GEO-LOGIX PTY LTD
ABN 86 116 892 936

Unit 2309
4 Daydream Street
Warriewood, NSW 2102

P 02 9979 1722
F 02 9979 1222
W www.geo-logix.com.au

8th August 2011

Mr Michael Rumble
Development Manager
Woolworths Ltd
mrumble@woolworths.com.au

SUBJECT: **Pre-DA Meeting, Council Information Request 21 – Site Contamination.**

SUBJECT SITE: **Proposed Woolworths Shopping Centre**
Lot 101 DP1028645, Corner New Illawarra and Old Illawarra Roads, Barden Ridge, NSW

Dear Michael,

As detailed in item request 21 of Council Letter 27th June 2011 (Ref: PA011/0083) it is understood Council require information with respect to potential site contamination in order to consider the subject site development.

In 2008 the prior site owner commissioned JBS Environmental (JBS) to undertake a Preliminary Contamination Assessment of the subject site. Geo-Logix has reviewed the report and believes the report will be sufficient for Council to address Site Contamination as per SEPP 55. The report prepared by JBS is detailed below:

- ◊ Preliminary Contamination Assessment, Lot 101 DP1028645 Corner of New Illawarra and Old Illawarra Roads, Barden Ridge, NSW. April 2008 Ref# JBS40517-12251.

The report was prepared for the landlord (Gandangara Local Aboriginal Land Council) to support a prior Development which was reported to be mixed commercial and residential. It is a Preliminary Environmental Report as per the SEPP 55 Guidelines definition. The report documents the sites history and is inclusive of limited soil sampling and analysis for potential contamination issues identified during site inspection.

The subject site is 9,383m^2 in area and is mostly bushland. **Historically there has been no development onsite except the presence of a former roadway in the western portion of the site.**

Based on site inspection JBS identified potential contamination issues associated with illegal waste tipping and the former roadway. JBS proceeded to undertake soil testing and performed analysis for typical suite of contaminants. The results of analysis were compared against residential land-use standards for the purpose of the proposed Development at that time.

The results of soil testing did not identify contamination in excess of commercial land use assessment criteria. In the context of Woolworths proposed Commercial Development the JBS Preliminary Assessment Report adequately addresses site contamination assessment.

It can be concluded based on the findings of JBS assessment the site is suitable for the development and no further environmental works / remediation are necessary.

Please do not hesitate to contact Geo-Logix (02) 9979 1722 should you require further information.

Yours Sincerely,

David Gregory
BSc (Hons), R.G., EIANZ CEnvP#139
Principal Geologist, Director

LIMITATIONS: It is understood that the Environmental advice provided by Geo-Logix is based on information provided in the Subject Reports. Geo-Logix provides no warranty of methodologies and procedures adopted to acquire the data, and/or the precision and accuracy of the data from which the Subject Report was prepared. Geo-Logix has formed an opinion based on scientific principal and experience. By accepting the advice presented in the letter report you agree to indemnify Geo-Logix against any loss, damage, liability, claim, suits, demands and actions for advice which, as a result of local geological/hydrogeological anomalies, or as a result of negligence on behalf of those who performed assessment and site remediation, caused further pollution or exacerbated existing pollution. Geo-Logix accepts no responsibility for third party use of this letter.

Preliminary Contamination Assessment

Gandangara Local Aboriginal land Council
Via Arben Management

Lot 101 DP1028645
Corner New Illawarra and Old Illawarra Rds
Barden Ridge, NSW

April 2008
JBS40517-12251
JBS Environmental Pty Ltd

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Barden Ridge, NSW

April 2008
JBS40517-12251
JBS Environmental Pty Ltd

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List of Abbreviations

A list of the common abbreviations used throughout this report is provided below.

AHD	Australian Height Datum
As	Arsenic
bgs	below ground surface
Cd	Cadmium
CSM	Conceptual site model
Cr	Chromium
Cu	Copper
BTEX	Benzene, toluene, ethylbenzene and xylenes
B(a)P	Benzo(a)pyrene
DECC	NSW Department of Environment and Climate Change
DQOs	Data Quality Objectives
DWE	NSW Department of Water and Energy
EMP	Environmental Management Plan
EPA	NSW Environment Protection Authority (now the DECC)
GILs	Groundwater investigation levels
Ha	Hectare
Hg	Mercury
HIL	Health based investigation level
JBS	JBS Environmental
LOR	Limit of Reporting
Mn	Manganese
Ni	Nickel
PAHs	Polycyclic aromatic hydrocarbons
Pb	Lead
PBIL	Phytotoxicity based investigation level
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
RPD	Relative Percentage Difference
SAQP	Sampling, Analysis and Quality Plan
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxic Characteristic Leaching Potential
TPH	Total Petroleum Hydrocarbons
WQOs	Water Quality Objectives
Zn	Zinc

