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REPORT
ON
REMEDIATION ACTION PLAN

CNR PRINCES HIGHWAY AND ARNCLIFFE STREET
ARNCLIFFE

Prepared for
NAHAS CONSTRUCTIONS PTY LTD

Project 45635.01
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Glossary of Terms

AHD	Australian height datum
ANZECC	Australian and New Zealand Environmental & Conservation Council
As	arsenic
ASS	acid sulphate soil
ASSMAC	Acid Sulphate Soil Management Advisory Committee
ASSMP	acid sulphate soil management plan
AST	Above-ground Storage Tank
B(a)P	benzo(a)pyrene (a polycyclic aromatic hydrocarbon compound)
bgl	below ground level
BTEX	benzene, toluene, ethyl benzene, total xylenes (monocyclic aromatic hydrocarbons)
Cd	cadmium
Cr	chromium (total)
Cr(III)	chromium with oxidation state III (stable in normal environments)
Cr(VI)	chromium with oxidation state VI (typically not stable in normal environments)
CT	contaminant threshold (screening criteria for waste classification assessment)
Cu	copper
C_6–C_9	light hydrocarbon chain groups
C_{10}–C_{14}	medium hydrocarbon chain groups
C_{15}–C_{28}	heavy hydrocarbon chain groups
C_{29}–C_{36}	heavy hydrocarbon chain groups
DEC	Department of Environment and Conservation
DNR	Department of Natural Resources
DP	Douglas Partners Pty Ltd
EPA	Environment Protection Authority (now part of the DEC)
GW	groundwater
ha	hectares
HIL	NSW EPA Contaminated Sites: *Guidelines for the NSW Site Auditors Scheme (2nd edition), 2006*. Health-based investigation levels (Columns 1 to 4)
Hg	mercury

Hotspot	contaminant concentration greater than 2.5 times the site assessment criteria
m	metres
mg/kg	milligrams per kilogram (or parts per million)
mg/L	milligrams per litre (or parts per million)
NATA	National Association of Testing Authorities
Ni	nickel
NSW	New South Wales
OCP	organochlorine pesticides
OPP	organophosphate pesticides
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PCA	P. Clifton & Associates Pty Ltd
PCB	polychlorinated biphenyls
pH	unit measure of acidity/ alkalinity
PID	photoionisation detector
PQL	practical quantitation limit
RAP	remediation action plan
RL	reduced level
%RPD	relative percentage difference
SAC	site assessment criteria
SCC	specific contaminant concentration (total concentration for waste classification assessment)
TCLP	toxicity characteristic leaching procedure
TRH	total recoverable hydrocarbons
TPH	total petroleum hydrocarbons
TOPIC	total photoionisable compounds
UCL	upper confidence limit of data set
UST	underground storage tank
VENM	virgin excavated natural material
Zn	zinc

REFERENCES

- NEPC *National Environment Protection Measure (Assessment of Site Contamination)* (1999);
- NEPC (1999). National Environmental Protection (Assessment of Site Contamination) Measure Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater, Background Ranges
- NSW EPA Contaminated Sites *Guidelines for Assessing Service Station Sites* (1994)
- NSW EPA Contaminated Sites *Sampling Design Guidelines* (1995)
- NSW EPA Contaminated Sites *Guidelines for Consultants Reporting on Contaminated Sites* (1997)
- NSW DEC Contaminated Sites *Guidelines for the NSW Site Auditor Scheme* (2nd edition) (2006)
- NSW EPA Contaminated Sites *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (2009)
- *Contaminated Land Management Act* (1997) and *Contaminated Land Management Amendment Act* (1997) *NSW Government Regulation* (1998, 2009)
- ANZECC *Australian Water Quality Guidelines for Fresh and Marine Waters* (2000)
- ANZECC/NHMRC *Australian Drinking Water Guidelines* (2004)
- ARMCANZ/ANZECC *Guidelines for Groundwater Protection in Australia* (1995)
- *Dutch Water Quality Guidelines (2000) –intervention values* – [adopted due to the absence of NSW EPA or ANZECC guidelines for TPH]
- NSW DECC *Waste Classification Guidelines (2008)*
- Stone, Y, Ahern C R, and Blunden B (1998). Acid Sulfate Soils Manual 1998. Acid Sulphate Soil Management Advisory Committee [ASSMAC], Wollongbar, NSW, Australia

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REMEDIATION ACTION PLAN
CNR PRINCES HIGHWAY AND ARNCLIFFE STREET
ARNCLIFFE

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1. INTRODUCTION

This Remediation Action Plan (RAP) for the site at the corner of the Princes Highway and Arncliffe Street, Arncliffe (the site) has been prepared by Douglas Partners Pty Ltd (DP) on behalf of Nahas Constructions Pty Ltd.

An Acid Sulphate Soil Management Plan (ASSMP) is included as part of this RAP. The ASSMP will be followed if materials are excavated from depths below the water table.

The subject site covers an approximate area of 1.25 ha and has previously been used for various industrial and commercial purposes including automotive workshops, a service station and a foundry. DP carried out a preliminary contamination assessment in 2005 (refer to Section 3, below). The site investigated by DP originally comprised Lots 1 – 9 DP 24018, however, it is understood that the site now also includes Lots 3 and 4 DP 1032962 to the east which were not included in the DP 2005 assessment.

The development will be carried out in two stages over a period of several years. The first stage will be a transition phase which includes the development of a supermarket and associated car park and a limited amount of other retail space, all to be constructed at-grade. All the Stage 1 structures will be superseded and replaced by a mixed residential/commercial development at a later date. It is understood that the proposed mixed residential/commercial development will involve bulk excavation for three levels of basement

car parking and that only minor areas of landscaping will be retained outside the basement footprint.

The site location is provided in Drawing 1, Appendix A, and site layouts for the proposed staged schemes are shown in Drawings 2, 3-1 to 3-3, Appendix A.

The RAP has been developed based on applicable standards and guidelines endorsed by the relevant authorities and the results of the previous assessments discussed in Section 3.

The objectives of the RAP are to describe the works which are necessary to remediate the site for the Stage 1 commercial development only. Remediation works for a combined commercial and residential use will be covered by a separate RAP prepared at a later date. The RAP also provides a scope of validation works to be undertaken to demonstrate that the site has been made suitable for the intended land use following remediation. The RAP also outlines the environmental controls to be adopted during site assessment/remediation works.

Under SEPP 55 – Remediation of Land, the consent authority will need to be advised of the works and to determine whether they are Category 1 or Category 2 works. Category 1 remediation works will require Development Consent. Category 2 works will require 30 days notice to the consent authority of the intention to proceed. Given the Part 3A determination of the project, DP considers that the proposed remediation may be a Category 1 classification.

2. PROPOSED DEVELOPMENT

The proposed development has been designated a Part 3A Development under the *Environmental Planning and Assessment Act*. In a Part 3A determination the Minister of Planning is the consent authority.

The first stage development is shown on Drawing 2. The drawing shows a supermarket with a loading dock as the principal element together with a smaller retail shop and supporting car park. The area occupied by each part of the development is as shown below;

- The supermarket will have an floor area of 4,200 m^2;
- The loading dock will have an area of 216 m^2;
- The retail outlet will have an area of 600 m^2;
- The car park will have space for 184 cars.

The floor level of the supermarket, including the retail outlet, and the loading dock will be raised above the 1:100 year flood level by about 0.5 m to a reduced level (RL) of 3.05 m and 4.0 m above Australian Height Datum (AHD) respectively. The car park will be at a lower level, generally varying between RL 2.25 m and 2.85 m AHD. The existing site level varies but is nominally 2.5 m AHD.

The second stage development is scheduled to occur prior to 2024 and will require the demolition of the first stage development. The later development will include a commercial ground floor, three basement levels of car parks and residential units above the ground floor commercial level. For this development the vast majority of the site will be bulk excavated.

3 RESULTS OF PREVIOUS INVESTIGATIONS

The following report has previously been prepared for the majority of the site (excluding Lots 3 & 4, DP 1032962):

Douglas Partners, *Report on Preliminary Contamination Assessment, Proposed Residential and Commercial Development, Princes Highway and Arncliffe Street, Arncliffe* (27 June 2005, reference 43034).

The report was based on a use of the site for commercial and residential uses (basically the Stage 2 development, with three levels of basement) and did not consider a solely commercial use (developed at grade) as that proposed for the first stage development. This RAP should be read in conjunction with the above report; the findings of which are summarised below.

3.1 Preliminary Contamination Assessment Report (DP June 2005)

The Preliminary Contamination Assessment covered Lots 1 – 9 DP 24018. It comprised a review of limited site history information and intrusive soil sampling from ten test bore locations and groundwater sampling from piezometers installed in three of the test bores. The site drawing, test bores and summary of laboratory results from this report are provided in Appendix B.

Issues of potential contamination concern identified at the site included:

- A concrete sump pit in Lot 1, which may have been used to dispose of by-products of the printing process, with potential contaminants including solvents, cyanide, hydrocarbons, chromium;
- A service station previously occupied Lot 9, with underground storage tanks (USTs) in the south-west corner and three (3) dip points observed in south-eastern section of Lot 9. Potential contaminants associated with this use include petroleum hydrocarbons (petrol, diesel, waste oils), phenols, heavy metals (in particular lead) and solvents;
- A possible UST in the laneway between Lots 1 and 2, the presence of which was not confirmed;
- A smash repairs business in Lots 2 and 3, which may have spilled oils/degreasers and solvents;
- A wash bay in Lots 7 and 8 with potential contaminants including heavy metals and hydrocarbons;
- Imported filling placed throughout the site and may include, amongst others, heavy metals, hydrocarbons, pesticides and asbestos.

Filling was encountered in all bores to a maximum depth of 1.8 m. The majority of the filling consisted of yellow brown sandy and silty clay as well as dark grey to black sandy clay filling. The majority of the filling appeared to be natural in origin with no signs of building rubble and other anthropogenic materials with the exception of the materials in Bore 101 which contained fragments of porcelain and vesicular ash and Bore 104 which contained vesicular ash. The filling in Bore 110 consisted of yellow brown sand with surficial black clay which had been heavily affected by black glue-like chemicals with a strong hydrocarbon odour.

Groundwater was encountered between 0.2 and 3.2 m below ground level.

