCHs, caustic (pH), VOCs, heavy metals, PAHs, phenols, emulsifiers, detergents
Area E: Locomotive Load Box, Weighbridge and Refuelling Facility	TPH, BTEX, VCHs, PAHs, phenols, heavy metals
Area F: North Western Portion and Ballast Recycling Depot	TPH, Heavy metals, PAHs, phenols, asbestos, herbicides
Area G: North Eastern Portion and Former Rail Reclamation Area	TPH, BTEX, heavy metals, arsenic, PAHs, phenols, VCHs, asbestos
Area H: South Eastern Portion	TPH, BTEX, PAHs, heavy metals
Area I: Sydney Water Land	None identified
Up-gradient sites	TPH, BTEX, Heavy metals, PAHs and VCHs

Section 6 Assessment Guidelines

6.1 Use of the Site

The site is currently used for industrial purposes, predominantly rail related. It is assumed that the site will continue to be used for on-going industrial land use. The following assessment guidelines are those currently endorsed by the DECC, NSW and adopted for the assessment of soil and groundwater contamination at commercial/industrial facilities located within NSW.

It is noted that some data assessment in previous site assessment reports adopted guidelines that have since been superseded. As such URS has retrospectively screened available soil and groundwater data (as presented in Tables 3 to 13 inclusive) against currently endorsed guidelines. The discussion of results presented in Section 4, however, occasionally relates to exceedances of superseded guidelines.

6.2 Site Soil Assessment Criteria

The soil assessment criteria adopted for the investigation data are listed in **Table 2a**.

These criteria are used to determine whether a contaminant has the potential to present an unacceptable risk to human health or the environment for the proposed site land use. If the 95% Upper Confidence Limit (UCL) of the arithmetic mean concentration of a COPC is less than the corresponding criterion, then the risk is considered to be acceptable. Individual concentrations should also be less than 250% of the assessment criterion and the standard deviation should be less than 50% of the assessment criterion. Where there is insufficient data to calculate a meaningful 95%UCL the absolute values should be compared against the respective assessment criteria.

The soil site assessment criteria adopted include the lower of the health-based investigation levels (HILs) for heavy metals, metalloids, phenol, PAHs, PCBs and OCPs as presented in Column 4 (commercial/industrial land use) of Appendix II (Soil Investigation Levels (SILs) for urban development sites in NSW) of the DECC, NSW (2006) Auditor Guidelines.

6.2.1 Health-based Investigation Levels

The HILs were originally published in 1996 by Imray and Langley originally in the National Environmental Health Forum (NEHF) Monograph, Soil Series No.1. This Monograph was revised and republished in 1999 and the document forms Schedule B (7a) (Guidelines on Heath-Based Investigation Levels) of the National Environment Protection Council (NEPC, 1999) National Environment Protection (Assessment of Site Contamination) Measure (NEPM). NEHF is now known as enHealth and the Monograph was republished in 2001.

The Column 4 criteria (NEHF F) are health–based investigation levels (HILs) for a commercial or industrial land use. The development of HILs for soils for this standard exposure setting has been based on the following set of facts, assumptions and inferences about how exposure takes place (the exposure scenario (EnHealth, 2001)):

- **Default exposure ratio:** 0.2 (this low ratio is based on adults being the key exposure concern);
- **Exposure period :** 8 hours per day, 5 days per week, 48 weeks per year, 30 years duration;
- **Assumes:** Soil contact opportunities arise during course of site use by public and workers;
- **Excludes:** Home-grown fruit and vegetables, poultry, groundwater consumption and volatile organic contaminants, unless already accounted for in setting HIL for that contaminant;
- **Direct soil exposure pathways:** direct soil ingestion, direct soil dermal contact and direct soil particulate inhalation;
- **Indirect soil exposure pathways:** Nil applicable.

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With consideration to the proposed ongoing industrial land use the above exposure scenario is conservative.

Column 4 of Appendix II of the *Auditor Guidelines* provides HILs for semi volatile TPH fractions. These HILs are speciated into aliphatic and aromatic fractions. As the routine laboratory analysis for semi volatile TPH is not speciated, the assessment criteria for semi volatile TPH fractions has been adopted from the NSW EPA (1994) Contaminated Sites: Guidelines for Assessing Service Station Sites (the "*Service Station Guidelines"*). These guidelines provide threshold concentrations for soil for sensitive (eg residential) land use for a range of services station related contaminants. These guidelines would be considered relatively conservative for a commercial/industrial land use.

The soil assessment criterion for TPH (C_{10}-C_{40}) has been adopted.

In the absence of HILs for volatile petroleum hydrocarbon compounds, and in accordance with the *Auditor Guidelines*, the criterion for TPH (C_6-C_9 fraction), benzene, toluene, ethyl benzene and total xylenes (BTEX) from the *Service Station Guidelines* have also been adopted as soil assessment criteria.

6.2.2 Asbestos in Soil

There are currently no national or DECC, NSW endorsed guidelines relating to human health or environmental investigation of material containing asbestos in site soils.

Consistent with previous NSW EPA guidance, no asbestos in surface soil should be permitted.

6.2.3 Aesthetics

In assessment of site soil contamination, for industrial facilities the *Auditor Guidelines* recommend that consideration also be given to whether contaminant odours from site soils have been adequately assessed.