Executive Summary

Introduction and Objectives

JBS Environmental Pty Ltd was engaged by the Gandangara Local Aboriginal Land Council via Arben Management (Arben) to conduct a Preliminary Contamination Assessment at Lot 101 DP1028645 (the site), located on the corner of New Illawarra Rd and Old Illawarra Rd, Barden Ridge, NSW 2234. The site has a total area of 9,383m^2.

It is understood that a Development Application is to be submitted to Sutherland Shire Council to develop the site for a retail/commercial and residential purposes. The Council require a preliminary assessment of potential site contamination to be submitted as part of the Development Application.

The objective of the investigation is to thoroughly document the site history, assess potential on and offsite sources of contamination, and undertake limited intrusive soil investigations to conclude whether the site is suitable for the proposed commercial/ residential use, or provide recommendations to enable such conclusions. The proposed investigation has been developed in general accordance with relevant guidelines made or approved by the NSW Department of Environment and Climate Change (DECC).

Scope of Work

The scope of work comprised: a site history review and detailed site inspection to identify potential areas of environmental concern and associated contaminants of potential concern; development of a sampling and analysis program; a targeted program of soil sampling and analysis; an assessment of soil contamination; and preparation of a detailed report in accordance with relevant NSW Department of Environment and Climate Change guidelines (**Section 6**).

Site Description

The site is a vacant block covered with thick vegetation. Some fly tipping has occurred in accessible areas, and remnant asphalt is present in the western portion.

Site History and Potential for Contamination

The site history review identified a former roadway through the western portion of the site. The remainder of the site has been vacant bushland since the 1930s.

The areas of potential concern at the site are identified in **Table 1** below.

Table 1 Areas of Environmental Concern and associated Contaminants of Potential Concern

Area of Environmental Concern (AEC)	Contaminants of Potential Concern (COPC)
Asphalt and subgrade from the former roadway in the northwestern portion of the site	Heavy metals, TPH, PAHs
Fill material along the eastern site boundary and in the northwestern portion of the site	Heavy metals, TPH/BTEX, PAHs, OCP/OPPs, PCBs, asbestos
Fly tipped material along the eastern site boundary and in the northwestern portion	Heavy metals, TPH, PAHs

Summary of Investigation Results

Soil samples were collected from 10 sampling locations across the site.

Small areas of remnant asphalt remain in the western portion of the site, and dumped material was present along the eastern site boundary, and within the northwestern portion.

There was no visual or olfactory evidence of contamination identified during the collection of soil samples.

Shallow silty sand fill material was identified near the eastern and northern site boundaries, adjacent to the Old Illawarra and New Illawarra Rds. The fill was underlain by natural sandy soil between 0.1 and 0.25m bgs.

Natural soils were typically found to consist of loose brown or grey silty sand with sandstone cobbles present. Bedrock, consisting of sandstone was typically found to be shallow, and observed outcropping in several areas.

On comparison of the soil analytical results with the adopted site criteria, the following results were obtained:

- The residual asphalt materials in the northern portion of the site contain levels of PAHs which require remediation in order to make this portion of the site suitable for the proposed use (ie. children's playground).
- The remainder of the site did not report any concentrations of metals, TPH/BTEX, OCP/OPPs, PCBs or asbestos which requires remediation for the proposed uses.
- No background soil concentrations were identified across the site which exceed the adopted site criteria.
- The potential for migration of contaminants from the site via surface water or groundwater is considered to be low based on the non-leachable nature of the minor soil contamination identified, and the likely depth to groundwater within the hard sandstone at the site.

Conclusions and Recommendations

On the basis of the results of this investigation, and subject to the limitations outlined in **Section 11**, the site can be made suitable for the proposed commercial/residential uses subject to the successful remediation and validation of the identified PAH impacted residual asphalt materials in the northern portion of the site

It is recommended that a Remedial Action Plan be prepared and implemented to address the identified PAH contaminated asphalt materials in the northern portion of the site.