Twelve filling and one natural soil sample was analysed for various combinations of the identified potential contaminants of concern, including;

- Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn);
- Monocyclic aromatic hydrocarbons (benzene, toluene, ethylbenzene and xylene – BTEX);
- Total petroleum hydrocarbons (TPH);
- Polycyclic aromatic hydrocarbons (PAH);
- Polychlorinated biphenyls (PCB);
- Organochlorine and organophosphate pesticides (OCP/OPP);
- Asbestos;
- Cyanide.

All laboratory results for the chemical contaminants analysed were within the NSW EPA *Contaminated Sites: Guidelines for the NSW Site Auditors Scheme, 1998* health-based guidelines for residential sites with minimum access to soil (Soil Investigation Levels (SILs) for Urban Redevelopment Sites in NSW, Column 4) applicable at the time of the investigation (revised guidelines have since been issued, dated 2006). The exception to meeting the guideline concentrations was the concentration of TPH in Bore 110/110A. Due to the elevated TPH concentration at 96,910 mg/kg, (and its replicate Z3 = 46,500 mg/kg) this location is considered to be contaminated. It was considered that the detected TPH possibly represents waste product generated from the operation of the printing press that formerly occupied the site. The TPH in the sample was found to be due to petroleum hydrocarbons, after undergoing a “silica gel clean-up” analysis. Samples from Bore 110 which were analysed for VOCs and cyanide compounds had concentrations that were below detectable limits.

Asbestos was not observed in filling materials during drilling and logging. During subsequent laboratory analysis, however, chrysotile asbestos was detected in one sample (109/1.2-1.4) which was collected from the filling material.

One groundwater sample was collected from each of the three groundwater wells, and were analysed for the following potential contaminants of concern:

- Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn);
- Monocyclic aromatic hydrocarbons; and
- Total petroleum hydrocarbons.

All results were within the *ANZECC (2000) Australian Water Quality Guidelines* 95% Level of Protection for marine water with the exception of zinc (in Bore 101). It was considered that as Bore 101 is an up-gradient bore and that the levels of concentrations of zinc in both the soils and the groundwater of down-gradient bores are low, the contamination is unlikely to be sourced from the subject site and thus there are no "site-derived" significant impacts on groundwater quality.

With respect to acid sulphate soils (ASS), three out of four samples sent for suspension peroxide oxidation combined acidity and sulphate (SPOCAS) testing (grey to black sandy clay and silty clay at approximately 2.8 m depth in Bores 103, 104 and 109) were identified to exceed the action criteria for disturbance of less than 1,000 tonnes of medium textured materials. It was considered that all material below the water table (approximately 1.5 - 2.0 m below ground level), in particular, the dark grey (black) sandy clay, the light grey sandy clay and the dark grey silty clay should be assumed to be potential acid sulphate soils (PASS). Given the potential disturbance of PASS during the previously proposed excavation, particularly for the proposed second stage development, the report stipulated that an ASSMP is required (this is provided in Section 9).

It was recommended that further investigation/remediation should be conducted in the following areas when site access allowed;

- Around the concrete lined pit at the rear of Lot 1;
- Around any USTs identified, including their removal and management of impacted materials and validation of pit/s;
- Asbestos contaminated filling.

It was also recommended that a Hazardous Building Materials Inspection be completed prior to demolition of the existing buildings.

The report concluded that, based on the site history, site observation and laboratory results and following further testing it was considered likely that the site could be rendered suitable for the proposed mixed residential/commercial use which is broadly identical to the current Stage 2 development.

4. OBJECTIVES OF THE RAP

The objective of the RAP is to ensure that the site is further assessed as discussed above and remediated, as required, in an acceptable manner, with minimal environmental impact, to a condition suitable for the proposed commercial first stage development. The RAP provides a strategy for site assessment/remediation which:

- Minimises impacts from the site on the environment and on the health and safety of site users;
- Maximises the protection of workers involved with remediation; and
- Renders the site suitable for the proposed commercial first stage development.

5. REVIEW OF SITE INFORMATION

5.1 Site Identification and Description

The subject site is identified as Lots 1 – 9 in DP 24018 and Lots 3 and 4 DP 1032962, in the Parish of St. George and the County of Cumberland. The site comprises the following street addresses:

- 78, 80 – 84, 86 – 92, 94 - 96 Arncliffe Street, Arncliffe;
- 45 - 53 Princes Highway, Arncliffe.

The site is bounded by Arncliffe Street to the north, the Princes Highway to the south, Brodie Spark Drive to the east and Suttons Holden Car dealership to the west (see Site Drawing, Appendix A). The local government authority is Rockdale City Council.

The site covers an approximately trapezoidal area of 1.25 ha. Levels are variable across the site. There is a dip of approximately 3 m along the Arncliffe Street frontage in a southerly direction, however, this may have been altered by levelling works during the construction of the buildings observed on site. There is also a slight dip of 0.5 m, from a levelled strip of land running in an east-west direction in the central part of the site towards the Princes Highway and a dip along the frontage to the Princes Highway, in a northerly direction of about 0.5 m.

The site was first inspected in May, 2005, and later on 14 July 2008 with respect to Lots 3 and 4, DP1032962. The following observations were made based on these inspections:

Lots 1 – 9 D.P. 24018

Lot 1 – This lot is occupied by a precast concrete panel warehouse and office. A concrete slab covers the entire base of the warehouse and office. Paragon Cosmetics (a small cosmetics warehouse and packaging facility) presently occupy these premises. A concrete sump pit, with dimensions of approximately 1 m by 1 m by 0.5 m deep, at the rear (eastern) side of Lot 1 was used for the disposal of the chemical by-products produced from the printing process. At the time of the site inspection the area around the sump was covered with rubbish, therefore preventing inspection of the sump.

Lots 2 and 3 – These lots are predominantly occupied by a steel fabricated building. A concrete slab covers the entire base of the building and office. Banksia Smash Repairs (auto repair and panel beating) currently occupies these premises. A spray painting booth was located inside the building. Between Lots 1 and 2 there is a 6.5 m wide concrete covered laneway which services both Banksia Smash Repairs and Paragon Cosmetics. It is also understood that there may have been an UST within this laneway that was apparently not removed. Two dip/fill points in the ground and a vent pipe were noted in this area and the approximate outline of the tank was marked out with spray paint (by others, unknown).

Lots 4, 5 and 6 – These lots are occupied by a steel fabricated split level warehouse. A concrete slab covers the entire base of the warehouse building and office areas on this site. Lot 4 is currently vacant (some cars are stored here from the adjacent smash repairs). Lot 5 is currently used by a tyre supply business. Legion Cabs presently occupy Lot 6 and use the warehouse for taxi fit-outs.

Lots 7 & 8 – These lots comprise a gravel yard, an office building, two metal sheds and a washbay. Park 'n' Fly (a business providing car parking) presently occupies the premises and uses the open areas for vehicle parking. The site was mostly filled with cars.

Lot 9 – This lot is occupied by an office building and a 't'-shaped steel building with flexible and concrete pavements servicing the office at the front of the property and providing access to the rear buildings on both the eastern and western boundaries. E R McNamara Smash Repairs (an auto repair shop providing mechanical repairs, panel beating and detailing) presently occupy this site. Lot 9 is an old service station and underground tanks are understood to be located in the south-west corner of the lot. During site inspections dip/fill points were noted, however, no vent pipes were observed. It is understood that the tanks are still in the ground. The approximate location of the tanks was marked out in blue spray paint (by others, unknown). Discussion with the current tenant indicated that there was also at least one suspected underground diesel/oil tank located close to the western boundary of the site in the laneway outside the building. Some irregularities in the bitumen surface were noted in this area, including a cap structure in the concreted portion under the small awning, which further suggests the presence of another UST in this area.

Lots 3 and 4 D.P. 1032962

Lot 3 – This lot comprised a vacant bitumen surfaced yard with a small awning structure in the southwest of the lot.

Lot 4 – This lot comprised a vacant concrete yard with a one storey brick building in the northwest corner of the lot. A few cars were parked in the yard, which appear to be an overflow from the adjacent business.

5.2 Site History

Available site history records/information were provided in the June 2005 report, the findings of which are summarised below. Additional pertinent information was collected later and reviewed for the preparation of this RAP. The additional information included historical title deeds and dangerous good licences, summaries of which are also included below.

5.2.1 Summary of History from June 2005 Report

Aerial photography and anecdotal information indicated that the site comprised a rural property estate in 1930. A water channel was visible through the site along the southern portion of the site at this time. The site was developed for industrial use by the early 1950s with three industrial buildings and possible plant visible in the 1951 photograph. The water channel appeared to have been filled in around 1986, associated with the construction of industrial development in the south of the site. The growth of industry (with more buildings) continued at the site until the present day.

Refer to Appendix B for a copy of aerial photographs from the previous report (DP June 2005).

5.2.2 Title Deeds

A historical title deeds search was obtained to provide ownership or occupancy information, including company names and the occupations of individuals, as applicable. The title information can assist in the identification of previous land uses and thus can give an indication of potentially contaminating activities, if any.

A summary of the records with the owner/occupier details and possible site uses are presented in Table 1. The full title deed records (including a cadastral plan) are included in Appendix C. Probable site uses were inferred from the occupation of the owner/occupier and, where applicable, from other historical information as outlined in other sections in this report.