6.3 Site Groundwater Guidelines

The site adopted investigation levels used to evaluate the groundwater analytical results have been taken from the ANZECC and ARMCANZ (2000), National Water Quality Management Strategy, "*Australian Water Quality Guidelines for the Protection of Aquatic Ecosystems"* (ANZECC / ARMCANZ, 2000). The ANZECC / ARMCANZ (2000) guidelines provide Trigger Values for organic and inorganic chemicals in freshwater and marine aquatic environments. Since the nearest surface water receptors are freshwater and are likely to have been impacted (to varying degrees) by urban run off, the screening criteria for fresh water aquatic ecosystems have been adopted for the site (95% level of protection).

The ANZECC / ARMCANZ (2000) guidelines do not provide reliable Trigger Values for toluene, ethyl benzene, total xylene and total PAHs. Therefore, the NSW EPA (1994) *Guidelines for Assessing Service Station Sites and the Threshold Concentrations for the Protection of Aquatic Ecosystems (Fresh)* (Threshold Concentrations) are used as screening criteria for these compounds.

No guideline levels exist for TPH in groundwater.

Adopted investigation levels for groundwater are summarised in **Table 2b.**

Section 6 Assessment Guidelines

6.4 Site Sediment Guidelines

The site adopted investigation levels used to evaluate the sediment analytical results have been taken from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000). These guidelines are used to screen contaminant concentrations in sediment by comparing concentrations to Interim Sediment Quality Guideline (ISQG) values. Two types of ISQG values are provided, the ISQG-Low value and the ISQG-High value. The ISQG-Low value represents a contaminant concentration at which low range effects have been observed in ecological systems, whereas the ISQG–High value represents a contaminant concentration at which median range effects have been observed.

Adopted investigation levels for sediment are summarised in **Table 2c.**

Section 7 Sampling and Analytical Plan

7.1 Sampling Plan - Groundwater

7.1.1 Groundwater Sampling Methodology

Existing Site monitoring wells were sampled using URS Standard Procedures for Groundwater Sampling as summarised below.

7.1.2 Water Level Measurement

Water level measurements were undertaken prior to purging of each well. The following measurements are undertaken:

- Thickness of non-aqueous phase liquids (NAPL) (if present);
- Static water level relative to the top of well casing; and
- Total depth of well.

Measurements were undertaken using an electronic interface probe (the probe was decontaminated between each well). The measurements were recorded on the field data sheets.

7.1.3 Well Purging

Purging of monitoring wells was undertaken using a dedicated pump (a Waterra^{TM} foot valve and tubing). Purging was continued until stable water parameters were achieved or until the bore was pumped dry. The water parameters were considered to be stable when successive parameters were +/-10 %. A physical description of the sample was recorded on the field data sheets.

All bores were sampled within 24 hours of being purged, subject to sufficient recharge of the well.

7.1.4 Groundwater Sampling

Groundwater monitoring wells were sampled using Waterra^{TM} pumps and dedicated/disposable bailers. In MWCS1, NAPL was measured using an interface probe. No groundwater samples were collected from this well. Groundwater samples were transferred from the bailer into the appropriate sample containers in the following general sequence:

- volatile organic compounds;
- semi volatile organic compounds;
- inorganic compounds.

Samples collected for dissolved metals analysis were field filtered with a 0.45 μm filter before being placed into the appropriately preserved sample container. Once filled, all sample containers were immediately tightly capped and placed in secure esky with ice.

The field parameters and a physical description of the sample were recorded on the field data sheets.

7.1.5 Water Parameters

A physical description of the sample was recorded on the field data sheets including:

- Colour;
- Turbidity;
- Odour;

Section 7 Sampling and Analytical Plan

- Films; and
- Phase separated liquids/non-aqueous phase liquids (NAPL).

The groundwater parameters were tested in the field at the time sample collection for the following field parameters:

- pH;
- electrical conductivity (EC);
- temperature;
- dissolved oxygen (DO); and
- redox potential.

7.1.6 Decontamination

Re-usable equipment, such as the water level meter and water quality meter sensors, were decontaminated before each use. The water level meter was rinsed in a solution of Decon 90, and then rinsed in potable water. The water quality meter sensors were rinsed in potable water, and then rinsed in a sample of water to be measured, prior to measuring water quality parameters. Decon 90 was not used on the sensors, as it can affect the accuracy of the measurements.

7.1.7 Quality Control Sample Collection Methodology

Quality control samples collected during the groundwater investigation are as outlined below:

- One intra-laboratory sample collected by splitting each bailer of sample into the primary and duplicate sample containers;
- One inter-laboratory field duplicate sample collected by splitting each bailer of sample into the primary and duplicate sample containers;
- A rinsate blank collected by pouring laboratory prepared supplied deionised water over the probe of the dip meter between successive wells; and
- One trip blank sample and one trip spike sample, comprising of laboratory prepared water and spiked water samples respectively were also included in the analytical suite.

7.2 Sampling Plan - Sediment (Stormwater Drains)

7.2.1 Sampling Methodology

Sediments were collected by hand using stainless a steel trowel to a consistent depth of 100 mm. The sediment was visually logged and the texture.

Sample containers (pre-labelled, 250 mL Teflon™-wadded glass jars) were filled to capacity with sediment. Large items of vegetation (leaves and sticks), rocks and anthropogenic debris were removed from the samples. Samples are placed in a secure esky with ice.

Sampling equipment (trowels etc.) were decontaminated between each sampling event and location.