1 Introduction

1.1 Background and Objectives

JBS Environmental Pty Ltd was engaged by the Gandangara Local Aboriginal Land Council via Arben Management (Arben) to conduct a Preliminary Contamination Assessment at Lot 101 DP1028645 (the site), located on the corner of New Illawarra Rd and Old Illawarra Rd, Barden Ridge, NSW 2234. The site has a total area of 9,383m^2.

It is understood that a Development Application is to be submitted to Sutherland Shire Council to develop the site for retail/commercial and residential purposes. The Council require a preliminary assessment of potential site contamination to be submitted as part of the Development Application.

The objective of the investigation is to thoroughly document the site history, assess potential on and offsite sources of contamination, and undertake limited intrusive soil investigations to conclude whether the site is suitable for the proposed commercial/residential use, or provide recommendations to enable such conclusions. An additional objective was to provide a preliminary material classification of the surface soils in the footprint of the proposed development.

The investigation was conducted in general accordance with relevant NSW Department of Environment and Climate Change (DECC) guidelines (**Section 6**).

1.2 Scope of Work

The scope of work comprised:

- A site history review and detailed site inspection to identify potential areas of environmental concern and associated contaminants of potential concern;
- Based on the results of the historical review and site inspection, development of a sampling and analysis program to investigate surface and shallow soils at the site;
- Soil sampling via handauger at 10 onsite locations to determine the potential for soil contamination at the site;
- Analysis of selected soil samples at a laboratory NATA certified for TPH, BTEX compounds, PAHs, heavy metals, OCP/OPPs, PCBs and asbestos. TCLP and SPLP analysis for metals and PAHs was conducted on a single sample;
- Preliminary material classification of surface soils in the footprint of the proposed development; and
- Preparation of a Preliminary Contamination Assessment report in general accordance with relevant DECC Guidelines.

2 Site Condition & Surrounding Environment

2.1 Site Identification

The location of the site is shown in **Figure 1**. The site details are summarised in **Table 2.1** and described in detail in the following sections.

Table 2.1 Summary Site Details

Lot/DP	Lot 101 DP1028645
Address	Corner of New Illawarra Rd and Old Illawarra Rd, Barden Ridge, NSW, 2234
Local Government Authority	Sutherland Shire Council
Site Zoning	Zone 10 – Neighbourhood Centre
Current Use	Vacant block covered by thick bushland with an access trail in the western portion.
Previous Use	The western portion was part of the former Illawarra Rd, with the eastsern portion of the site being vacant.
Site Area	Approximately 9,383m^2

2.2 Site Description

The site is a vacant block covered with thick vegetation (**Figure 2**). There are no buildings or structures currently located on the site. A small area (2m^2) of asphalt was noted in a depression which looks to be part of an old roadway through the northern portion of the site. The site slopes gently to the west towards a small gully adjacent to New Illawarra Rd.

Photo 1 – Site and surrounding areas in 2006**.**

Some shallow fill material is identified in the northern portion of the site, likely associated with the former road in this area. Fill material is also identified along the eastern site boundary, adjacent to Old Illawarra Rd. Remaining areas of the site consist of natural soils, with sandy soils and natural sandstone outcrops visible.

Bare soil is identified in the northern corner of the site in a cleared area near the road intersection. Vegetation at the site is abundant and does not appear to be stressed.

Three piles of dumped rubbish are located along the eastern site boundary, and another in the northwestern portion of the site. The rubbish piles include plastic containers, aluminium cans, green waste, clothing as well as a small amount of clay soils.

The site is bound to the north by New Illawarra Rd, to the east by Old Illawarrd Rd, to the south by a vacant cleared block, and to the west by bushland. The site is bound to the north, south and west by a chain wire fence.

2.3 Surrounding Landuse

The landuse of adjacent properties or properties across adjacent roads is shown in **Figure 2** and summarised below.

- Northeast – A church and grounds, and residential properties are located across Old Illawarra Rd;
- South – A vacant cleared block is located adjacent to the southeastern site boundary. A primary school and grounds are located further southeast, approximately 30m from the southeastern site boundary;
- Southwest – Vacant property covered by bushland, with an access trail running along a shallow gully parallel to New Illawarra Rd; and
- Northwest – New Illawarra Rd followed by Lucas Heights playing fields to the west, and areas of natural bushland to the northwest. A Landfill Gas Power Station is located on the opposite side of New Illawarra Rd, approximately 300m southwest of the site.