Table 1 - Summary of Title Deeds Search

Date	Owner/Occupier	Probable Site Use
Lots 1 – 9 DP 24018 & Lot 3 & 4 DP 1032962 (Entire site)		
23/2/1891	Frederick Charles Willich (23/2/1891) Margaret Willich (17/7/1913)	Rural
1/12/1922	Harry Percival Cordukes	Rural
10/9/1929	Alexander Wyndham Cordukes (10/9/1929) Harold James Piper Hannah Cordukes (13/10/1945)	Rural
25/10/1947	Arthur John Glasson (Brass Moulder)	Industrial
Lot 1 DP 24018		
22/5/1952	Nellie Gladys Glasson	Industrial – brass moulding foundry
27/5/1980	Arthur John Glasson James Fulton Yeomans	Industrial – brass moulding foundry
7/7/1980	# Shirley Beryl Greening # Raymond Keith Glasson # John Arthur Glasson	Industrial – brass moulding foundry
Lots 2 & 3 DP 24018		
21/6/1968	# S.R.J. Pty Limited	Industrial
Lots 4 & 5 DP 24018		
11/5/1973	# E.J. Atkins Cranes Pty Limited	Industrial
Lot 6 DP 24018		
10/12/1976	# Raymond Keith Glasson	Industrial – brass moulding foundry
Lots 7, 8 & 9 DP 24018		
22/5/1952	Nellie Gladys Glasson	Industrial – brass moulding foundry
31/8/1959	# S.R.J. Pty Limited	Industrial
Lot 3 DP 1032962		
5/10/1951	Hastings Deering Building Limited	Industrial
14/9/1953	Youngs Car Sales Pty Limited	Industrial – Car dealership
8/5/1957	A.C.A. Engineering Pty Limited	Industrial – Manufacturing of automation/control systems
27/9/1974	Berenice Elsa Scott Doreen Rose Scott Florence May Roberts	Industrial
20/1/1983	# Antonios Kontellis (Car salesman) # Giassimo Kontellis	Industrial – Car dealership

Date	Owner/Occupier	Probable Site Use
Lot 4 DP 1032962		
2/2/1950	Metham's Motors Pty Limited	Industrial – Car sales/repairs
28/2/1951	Hastings Deering Building Limited	Industrial
14/9/1953	Youngs Car Sales Pty Limited	Industrial – Car dealership
26/4/1956	Shell Company of Australia Limited	Industrial/Service Station
22/7/1964	Chalcraft Press Pty Limited	Industrial
21/7/1971	Bruce Menzies	Industrial
1/2/1973	Trevor Brian Dollimore (Motor Dealer) Fay Myra Dollimore	Industrial – Car dealership
22/10/1976	Antonio Curcuruto (Car Salesman) Francesca Maria Conceta Curcuruto Antonios Kontellis (Car Salesman) Giassimo Kontellis	Industrial – Car dealership
7/12/1977	# Antonios Kontellis (Car Salesman) # Giassimo Kontellis	Industrial – Car dealership

Current registered proprietors of the land.

The site appears to have operated as rural land from at least 1891 to approximately 1947, after which time the land use changed to industrial. Lots 1 – 5 DP 24018 were developed with industrial buildings of unknown use, presumably used for warehouses/packaging/brass foundry businesses. It is understood that Lot 1 operated as a printing press. A brass foundry was built on Lot 6 circa 1950 – 1960 (based on signage on present building, verbal anecdotal evidence and occupation of owners as brass moulder) although the brass moulding plant could have covered a wider area at one stage (based on the land title records). A service station was built on Lot 9 and operated until circa 1999. Lot 3 D.P. 1032962 was probably developed as a car dealership in the early 1950s and then for manufacturing (possibly) and then back to a car dealership in the early to mid 1980s. Lot 4 D.P. 1032962 was used as a car dealership in the early 1950s.

5.2.3 WorkCover NSW Records

A search of the WorkCover NSW Dangerous Goods Licences pertaining to the site revealed that an approximately 3,800L UST (Class 3 flammable liquids) was installed in the laneway between Lots 1 and 2 in 1972. Refer to Appendix C for a copy of the records. It is not clear if the tank has since been removed. Site observations, which noted the presence of dip/fill points and an adjoining vent pipe, suggest that the UST has not been removed.

No records were available for the former service station site.

5.3 Geology and Hydrogeology

Reference to the Sydney 1:100 000 Geological Series indicates that the site is underlain by alluvial and estuarine sediments of Quaternary age. These sediments generally comprise silty to peaty quartz sand, silt and clay which has ferruginuous and humic cementation in places and common shell layers. A small outcrop of Hawkesbury Sandstone of Tertiary age is recorded on the northern boundary of the site. On the eastern side of the Princes Highway, the geology is noted to be of Quaternary sediments associated with a “freshwater swamp” comprising “peat, sandy peat and mud.”

Field work for the previous assessment (DP June 2005) and the preliminary geotechnical investigation confirmed the presence of shallow Hawkesbury Sandstone on the northern site boundary and alluvial and estuarine sediments to variable depths across the remainder of the site. The placement of filling on site was also noted during this investigation.

Low lying topography and close proximity to the Cooks River and Wolli Creek suggests that free groundwater levels would be at a relatively shallow depth below natural ground levels on site. Field observations and monitoring of the piezometers on site in 2005 indicated groundwater levels vary between 0.2 and 1.2 m RL. It is believed that groundwater flow is generally in a north-east direction (towards the Cooks River). However, at the time of the investigation (2005) there was a possible drawdown effect in the vicinity of Bore 109 as a result of excavation works for new sewerage lines, which may have temporarily changed groundwater flow to a westerly direction towards Bore 109.

A review of the *Acid Sulphate Soils Risk Map* (Department of Environment and Climate Change, 2007), indicates that the site is located in an area of 'high probability or occurrence of ASS with the environment of deposition suitable for the formation of ASS materials' with the depth to ASS described as 'within 1 m' to '1-3 m below ground surface'. On this basis, it is considered that the likelihood of encountering acid sulphate soils at the site is high.

6. REMEDIATION GOALS, APPROACH AND ACCEPTANCE CRITERIA

6.1 Remediation Goals

Generally, the main objectives of the site assessment/remediation works are to ensure that the remediated site will be suitable for the proposed land use, and that the works will pose:-

- No unacceptable risk to human health; and
- No unacceptable risk to the environment.

In this regard the proposed works have been based upon a commercial land use by the proposed supermarket and, ultimately, further remediation may be required to make the site suitable for a combined commercial and residential use. An RAP for the second stage commercial and residential use remediation will be prepared separately and implemented at the appropriate time.

6.2 Remediation Approach

The remediation approach proposed by DP comprises the active remediation of site soils where they do not meet the RAC *and* also have the potential to migrate to the groundwater. Where contamination has been identified and it can be shown that, for the Stage 1 development, there is no potential to impact the groundwater and the contamination is not volatile, it is proposed that the site soils are managed by a Cap and Contain strategy. This results in contamination remaining on site beneath a surface cap which would isolate the contamination and, therefore, there would be no complete pathway between the site users and the residual contamination. The capping material would include imported clean fill to

raise site levels above the flood level (virgin excavated natural material [VENM]) and the floor slab of the buildings. In the loading dock the cap would be the VENM fill and the road pavement. In the car park, where there would be less imported fill, the cap would be formed mostly by the road pavement. The implementation of a Cap and Contain strategy would need to be agreed to by the consent authority in accordance with DECCW guidelines. The site would also be subject to ongoing management to maintain the integrity of the capping system and this would be achieved through an Environmental Management Plan (EMP). The existence of the EMP would be recorded on the title of the property or through a Section 88b instrument and also recorded on the S 149 planning certificate.

6.3 Remediation Acceptance Criteria

6.3.1 Soils/filling

On the basis of the proposed commercial development the relevant soils assessment criteria include:-

- NSW DEC (2006) publication *Guidelines for the NSW Site Auditor Scheme,* Appendix II, Soil Investigation Levels for Urban Development Sites in NSW, Health-Based Investigation Levels (HIL) for commercial or industrial use (Column 4 health-based investigation levels [HIL]);
- NSW EPA (1994) Contaminated Sites *Guidelines for Assessing Service Station Sites,* Threshold Concentration for Sensitive Site Landuse (for the entire range of TPH/BTEX in the absence of other, comprehensive, Department of Environment, Climate Change and Water [DECCW]endorsed guidelines). The threshold concentrations will be used in conjunction with the HIL (DEC 2006, Column 4) TPH speciation for medium to long chain TPH.

The adopted remediation acceptance criteria (RAC) for the site are provided in Table 2. Materials remaining on site and imported fill materials are required to comply with the following RAC. Site soils not complying with the RAC will need to be Capped and Contained as discussed in Section 8. Any bulk filling material imported onto the site will need to be verified as virgin excavated natural material (VENM) and to meet the RAC. The Provisional Phytotoxicity-Based Investigation Levels (PPIL) for sandy loams contained in *Guidelines for the NSW Site Auditor Scheme* will not apply for a commercial site.

Table 2 - Site Remediation Acceptance Criteria for Soil

Contaminant	Adopted Criteria (RAC) mg/kg	Source Document
TPH		NSW EPA *Guidelines for Assessing Service Station Sites* (1994) threshold concentrations for sensitive land use soils. The NSW DECC Contaminated Sites *Guidelines for the NSW Site Auditor Scheme* (2nd edition) (2006) Appendix II, Soil Investigation Levels for Urban Redevelopment Sites in NSW, Heath-based investigation levels for commercial sites (HIL Column 4) have also been referenced for the aromatic and aliphatic fractions of the medium to heavy portions of TPH.
$C_6 – C_9$	65	
$C_{10} – C_{36}$	1000	
$>C_{16} – C_{35}$ (aromatics)	450	
$> C_{16} – C_{35}$	28,000	
$> C_{35}$ (aliphatics)	280,000	
BTEX		
Benzene	1	
Toluene	130[b]	
Ethylbenzene	50[c]	
Xylene	25[c]	
Metals	*HIL*	NSW DEC Contaminated Sites *Guidelines for the NSW Site Auditor Scheme* (2nd edition) (2006) Appendix II, Soil Investigation Levels for Urban Redevelopment Sites in NSW, Heath-based investigation levels for commercial sites (HIL). .
arsenic (total)	500	
cadmium	100	
chromium	60000	
copper	5000	
lead	1500	
mercury	75	
nickel	3000	
zinc	35000	
Total Phenols	42500	
PAH		
total	100	
benzo(a)pyrene	5	
PCB	50	
OCP		
aldrin + dieldrin	50	
chlordane	250	
DDT (including DDD, DDE, DDT)	1000	
heptachlor	50	
Asbestos	No visible asbestos present in soil at the surface. 0.001% asbestos fibres or 0.01% asbestos-cement present	WA Department of Health *Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia, May 2009*

b threshold levels based on human health and ecological protection. Full details provided in referenced guideline
c threshold levels based on human health protection. Full details provided in referenced guideline

Conformance with the RAC will be attained when;

- either all validation samples meet the specified RAC value, or,
- when the 95% upper confidence limit (95% UCL) of average concentration for each contaminant in the remediated materials is below the RAC, and
- no individual exceedance is greater than 2.5 times the RAC.

6.3.2 Groundwater

Generally no elevated levels of potential contaminants were identified in groundwater at the site in the previous assessment (DP June 2005), with the exception of zinc which exceeded the *ANZECC (2000) Australian Water Quality Guidelines* trigger value for the 95% Level of Protection (LOP) for marine water. However, it was considered that as Bore 101 is an up-gradient bore and that the levels of concentrations of zinc in both the soils and the groundwater of down-gradient bores are low, the contamination was unlikely to be sourced from the subject site and thus there are no significant "site-derived" impacts on surface water and groundwater quality. Notwithstanding this, however, and noting the time lapse since the previous assessment, it is considered that further groundwater assessment is warranted, in particular to assess the potential impacts of the USTs and other AECs (e.g. washbays) on the groundwater and also for the potential migration off site.

The GILs have been sourced from the *Guidelines for Fresh and Marine Water Quality* ANZECC (2000) for the protection of 95% LOP of species for marine environments or for freshwater environments where a marine criterion is not available.

In the absence of an ANZECC (2000) guideline for ethylbenzene and toluene, the NSW EPA *Guidelines for Assessing Service Station Sites (*1994) GILs have been adopted.

The *Airports Act*, Airport (Environment Protection) Regulations (1997) guidelines have been adopted as screening criteria due to the absence of high reliability NSW EPA or ANZECC (2000), guidelines for TPH in groundwater. The adopted threshold concentrations are given in Table 3 for the contaminants of concern.

Table 3 – Groundwater Investigation Levels (GIL) and Rationale

Contaminant	Adopted Criteria (GIL) µg/L	Rationale
Metals Arsenic (III) Cadmium Chromium (III) Copper Lead Mercury Nickel Zinc	 24 5.5 27.4 1.3 4.4 0.4 70 15	*ANZECC (2000) Australian Water Quality Guidelines for the protection of 95% of marine species* * Trigger values for freshwater (95% protection of species) are given in the absence of reliable trigger values for marine water species
TPH $C_6 – C_9$ $>C_9$	 150 600	Airport (Environment Protection) Regulations (1997), Schedule 2 Water Pollution Accepted Limits: Table 1.03 – Accepted limits of contamination [adopted due to the absence of high reliability NSW EPA or ANZECC guidelines for TPH]*
BTEX Benzene Toluene Ethylbenzene Xylene	 700 300 140 550*	*ANZECC (2000) Australian Water Quality Guidelines for the protection of 95% of marine water species* have been adopted for benzene NSW EPA[1] Contaminated Sites *Guidelines for Assessing Service Station Sites* (1994) *Threshold concentrations for waters, Protection of Aquatic Ecosystems* is adopted in the absence of other comprehensive investigation levels for toluene, ethyl benzene or xylene in groundwater. * Trigger values for freshwater are given in the absence of reliable trigger values for marine water species
PAH Total Benzo(a)pyrene Naphthalene	 Not specified Not specified 70	*ANZECC (2000) Australian Water Quality Guidelines for the protection of 95% of marine water species* * Trigger values for freshwater are given in the absence of reliable trigger values for marine water species
OCP Chlordane DDT Endosulfan Endrin Heptaclor	 0.08* 0.01* 0.01 0.008 0.09*	
PCB Total Aroclor 1242 Aroclor 1254	 Not specified 0.6* 0.03*	
Phenols	400	
Iron (Filterable)	300	*ANZECC (2000) Interim Working Level*

* Other than a 'low reliability' final chronic value of 7 µg/L for petroleum hydrocarbon. This threshold was not adopted as detection limits in the order of 7 µg/L are not routinely achievable by NATA accredited laboratories.

[1] NSW EPA is now part of the NSW Department of Environment and Climate Change (DECC).

7. FURTHER SAMPLING AND ANALYSIS

The following works, as a minimum, will be carried out prior to site demolition. The works will establish the extent of the remediation required.

- Conduct systematic sampling from at least 23 sampling locations, positioned in a grid based pattern across the subject site, including at least three (3) samples from Lots 3 and 4 DP 1032962, plus additional sampling locations targeting the identified (areas of environmental concern (AECs) as listed in Table 4, below;
- Install four (4) piezometers to supplement the existing piezometers and to confirm the groundwater quality. Sample from the four new piezometers and the three originally installed. If the original (2005) piezometers are not extant then new replacement wells should be installed;
- Conduct judgemental sampling, including: excavation/drilling of a number of test pits/trenches/bores to a nominal depth of 4 m at the former service station and in other locations identified as potentially containing a UST(s).
- Inspection for signs of USTs in other areas;
- Sampling at other locations where signs of chemical contamination are noted and analysis for the contaminant/s of concern.

Prior to remedial works the buildings and concrete slabs/pavements will need to be demolished/removed (including removal of asbestos-containing building materials by an AS2 licensed contractor or, if friable, an AS1 licensed contractor). It is recommended that a Hazardous Building Materials report is prepared prior to demolition. These works are not specifically covered by this RAP.

The identified areas of environmental concern are summarised in Table 4 together with the potential contaminants associated with each AEC. The locations of the AEC are shown in Drawing 1, Appendix A.

Table 4 – Summary of Identified AEC

AEC No.	Description	Contaminants of Potential Concern	Location
1	Concrete sump pit and associated pipelines	TPH/BTEX, chromium, cyanide	Lot 1, south-eastern end
2	Possible UST (~4000 L)	TPH/BTEX, PAH, lead, phenols	Laneway between Lots 1 & 2
3	Spray painting booths	Heavy metals, TPH/ BTEX, VOC	Lots 2/3 and Lot 9
4	Smash repairs businesses (spills of oils/degreasers)	Heavy metals, TPH/ BTEX, PAH, VOC	Lots 2/3, Lot 9
5	Former brass foundry	Heavy metals, TPH/ BTEX, PAH, phenols, VOC	Lot 6
6	Wash bay	Heavy metals, hydrocarbons, PAH	Lot 7, north-eastern corner
7	Former service station (USTs, bowser points, pipe trenches, oil tanks, hydraulic hoists etc)	Heavy metals, TPH/BTEX, PAH, phenols	Lot 9, southern corner and along western boundary
8	General fill across the site	Heavy metals, TPH/ BTEX, PAH, phenols, asbestos, OCP, VOC	All Lots

Notes:
Heavy metals - As, Cd, Cr, Cu, Pb, Hg, Ni, Zn
TPH - Total Petroleum Hydrocarbons
BTEX - Benzene, Toluene, Ethyl benzene, Xylene
PAH - Polycyclic Aromatic Hydrocarbons
VOC - Volatile Organic Compounds

In general additional soil samples will be analysed for a combination of the following analytes;

- Heavy metals - As, Cd, Cr, Cu, Pb, Hg, Ni, Zn;
- TPH - Total Petroleum Hydrocarbons;
- BTEX - Benzene, Toluene, Ethyl benzene, Xylene;
- PAH - Polycyclic Aromatic Hydrocarbons;
- VOC - Volatile Organic Compounds;
- PCB Polychlorinated Biphenyl;
- OCP Organochlorine pesticides;
- Total phenol;
- Asbestos

Groundwater samples will be analysed for the following analytes;

- Heavy metals - As, Cd, Cr, Cu, Pb, Hg, Ni, Zn;
- TPH - Total Petroleum Hydrocarbons;

- BTEX - Benzene, Toluene, Ethyl benzene, Xylene;
- PAH - Polycyclic Aromatic Hydrocarbons;
- VOC - Volatile Organic Compounds;
- OCP Organochlorine pesticides;
- Total phenol;
- Hardness;
- pH.

8. REMEDIAL WORKS

The extent of remedial works will depend on a number of factors, including;

- The results of the additional sampling programme outlined in Section 7, above;
- The nature of the contamination, particularly, the volatile nature of the contaminant, the potential for the contaminant to migrate and the overall suitability of the contamination to be capped;
- The extent to which the contaminated soil has to be removed for construction purposes.

On the basis of the current data only limited remediation is required for a commercial land use, however, it is anticipated that this will change following the collection of additional data.

8.1 Asbestos

Asbestos has previously been identified in Bore 109 in a sample taken at 1.2 – 1.4 m bgl. Asbestos can be retained on site and capped and managed in accordance with the proposed strategy. Further planned investigations may identify asbestos at other locations. If the asbestos contaminated soil at Bore 109 or other locations, as identified, is not suitable to remain on site for construction purposes then the following works will be required;

a. The affected area will be closed off by the use of barrier tape and warning signs. Warning signs shall be specific to Asbestos Hazards and shall comply with the Australian Standard 1319-1994 – *Safety Signs for the Occupational Environment*;

b. Work shall comply with WorkCover requirements including *Working with Asbestos*, *2008*;

c. An Occupational Hygienist is to inspect the area and confirm the presence of asbestos and determine whether the asbestos is classified as friable or bonded asbestos and determine the extent of remediation works to be undertaken. A report detailing this information will be compiled by the Occupational Hygienist and provided to the Principal (or their representative) and the site manager;

d. The impacted soil will be classified and disposed of, as a minimum, as Special Waste (Asbestos) at an appropriately licensed facility. In dry and windy conditions the stockpile will be kept lightly wetted and may be covered with plastic sheet whilst awaiting disposal;

e. All work associated with asbestos in soil will be undertaken by a contractor holding a class AS-1 Licence for friable asbestos or AS2 Licence for bonded asbestos, as appropriate. WorkCover must be notified 7 days in advance of any asbestos works;

f. Monitoring for airborne asbestos fibres, if removal of friable asbestos is involved, is to be carried out during the soil excavation in asbestos contaminated materials or if recommended by Occupational Hygienist;

g. Documentary evidence (weighbridge dockets) of correct disposal is to be provided to the Principal (or their representative);

h. At the completion of the excavation, a clearance inspection is to be carried out, soil samples taken and analysed for asbestos fibres followed by written advice provided by an Occupational Hygienist that the area is safe to be accessed and worked (with respect to asbestos impact) or that there is residual asbestos impacted soil .

i. The filling material remaining may still contain asbestos which will be capped. Appropriate precautions will be undertaken to make the area safe whilst working in this area. This may include covering or sealing by an appropriate physical barrier layer of non-asbestos containing material, with the inspected area clearly demarcated with an appropriate marker, barricades and signage etc;

j. Details are to be recorded in the site record system;

k. Following advice by an Occupational Hygienist, the area may be reopened for further excavation or construction work.