The Landfill Gas Power Station and Lucas Heights Playing Fields are indicative that the area west of New Illawarra Rd was used for landfill purposes historically. However, the landfill area is located hydraulically crossgradient from the site, and is not considered to pose a significant offsite potential contaminant source to the site.

Based on review of the remaining surrounding land uses, there does not appear to be any other significant potential contaminant sources located in the properties around the site.

Other waste facilities and landfills, located approximately 2.5km to the southwest of the site on the opposite side of Bardens Creek, are unlikely to pose a potential offsite source of contamination based on their distance from the site, and the topography of the general area.

2.4 Topography

The regional topographic map (LPI, 2001[1]) indicates the elevation of the site is approximately 120m Australia Height Datum (AHD). The site is located on a plateau with a shallow slope to the southeast. The plateau ends approximately 900m southeast at a steep slope down to the Woronora River, located approximately 1km from the site. The land to the west New Illawarra Rd slopes gently to the northwest and west towards Mill Creek and Bardens Creek.

Small amounts of fill material are evident along the eastern site boundary adjacent to Old Illawarra Rd. Some cutting may have occurred in the northern portion of the site where a former road was located. Small areas of fill, roadbase and asphalt were identified in this portion of the site.

The site has a shallow slope towards the west, possibly due to cutting in the former road area, which now forms a shallow gully in the northwestern portion of the site, and offsite areas to the west.

2.5 Geology

The regional geological map (DoM, 1966[2]) indicates that the geology within the site is dominated by Hawkesbury Sandstone (quartz sandstone with some shale) belonging to the Wianamatta Group.

Based on the Acid Soil Sulfate Risk Map (1997)[3], the site and immediate surrounds have no known occurrence of acid sulfate soil materials.

2.6 Hydrology

The nearest water body to the site is the Woronora River located approximately 1km southeast of the site. The Woronora River joins the Georges River approximately 7km to the northeast, which flows into Botany Bay approximately 14km northeast of the site.

Bardens Creek is located approximately 1.4km west of the site and joins with Mill Creek, located approximately 2.2km northwest. Mill Creek flows into the Georges River north of the site.

Rainfall runoff at the subject site during heavy or prolonged rain periods is expected to be based on site topography. Surface water is expected to run off generally to the west.

2.7 Hydrogeology

A search of registered groundwater bores was undertaken through the NSW Department of Water and Energy (DWE). No registered bores were located within a 1km radius of the site. No information was made available for the location and use of the nearest bore.

The Sydney Coastal Councils Group (SCCG, 2006)[4] confirms that the major geological unit in the Barden Ridge area is Hawkesbury Sandstone. Hawkesbury sandstone is characterised as a porous rock. The porous rock aquifers in the Sydney region contain limited quantities of groundwater because of the manner in which the water bearing zones formed. These aquifers have not strictly developed the type characteristics of a

[1] *Port Hacking 1:25 000 Topographic and Orthophotomap. Sheet 9129-4N*. Lands and Property Information NSW (LPI, 2001).
[2] *Wollongong Geological Series Sheet SI 56-9.* Geological survey of NSW – Department of Mines, 1966 (DoM, 1966).
[3] *Acid Sulfate Soil Risk Map (Edition 2).* Department of Land and Water Conservation, 1997. (DLWC,1997).
[4] *Groundwater Management Handbook.* Sydney Coastal Councils Group. September 2006. (SCCG 2006)

confined aquifer. The sandstone itself forms both the confining layers (cemented fine grained intervals) and the aquifer (water bearing zones of coarse grained and fractured rock).

Porous rock aquifers can be characterised by the presence of springs, where groundwater discharges at the land surface. Springs occur where water bearing zones intersect the land surface on cliff faces or in excavations, on in places where shale bands in within the sandstone force groundwater to flow laterally rather than infiltrate deeper into the rock mass.

Commonly these perched systems are formed on steep sandstone cliffs and recharged for the tops of the hills where they occur. The perched aquifer systems are not significant as a water resource. This is confirmed by the DWE search undertaken by JBS which did not identify any licensed bores in proximity of the site. However, such perched waters frequently provide support to small, dependent ecosystems that have developed in response to the semi-permanent discharge. No other beneficial uses of this groundwater have been identified by JBS, or are reported in SCCG (2006) in the Barden Ridge area.