8.2 Concrete Sump Pit

The soil around the concrete sump pit in Lot 1 was tested in the June 2005 assessment and was found to contain high TPH concentrations, and, therefore, was considered to be contaminated. It is proposed that the concrete lined pit is removed and the associated filling and drainage lines are removed and the resultant pit and excavation validated, as follows:

a. Remove and dispose of the structure, contents and associated pipe-work by a qualified contractor;

b. Excavate and stockpile impacted materials (based on field observations) for treatment/classification;

c. Validation of the remedial pit and excavated drainage lines by a qualified environmental consultant for the contaminants of concern at the sampling density specified in S. 11;

d. As required, 'Chase out' contaminated materials remaining in the remedial based on validation results and further validation sampling and analysis as required to assess appropriate removal of impacted materials;

e. Treatment, waste classification and off-site disposal of impacted materials in accordance with Section 10. Given that the materials within the pit were provisionally classified as Hazardous Waste in the DP June 2005 Report under the now superseded waste classification guidelines, the NSW DECC *Environmental Guidelines: Assessment Classification and Management of Liquid and Non-Liquid Wastes* (1999), it is anticipated that the materials will require treatment prior to disposal. It is understood that the client prefers the treatment to be conducted on site, prior to disposal. The proposed methodology for the treatment is given in Section 10.1. Please not the practicality of the treatment method should be checked and verified via field trials;

f. Inclusion of validation, waste classification and disposal documents (including landfill dockets and destruction certificates in the case of USTs) in the validation report.

8.3 UST Pits

Based on site history information and site observations, USTs will be required to be removed from the site. Such structures and any associated pipe work should be managed/removed as follows:

a. Upon identification of the UST or pipework, the site foreman is to be notified and the area barricaded;

b. Visual checking of the tank and associated pipe-work for signs of concern;

c. removal of any liquids from the UST and disposal off site (by a licensed liquid waste contractor);

d. Remove and dispose of the structure and associated pipe-work by a qualified contractor. The tanks must be removed in accordance with Australian Institute of Petroleum (AIP) Code of Practice and/or AS 4976-2008;

e. Excavate and stockpile impacted materials (based on field observations) for treatment/classification;

f. Validation of the remedial pit and drainage lines by a qualified environmental consultant for the contaminants of concern at the sampling density specified in S. 11.

g. 'Chase out' materials, as required, in the remediation pit identified to be contaminated, and further validation sampling and analysis as required to assess appropriate removal of impacted materials;

h. Treatment, waste classification and off-site disposal of impacted materials, as per Section 10.2;

i. Inclusion of validation, waste classification and disposal documents (including landfill dockets and destruction certificates in the case of USTs) in the validation report.

8.4 Other AECs Requiring Excavation

a. Excavate and stockpile impacted materials (initially based on field observations) for treatment/classification;

b. Validation of the remedial pit and drainage lines by a qualified environmental consultant for the contaminants of concern at the sampling density specified in S. 12.

c. 'Chase out' as required of "residual" materials in the remediation pit identified to be contaminated, and further validation sampling and analysis as required to assess appropriate removal of impacted materials;

d. Treatment, waste classification and off-site disposal of impacted materials in accordance with Section 10.2;

e. Inclusion of validation, waste classification and disposal documents (including landfill dockets and destruction certificates in the case of USTs) in the validation report.

8.5 Unexpected Finds

During any excavation works taking place on the site may uncover soil, materials or structures that are unexpected and which may appear to be contaminated because of odours and visual impacts or they may contain liquids or soils that have not previously been identified. In this event the affected work area shall be cordoned off by suitable barricades and the environmental consultant will make an inspection. Samples may be taken to assess the nature of the contamination and the area will remain fenced off until the environmental consultant provides advice on the proposed course of action and the extent of remedial works, if any.

9. ACID SULPHATE SOILS MANAGEMENT PLAN

Based on findings of the previous assessment, potential acid sulphate soils (PASS) may be present below the water table (approximately 1.5 - 2.0 m below ground level). In particular, such materials include the dark grey (black) sandy clay, the light grey sandy clay and the dark grey silty clay noted in the previous assessment. Moreover, in reference to the *Acid Sulphate Soils Risk Map* (Department of Environment and Climate Change, 2007), the site is located in an area of 'high probability or occurrence of ASS with the environment of deposition suitable for the formation of ASS materials' with the depth to ASS described as 'within 1 m' to '1-3 m below ground surface'. On the basis that much of the site will be raised in level, it is considered that the likelihood of encountering acid sulphate soils at the site is not high except in remedial pits. However, the extent and depth of the proposed excavations is not known and, therefore, there may be a potential for PASS to be disturbed. Therefore, an appropriate ASSMP has been prepared to minimise the risk posed by such excavation. When PASS/ASS materials are encountered, the following procedures are recommended:

- Separation of the PASS/ASS from non-ASS materials;
- Placement of the identified PASS/ASS in an appropriately bunded area (or skip) to prevent discharge of acid to the environment and treatment with lime (liming rates are presented in Appendix D). As a further safeguard, the base of the lime treatment area should be lined with 100 mm of aglime;
- Additional analysis of suspected acid sulphate soils for SPOCAS and chromium reducible sulphur tests to confirm presence of PASS and/or ASS and to refine liming rates;
- Management of leachate, including prevention of acidic discharge to the environment and treatment with a neutralising agent, if necessary, based on field pH results;
- Separate transport and disposal of the lime treated ASS waste to an appropriately licensed waste facility. As a minimum, lime treated ASS should be disposed of at a DECCW licensed General Solid Waste Landfill (subject to the final waste classification of the waste, the landfill category may be further upgraded).

The methodology for lime treatment (if required) is presented in Appendices D - F.

10. WASTE CLASSIFICATION AND SPOIL MANAGEMENT PLAN

Excavated spoil to be disposed off site will be classified, managed and disposed in accordance with the *Protection of the Environment Operations (POEO) Act* 1997. With respect to classification this requires materials to be classified in accordance with the NSW Department of Environment and Climate Change (DECC) *Waste Classification Guidelines* (April 2008).

10.1 Concrete Sump Pit

The materials within the concrete lined pit in Lot 1 (in the vicinity of Bore 101/A) were classified as Hazardous Waste in the DP June 2005 Report under the now superseded waste classification guidelines, the NSW DECC *Environmental Guidelines: Assessment Classification and Management of Liquid and Non-Liquid Wastes* (1999). It is recommended that the pit soils are excavated and the waste classification of the material determined through *ex situ* assessment prior to disposal. On-site treatment, if required, is understood to be the client's preferred option. The soil will be laid out in a covered (roofed) area with, impermeable or lined surface and bunded using hay bales wrapped in geotextile fabric to prevent migration outside the bund.

Total petroleum hydrocarbons are anticipated to be the main contaminants of concern in the pit and surrounding soils. It is therefore considered that bioremediation and volatilisation of TPH products, facilitated by the regular turning of the soil, may result in reduced contaminant concentrations, with the aim of reducing the classification to General Solid Waste (non-putrescible). In addition to regular turning and aeration of the soil, the application of a biodegradation product, such as BioSolve, may be necessary in reducing the TPH concentration to General Solid Waste concentrations. The progress and effectiveness of the bioremediation process should verified by field checks and regularly monitored and checked, as the process would require an extended period.

10.2 Materials Requiring Classification

Soils to be disposed off site will require to be classified according to the DECCW waste guidelines.

Based on the preliminary findings (DP 2005), it is anticipated that the main contaminants that are likely to exceed the RAC are TPH, BTEX (especially around any USTs) and asbestos. The contaminated soil will be stockpiled on an impermeable or lined surface and bunded using hay bales wrapped in geotextile fabric to prevent migration outside the bund. Preliminary analysis can be conducted to assess whether the contaminants are within the General Solid Waste classification. If the TPH and/or BTEX exceed this classification the impacted soil will be turned regularly using a small backhoe to allow the bioremediation and volatilisation of TPH and any related BTEX products with the aim to reduce these contaminant concentrations, if necessary, to a lower waste classification (of General Solid Waste). If the stockpiled material (assumed to be impacted by volatile hydrocarbons only) is aerated by turning regularly (say daily), sampling and testing for the contaminants of concern can be undertaken after, say, a few weeks (depending on final volumes and weather conditions) to obtain a waste classification for disposal purposes. The process will be repeated as necessary if the TPH fractions remain high.

It is noted that the previous assessment found that all material below the water table (approximately 1.5 - 2.0 m below ground level), in particular, the dark grey (black) sandy clay, the light grey sandy clay and the dark grey silty clay should be assumed to be PASS, and thus be subject to an Acid Sulphate Soil Management Plan. It should be noted that for the purposes of off-site disposal the lowest waste classification available for (treated) PASS is General Solid Waste.

10.3 Spoil Contingency Plan

Any materials which fail to meet the DECCW criteria for direct landfill disposal (e.g. if materials from concrete sump pit are classified as Hazardous Waste following *ex situ* re-assessment) following initial classification testing will require to be segregated and securely stockpiled pending further testing and treatment. The contingency plan to cater for the

storage, treatment and disposal of excavated spoil which fails to meet landfill criteria is as follows:-

- On the basis of on-site observations and the contaminant exceedances detected, materials will be carefully excavated, segregated and placed in well delineated locations. All stockpiles of contaminated material shall be surrounded by star pickets and marking tape or other suitable material to clearly delineate their boundaries.;
- Stockpiles of excavated materials will be appropriately bunded with hay bales/ sandbags and if required covered and/ or lined with impermeable plastic sheeting. Any stockpile to remain on-site overnight should be adequately secured in order to reduce the risk of sediment run-off;
- Sampling and analysis at a rate of up to 1 sample per 250 m^3 (25 m^3 – 250 m^3, or a minimum of 3 samples) of segregated stockpiles will be conducted to determine the concentration of the target contaminant parameters in the excavated materials;
- Disposal arrangements will be determined based on sampling results as follows:-
  - material which meets the DECCW threshold criteria for disposal as Special Waste (Asbestos), General Solid Waste or Restricted Solid Waste (including appropriate use of relevant DECCW Approvals for the immobilisation of waste) shall be disposed directly to landfill;
  - material which exceeds the disposal guideline levels for Restricted Solid Waste (i.e. formerly Hazardous Waste) shall remain segregated in stockpiles pending treatment/ alternate disposal arrangements.
- Stockpiled materials which cannot be landfilled directly i.e. those requiring further assessment or treatment, will be covered by anchored plastic sheet or geotextile to prevent erosion and wind blow of contaminated materials. Materials considered to have the potential to produce contaminated leachate will be stockpiled in an area with an appropriate leachate collection system or in a covered (roofed) environment;
- Materials which require treatment will be suitably tested to establish if they can be effectively bio-remediated or encapsulated/chemically stabilised in accordance with DECCW's requirements. Materials treated in this manner must be TCLP tested to ensure they meet the appropriate leaching criteria prior to disposal;

- Agreement as to the appropriateness of the treatment and disposal method for materials exceeding the leaching guidelines must be obtained from the NSW DECCW, and a disposal consent must be sought from the Hazardous Waste Regulation Unit of the DECCW prior to the removal of such wastes from the site.

Additional measures will also need to be taken for the storage and treatment of materials classified as PASS as per Section 9.

10.4 Loading and Transport of Contaminated Material

Transport of all material to and from the site shall be via a clearly delineated, pre-defined haul route.

Removal of waste materials from the site shall only be carried out by a licensed contractor holding the appropriate licence, consent or approvals as required by the *Protection of the Environment Operations (POEO) Act* 1997 and with the appropriate approvals obtained from the NSW DECCW, if required.

Details of all contaminated and spoil materials removed from the site (including VENM) shall be documented by the contractor with copies of weighbridge slips, trip tickets and consignment disposal confirmation (where appropriate) provided to the Environmental Consultant and the Principal's Representative (PR). A site log shall be maintained by the PR to track disposed loads against on-site origin, location of the materials and sample numbers.

Truck dispatch shall be logged and recorded by the contractor for each load leaving the site. A record of the truck dispatch will be provided to the PR.

10.5 Disposal of Material

All materials removed from the site shall be disposed to a location legally allowed to receive them in accordance with the *Protection of the Environment Operations (POEO) Act* 1997. Copies of all necessary approvals from the necessary landfills shall be given to the PR prior to any contaminated material being removed from the site.

Copies of all consignment notes for the transport, receipt and disposal of all materials (including VENM) will also be maintained as part of the site log and made available to the Environmental Consultant for inspection and reporting purposes upon request. This information will include the on-site source of the materials and the disposal location and tonnages (weigh bridge dockets).

All relevant analysis results shall be made available to the contractor and receiving site/ waste facility to enable selection of a suitable disposal location. Holding arrangements, treatment and disposal requirements for excavated materials which fail to meet the landfill disposal guideline levels for moderately contaminated fill are discussed in Section 10.3.

11. VALIDATION PLAN

The validation strategy has been devised broadly on the basis of the following documents:

- NSW DEC *Guidelines for the NSW Site Auditor Scheme 2nd edition* (2006)
- NSW EPA (1995)*: Sampling Design Guidelines* (with respect to the sampling density);
- NSW EPA (1994)*: Guidelines for Assessing Service Station Sites* (with respect to TPH contamination).

11.1 Frequency of Validation Samples

i) Site Validation Sampling Across General Site Area

Soil

Samples will be collected at the following frequency:

- 23 locations in Lots 1-9 DP 24018 and Lots 3 and 4 DP 1032962, placed generally in a grid based pattern to provide appropriate coverage and some targeted locations;
- At least one (1) sampling location placed in the AEC or as otherwise specified.

Soil samples will be analysed for the following:

- Every sample will be analysed for the contaminants of prime concern (heavy metals, TPH/BTEX, VOC, PAH);
- Every third sample will be analysed for other contaminants of potential concern (phenol, PCB, OCP);
- On the basis that asbestos previously been identified at the site at one location (Bore 109), every second filling sample will be analysed for asbestos. However, if significant amounts of building rubble are observed in the filling during excavation then the sampling density will be increased to every sample;
- analysis of specific samples for any identified additional contaminants of concern. Potential for concern will be based on visual and olfactory observations, PID results and proximity to potential sources;
- analysis of selected samples for TCLP analysis based on total concentration results, including a range of levels elevated above the screening (CT) criteria and targeting the most elevated results;
- QA/QC sampling and analysis as per S 11.4.

Groundwater

- Four additional groundwater wells (to the previous DP June 2005 investigation) will be installed to target areas down-gradient to the UST and other pertinent AECs, and to provide site coverage. Drawing 1, Appendix A shows the proposed, preliminary locations of the groundwater wells.
- One groundwater sample from each new groundwater well and one sample from each of the three existing bores, Bores 101, 104 and 109 from the DP June 2005 assessment (i.e. seven in total) will be analysed for the following analytes:
  - Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn);
  - Total Petroleum Hydrocarbons;
  - Monocyclic aromatic hydrocarbons (benzene, toluene, ethylbenzene and xylene);
  - Volatile organic compounds ;
  - Organochlorine pesticides
  - pH and Hardness;
  - QA/QC sampling as per S 11.4.

ii) Remedial excavations

Asbestos

Samples will be collected from remedial excavations at the following frequency, if required:

- BASE OF EXCAVATION – approximately 1 sample nominal 10 m x 10 m grid (minimum 1 sample per excavation base) from exposed surface for up to 500 m. Sampling Design Guidelines for larger areas;
- SIDE OF EXCAVATIONS - 1 sample per 10-20 linear metre depending on size of excavation and 2-3 m depth intervals (minimum 1 sample per wall);
- QA/QC sampling and analysis in accordance with Section 11.4.

Samples will be analysed for the following:

- Every sample for heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc), TPH/BTEX and PAH;

- Every sample for asbestos;
- Every third sample for phenols, OCP, PCB.

Concrete sump pit

Samples will be collected from the remedial excavation at the following frequency:

- Base of sump pit excavation - 1 sample per 25 m^2 i.e. 5 m x 5 m grid with a minimum of 1 base sample;
- Side of sump excavation - 1 sample per 10 linear metre (minimum of 1 sample per side) and 1 sample per 2 - 3 m depth interval;
- Fuel feed lines/pipe-work - 1 sample at base of pipe trench per 10 linear metre;
- QA/QC sampling and analysis in accordance with Section 11.4.

Every sample will be analysed for the following:

- heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc);
- Total PAH;
- TPH/BTEX;
- Phenols;
- OCP;
- PCB;
- VOC
- cyanide;
- Asbestos.

USTs

Samples will be collected from remedial excavations at the following frequency:

- Base of tank pit excavation – minimum of 1 per removed tank (e.g. 3 tanks in one pit would require 3 samples at base of pit);
- Side of tank pit excavation – 1 sample per 10 linear metre (minimum of 1 sample per side) and 1 sample per 2 - 3 m depth interval;
- Bowsers – 1 sample from each bowser;
- Fuel feed lines/pipe-work - 1 sample at base of pipe trench per 10 linear metre;
- QA/QC sampling and analysis in accordance with Section 11.4.

Samples will be analysed for the following:

- Every sample for heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc), TPH/BTEX and PAH, phenols;
- Every third sample for OCP, PCB and asbestos.

Other AEC

Samples will be collected from remedial excavations at the following frequency:

- Base of excavation – 1 sample per 25 m^2 i.e. 5 m x 5 m grid with a minimum of 1 sample per base (note, areas in excess of 125 m^2 to be tested in accordance with the Sampling Design Guidelines, as a minimum);
- Side of tank pit excavation – 1 sample per 10 linear metre (minimum of 1 sample per side) and 1 sample per 2 – 3 m depth interval;
- QA/QC sampling and analysis in accordance with Section 11.4.

Samples will be analysed for the primary contaminants of concern, as relevant to the particular AEC (refer to Table 4, Section 7). Other common contaminants will also be tested based on visual and olfactory observations, PID results and proximity to potential sources. Common contaminants that may be included in the analytical suite as relevant to the AEC are:

- heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc);
- Total and leachable PAH;
- TPH/ BTEX;
- Phenols;
- OCP;
- PCB;
- VOC;
- Asbestos.

11.2 Waste Classification

Materials requiring additional classification (e.g. from remedial excavations) will be analysed as follows:

11.2.1 Filling Materials

Samples will be collected at the following frequency:

- at least 1 sample per 250 m^3 of like filling (25 m^3-250 m^3, a minimum of 3 samples per material type)
- QA/QC sampling and analysis in accordance with Section 11.4.

Samples will be analysed for the following:

- Every sample will be analysed for the contaminants of prime concern (heavy metals, TRH/BTEX, PAH);

- Every third sample will be analysed for other contaminants of potential concern (phenol, PCB, OCP);
- Every third filling sample will be analysed for asbestos;
- Analysis of specific samples for any identified additional contaminants of concern. Potential for concern will be based on visual and olfactory observations, PID results and proximity to potential sources;
- Analysis of selected samples for TCLP analysis based on total concentration results, including a range of levels elevated above the screening (CT) criteria and targeting the most elevated results.

11.2.2 Natural Materials

Natural materials will be inspected for any signs of environmental concern (e.g. staining, odour) by the environmental consultant, and impacted materials will be excavated and disposed as contaminated soil (not VENM) as described above. Materials with no identifiable anthropogenic impacts will be collected and analysed at the following frequency:

- *ex situ* materials: - approximately 1 sample per 1-5000 m^3 or a minimum of 3 samples per material type;
- QA/QC sampling and analysis in accordance with Section 11.4.

Samples will be analysed for the following:

- Every sample will be screened for the presence of ASS/PASS (based on pH and peroxide pH tests);
- Every sample will be analysed for the contaminants of prime concern (heavy metals, TRH/ BTEX, PAH);
- Every third sample will be analysed for other contaminants of potential concern (phenol, PCB, OCP);
- Analysis of specific samples for any identified additional contaminants of concern. Potential for concern will be based on visual and olfactory observations, PID results and proximity to potential sources;
- Samples with a noted potential for ASS/PASS should be analysed for a SPOCAS/chromium reducible sulphur to verify the absence or otherwise of ASS/PASS.

11.3 Imported Materials

Any soil material imported onto the site for site formation, capping or to backfill remedial excavations shall be virgin excavated natural material (VENM) (except in the case of imported topsoil for landscaping). A suitable report prepared by a qualified environmental consultant (including analytical results for at least one sample per source site) stating that the material is VENM will be required. This report will need to be provided to, and approved by, the environmental consultant for the subject site prior to importation of material onto the subject site. If necessary, additional validation analyses will be undertaken to verify the status/ suitability of the VENM material.

Sample frequencies for imported materials (VENM):

- VENM – 1 sample per 1-5000 m^3 or a minimum of 3 samples per source site;
- QA/QC sampling and analysis in accordance with Section 11.4.

The analytical suite for imported materials will depend on the contaminants of concern for the source site. Samples will be analysed for the following:

- Every sample will be analysed for the contaminants of prime concern (heavy metals, TPH/BTEX and PAH);
- Every third sample will be analysed for other contaminants of potential concern (phenol, PCB, OCP, asbestos);
- Analysis of specific samples for any identified additional contaminants of concern. Potential for concern will be based on visual and olfactory observations, PID results and proximity to potential sources.

11.4 Field Quality Assurance

All sampling data will be recorded on DP chain-of-custody sheets. The soil sampling procedure will be as outlined below:

- Sampling from surface or from the excavator bucket and using disposable sampling equipment or stainless steel hand tools;
- Decontaminating all re-usable sampling equipment prior to collecting each sample using a 3% solution of phosphate free detergent (Decon 90) and distilled water;
- Transferring samples into laboratory-prepared glass jars with Teflon-lined lid, and capping immediately;
- labelling sample containers with individual and unique identification, including project number and sample number;
- collecting an additional replicate set of samples in sealed plastic bags for visual identification and records purposes, and for PID headspace screening if required;
- Analysis of 5% intra-laboratory samples and 5% inter-laboratory samples (tested for heavy metals, TPH and PAH, or if a lesser suite of analysis is being conducted on the primary sample, the rinsate will be tested for the full suite of the primary sample);
- 1 field rinsate blank sample per day of validation sampling (tested for heavy metals, TRH, PAH, or if a lesser suite of analysis is being conducted in the primary samples, the replicates will tested for the full suite in the primary samples);
- 1 trip blank per day of validation sampling (TPH, BTEX), minimum of 10 validation samples per day;
- 1 trip spike per day of validation sampling (BTEX), minimum of 10 validation samples per day;
- Placing the glass jars into a cooled, insulated and sealed container for transport to the laboratory; and
- Transporting the replicate bag samples to the DP laboratory under ambient conditions for storage.

DP's quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling programme to ensure sampling precision and accuracy and prevent cross contamination.

11.5 Quality Control

The quality controls of documentation completeness, data completeness, data comparability, data representativeness, precision and accuracy for sampling and analysis are described in Table 5.

Table 5 – Objectives of Quality Control of Data

Quality Control	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation, Sample Receipt Notices, completion of validation sample plans.
Data completeness	Sampling density according to provisions in the approved RAP, and analysis of appropriate determinants based on site history and on-site observation.
Data comparability and representativeness	Use of NATA accredited laboratories, use of consistent sampling technique, use of experienced field personnel.
Precision and accuracy for sampling and analysis	Achievement of 30-50%% RPD for replicate analysis, acceptable levels for laboratory QC criteria.

11.6 Validation Reporting

A validation assessment report will be prepared by a qualified environmental consultant in accordance with NSW EPA Contaminated Sites *Guidelines for Consultants Reporting on Contaminated Sites* (1997) and other appropriate guidance documentation. The objective of the validation report is to confirm that the site has been remediated to a suitable standard for the proposed mixed commercial development and occupation and that no related adverse human health and environmental effects have occurred or are likely to occur as a result of the works. The validation report will also include a summary of the information from previous investigations.

The validation report will include details of the total volume of contaminated materials removed from site, present detailed analytical results, confirm that any imported fill is clean and indicate the final disposal destination and tonnage of the materials received at landfill in order to correlate with the volumes removed from site.

12. OUTLINE ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The work shall be undertaken with all due regard to the minimisation of environmental effects and to meet all statutory requirements. The successful contractor shall have in place an Site Environmental Management Plan (SEMP) such that work on the site complies with the requirements of the following Acts:-

- Pollution Control Act;
- Environmental Offences and Penalties Act;
- Hazardous Chemicals Act;
- Environmentally Hazardous Chemicals Act;
- Dangerous Goods Act;
- Protection of the Environment Operations Act;
- Construction Safety Act; and
- Occupational Health and Safety Act (WorkCover).

The measures outlined below should be implemented during the remediation phase. All personnel should be made familiar with the SEMP prior to the commencement of site works as required.

12.1 Interim Controls

Prior to the commencement of site remediation works, the following interim controls will be in place:

- The construction of permanent fences around the subject area meeting appropriate specifications to prevent unauthorised entry;
- Any pits or unstable areas on site that may generate potential OH&S or operational risk should be demarcated and taped off, with appropriate rectification action undertaken (e.g. backfilling of pits as soon as practicable to prevent undue injuries to workers etc.).

12.2 Soil Management Plan

(a) Transport

Transport of materials to or from the site will be via an appropriate predefined haul route. All haulage routes for trucks transporting soil, materials, equipment or machinery to and from the site should be selected to meet the following objectives:

- Comply with all road traffic rules;
- Minimise noise, vibration and odour to adjacent premises; and
- Utilise State Roads and minimise use of local roads.

Removal of waste materials from the site will only be carried out by a licensed contractor holding appropriate consent and approvals to dispose of the waste materials in accordance with the *Protection of the Environment Operations (POEO) Act* 1997 and with the appropriate approvals obtained from the DECCW, if required.

The remediation work will be conducted such that all site vehicles:

- conduct deliveries of soil, materials, equipment or machinery during the specified hours of remediation, as approved by the consent authority;
- have securely covered loads to prevent any dust or odour emissions during transportation; and
- exit the site in a forward direction where possible.

In addition, measures will be implemented to ensure no contaminated material is spilled onto public roadways or tracked off site on vehicle wheels.

All loads will be tarpaulin covered and may be lightly wetted as required to ensure that no materials or dust are dropped or deposited outside or within the site. Prior to exiting the site each truck should be inspected by the client's representative and either noted as clean (wheels and chassis) or broomed/hosed down prior to leaving the site. Any soil spilled onto street will be cleaned daily by mechanical or hand methods on a daily basis.

(b) Disposal of Materials

All materials excavated and removed from the site should be disposed to a site legally allowed to receive it in accordance with relevant legislation, regulatory guidance, licences or DECCW approvals/ advice including the *Protection of the Environment Operations (POEO) Act* 1997.

(c) Rehabilitation and Reinstatement of the Site

Materials imported onto the site will be imported clean filling meeting the requirements set out in Section 11.3. The materials will be analysed and certified as meeting RAC by the contractor.

Geotechnical considerations in regard to fill placement and compaction should also be taken into account.

(d) Noise Control Plan

The remediation works should comply with the requirements specified by the authorities (eg consent authority and/or DECCW). Noise and vibration should be restricted to reasonable levels. All equipment and machinery should be operated in an efficient manner to minimise the emission of noise.

12.3 Vibration Control

The use of any plant and/or machinery should not cause unacceptable vibrations to nearby properties and should meet Council requirements.

12.4 Dust Control

Dust emissions should be confined within the site boundary. The following dust control procedures will be employed to comply with this requirement as necessary:

- Erection of dust screens around the perimeter of the site;
- Securely covering all loads entering or exiting the site;
- Use of water sprays across the site to suppress dust;
- Covering of all stockpiles of contaminated soil remaining on site more than 72 hours; and
- Keeping excavation and stockpile surfaces moist.

12.5 Odour Control

No odours should be detected at any boundary of the site during remediation works by an authorised Council Officer relying solely on sense of smell. The following procedures should be employed to comply with this requirement *as required*:

- Use of appropriate covering techniques such as plastic sheeting, polythene or geotextile membranes to cover excavation faces or stockpiles;
- Fine spray of water and/or hydrocarbon/odour mitigating agent on the impacted areas/materials;
- The use of water spray, as and when appropriate, to eliminate wind blown dust;
- Use of sprays or sprinklers on stockpiles or loads to lightly condition the material;
- Restriction of stockpile heights to 2-3 m above surrounding site level;
- Ceasing works during periods of inclement weather such as high winds or heavy rain; and
- Regular checking of the fugitive dust and odour issues to ensure compliance. Undertake immediate remedial measures to rectify any cases of excessive dust or odour (e.g. use of misting sprays or odour masking agent);
- Adequate maintenance of equipment and machinery to minimise exhaust emissions.

12.6 Groundwater Management

At this stage, no remediation of groundwater is envisaged for the proposed remediation works (although further groundwater monitoring will be conducted as part of the validation assessment to confirm that this is the case). It is assumed that dewatering will not generally be required but may be required at specific locations, such as the UST pits. Water requiring off-site discharge should be disposed of in accordance with relevant guidelines and licenses. Regular monitoring should be conducted to ensure water quality meets disposal guideline criteria. If groundwater does not meet the consent conditions for disposal into the stormwater system, then arrangements may need to be made for treatment or discharge into the sewerage system (including consent of the appropriate authorities). It is noted that the approval body for discharge into the stormwater system is Rockdale City Council. Sydney Water is responsible for discharge into sewerage system under a Trade Waste Agreement between the parties.

The management of dewatering is the responsibility of the DECCW under the *Water Management Act* 2000. Advice should be sought from the Department in regards to licensing requirements. All regulatory requirements relating to dewatering must be met prior to commencement of any dewatering works. It may be necessary to obtain a temporary dewatering license for the duration of construction activities.

12.7 Occupational Health and Safety

The remediation contractor should have in place a suitable OH&S plan prior to commencement of works. An outline of OH&S measures relevant to chemical contaminants is provided below.

All workers on site should wear appropriate personal protection equipment when dealing with potentially contaminated soil or water. This should include long sleeved shirt, trousers, covered steel capped shoes. Gloves and dust masks should be work as required to mitigate exposure to contaminated materials. If any signs of concern are noted at the site advice

should be sought regarding specific PPE requirements (e.g. vapour masks). Working with asbestos contaminated soils will require PPE as specified in *Working with Asbestos* 2008.

In the event of any emergency situation arising, the site supervisor should be informed immediately. The names and contact numbers of relevant personnel should be prominently displayed in the site office at all times.

It is the Principal's responsibility to ensure that all site remediation works should comply with all Occupational Health and Safety and Construction Safety Regulations of the NSW WorkCover Authority.

12.8 Hours of Operation

All remediation work should be conducted within the hours specified by the consent authority.

12.9 Contingency Plans to Respond to Site Incidents

The key to effective management of incidents is the timely action taken before any situation reaches a reportable or critical level. Therefore, surveillance activities are extremely important, and should be conducted for the measures prescribed herein and any other measures prescribed in any additional environmental management plan developed subsequently. During construction activities on the site, the following inspection or preventative actions should be performed by the main contractor:

- Regular inspection of works;
- Completion of routine environmental checklists and follow-up of non-compliance situations;
- Maintenance of supervision on-site;

- An induction process for site personnel involved in the remediation works that includes relevant information on environmental requirements, and ensures that all site personnel are familiar with the site emergency procedures.

The Principal's site foreman should be responsible for initiating an immediate emergency response using the resources available on the site. Where external assistance is required, the relevant emergency services should be contacted. A table such as that below, containing contact details for key personnel who may be involved in an environmental emergency response should be completed and be readily available to personnel at all times. The table should be completed, and thereafter amended as required.

Name	Contact Details
Emergency Services: **Fire Brigade, Ambulance and Police**	
Nearest Doctor's Surgery	
Nearest Medical Centre	
Nearest Hospital	
NSW EPA (part of the DECC)	
Randwick Council	
Water Authority	
Energy Australia	
AGL	
Waste Disposal and spill clean up services	
Neighbours	

Note: This table or similar should be **completed by the contractor prior to commencement of works** and, subsequently, regularly updated.

13. CONCLUSIONS

It is considered that conformance with this RAP will minimise the potential for environmental impacts during the remedial works at the site.

The objective of the validation report will be to confirm that the site has been remediated to a suitable standard for the proposed commercial development and occupation and that no related adverse human health and environmental effects have occurred as a result of the temporary works.

Subject to proper implementation of the RAP including the results of further sampling and analysis, it is considered that the site can be rendered suitable for the commercial land use.

An Environmental Management Plan will be prepared on the successful completion of the Cap and Contain strategy. The EMP will be noted on the title and the planning certificate.

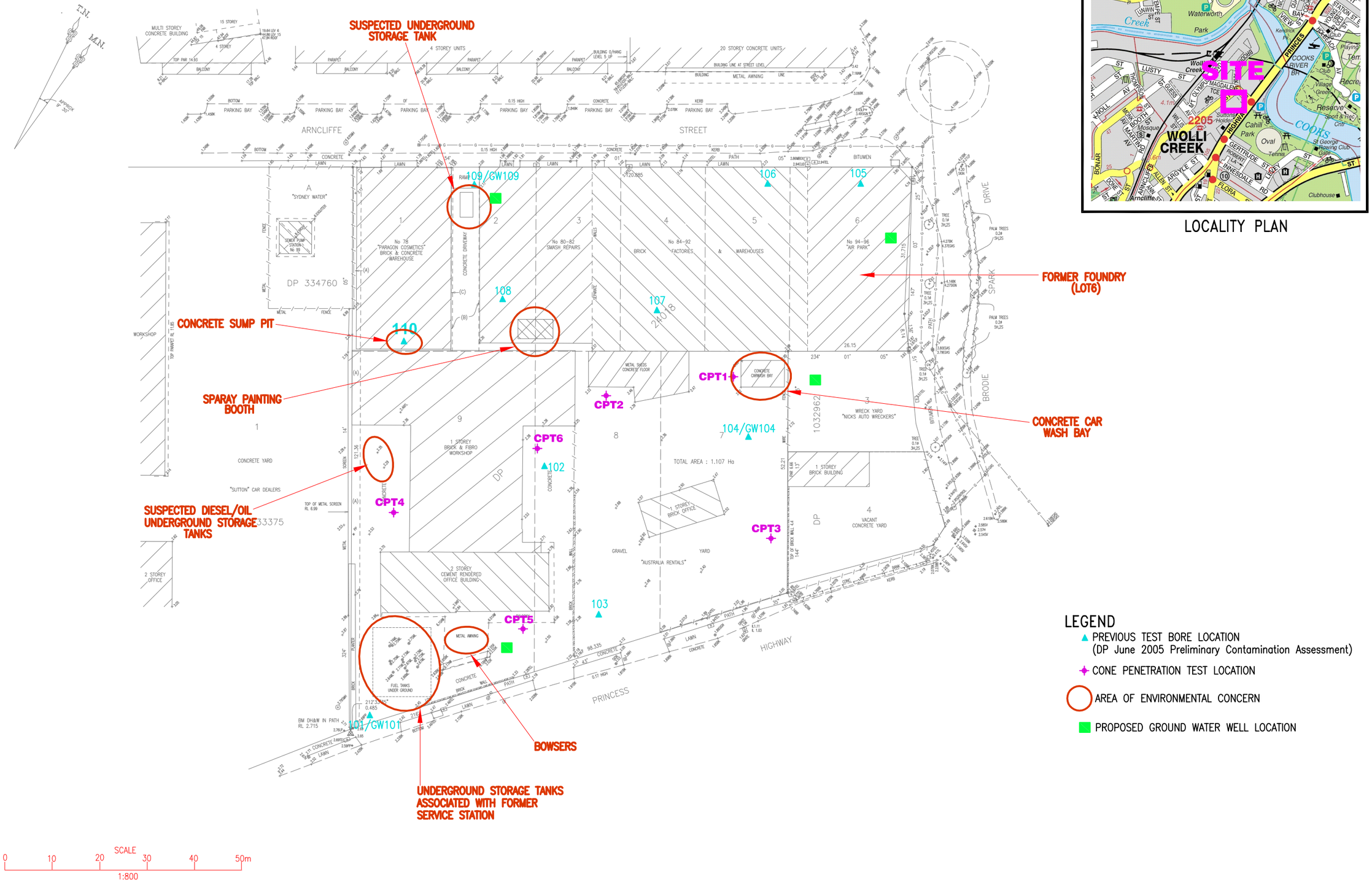
DOUGLAS PARTNERS PTY LTD

Lindsay Rockett
Senior Associate

Reviewed by:

Ronnie Tong
Principal

APPENDIX A
Drawings and Notes Relating to This Report



LOCALITY PLAN

LEGEND

- ▲ PREVIOUS TEST BORE LOCATION (DP June 2005 Preliminary Contamination Assessment)
- ✦ CONE PENETRATION TEST LOCATION
- ◯ AREA OF ENVIRONMENTAL CONCERN
- ■ PROPOSED GROUND WATER WELL LOCATION

Douglas Partners *Geotechnics • Environment • Groundwater*	CLIENT: NAHAS Constructions Pty Ltd	OFFICE: SYDNEY	TITLE: **Location of Test Bores Areas of Environmental Concerns Remediation Action Plan Arncliffe Street ARNCLIFFE**
	PROJECT No: 45635	DRAWN BY: PSCH	DRAWING No: 1
	DATE: 23.7.2008 SCALE: As shown	APPROVED BY:	

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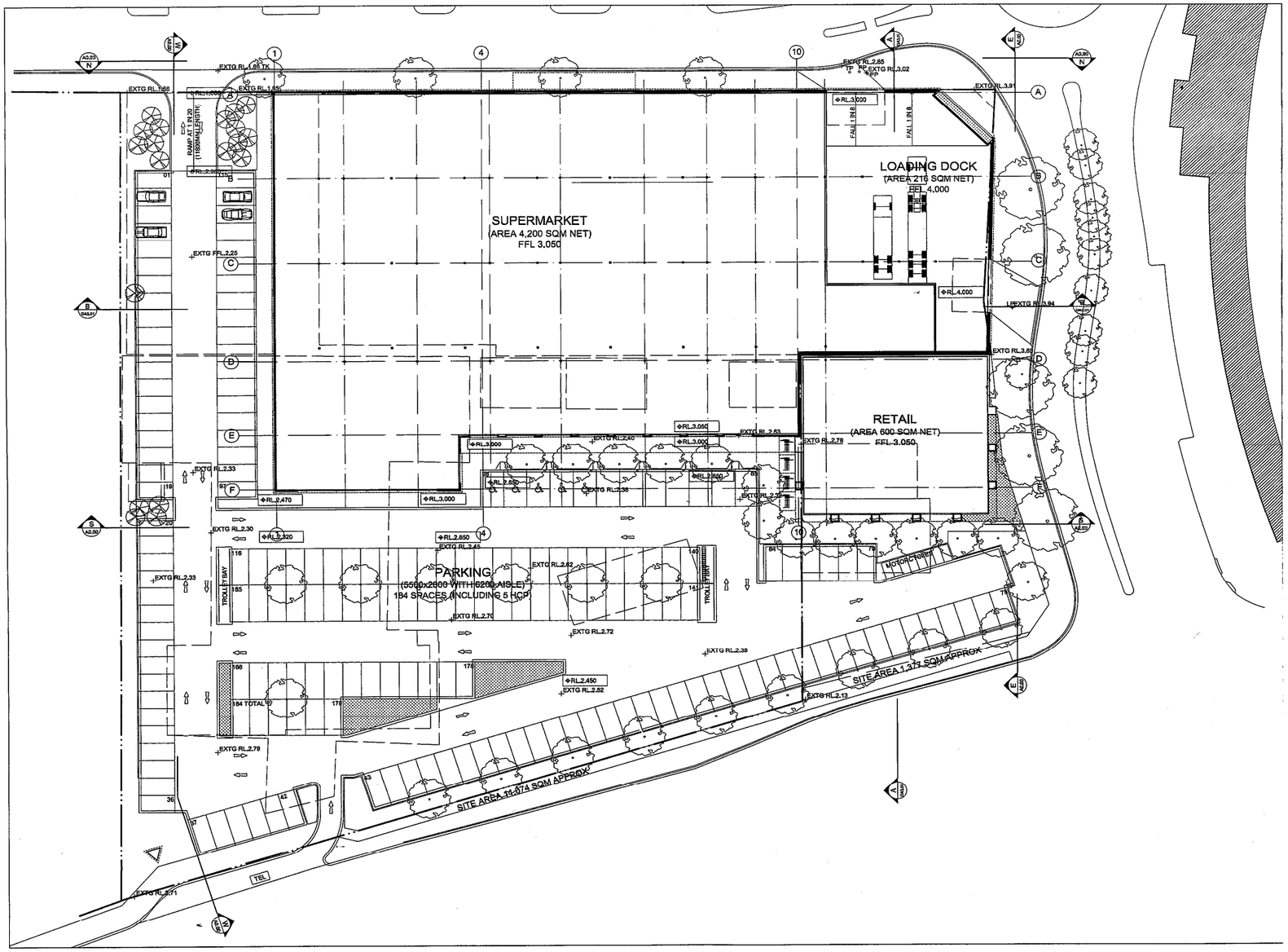

Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: NAHAS Constructions Pty Ltd PROJECT No.: 45635.01	OFFICE: Sydney DRAWN BY: LR	TITLE: Stge 1 Development Proposal Plans Remediation Action Plan Arncliffe Street Arncliffe	Drawing No: 2
	DATE: Sept 2009 / SCALE: As Shown	APPROVED BY: LR		

Douglas Partners
Geotechnics · Environment · Groundwater

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water

table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7

  as 4, 6, 7
  N = 13

- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm

  as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

q_c (MPa) = (0.4 to 0.6) N (blows per 300 mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section

is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.