From review of the site location and surrounding geology, groundwater is anticipated to occur within these porous rock aquifers as a perched aquifer.

Regional groundwater movement would be anticipated to occur in a southeasterly direction towards the Woronora River, located approximately 1km from the site.

3 Site History

3.1 Aerial Photographs

Aerial photographs from 1961, 1970, 1983, 1990, 2002 and 2005 were obtained from the Land and Property Information Centre, and are included in **Appendix A**.

Relevant information from the aerial photograph review is summarised below.

- In 1961, the northwestern portion of the site appears to be part of the former Illawarra Rd, while the central and southern portion of the site is vegetated. No buildings can be identified on the site. Old Illawarra Rd is visible to the northeast of the site. A number of rural or commercial/industrial properties can be identified to the east and north along the former Illawarra Rd. A small complex of buildings in a cleared area can be identified across Old Illawarra Rd. A large cleared area can be identified to the south of the site, although it does not appear to have any structures on it. Land has been cleared along the creekline to the west of the site.
- In 1970, the New Illawarra Rd has been established, the Old Illawarra Rd can be seen northeast of the site, and the former Illawarra Rd can be seen as an apparently abandoned roadway running through the northwestern portion of the site. The central and southern portions of the site remain vegetated. No buildings are identified onsite. The large cleared area to the south of the site remains. The small complex of buildings across Old Illawarra Rd, and rural and commercial/industrial properties along the former Illawarra Rd appear similar to the previous photograph.
- In 1983, the site and immediate surrounds appear similar to the previous photograph. No buildings are identified onsite. Areas to the west remain as cleared land which may have been used for quarrying. Several small dams can be identified to the east of the creek, to the west of the site. Additional commercial/industrial and rural properties are noted along Old Illawarra Rd. A new residential area has been developed to the north of the site.
- In 1990, the site remains similar to the previous photograph, although the former Illawarra Rd is now a small access road running parallel with New Illawarra Rd. No buildings are identified onsite. The small building complex across Old Illwarra Rd has been extended, and is in the location of the current church. Areas south and west of the site remain cleared, with no obvious buildings on them. Areas to the northwest remain as natural bushland. Extensive residential development has occurred to the northeast of the site across Old Illawarra Rd.
- In 2002, the site appears to be almost completely vegetated, and the former Illawarra Rd is a small track through the northwestern portion of the site. No buildings are identified onsite. The school has been built in the cleared area to the south of the site, and the church to the east of the site appears similar to the previous photograph. Areas west of the site remain cleared, and areas further east and northeast are now predominantly residential.
- In 2005, the site appears similar to the previous photograph. No buildings are identified onsite. Lucas Heights Playing Fields can be clearly identified west of the site, across New Illawarra Rd. Residential areas extend north, east and southeast from the site.

3.2 Title Details

A historic title search was conducted the Lot included within the investigation. Results are included in **Appendix B** and summarised below:

- 1884 – a crown grant was made to Henry Prince, William Henry Gritler, Henry Chetwood Doyle and William George Anslow.
- 1902 – the site was transferred to Henry Prince, William Henry Gritler, Henry Chetwood Doyle and Henry Bertie Gritler, gentlemen.
- 1905 – transferred to Walter Frederick Elkington, an agent.
- 1908 – transferred to Alice Mary Furniss, wife of Joseph Frederick Furniss, an engineer.
- 1917 – transferred to The Commonwealth of Australia.
- 1984 – transferred to The State of New South Wales.
- 2003 – transferred to the Gandangara Local Aboriginal Land Council.

3.3 DECC Records

A search of the DECC's public register under the *Protection of the Environment Operations Act 1997* was undertaken, and results are included in **Appendix C**. The search identified that, for the site, there were:

- No prevention, clean-up or prohibition notices;
- No transfer, variation, suspension, surrender or revocation of an environment protection licence.

It is noted that licenses were issued under the *POEO Act 1997* for properties within the general area including:

- two licenses for concrete batching facilities;
- two licenses for waste recycling;
- two licenses for waste management;
- one licence for electrical generation from gas; and
- one license for an amenties building at a playing field.

A search was undertaken through the DECC's public contaminated land register (**Appendix C**). The search identified that, for the site, there have been no notices issued under the *Contaminated Land Management Act 1997* for the site.

It is noted that 2 current and 2 former notices are related to the Harrington's Quarry/IWC Landfill located more than 2.5km west and southwest of the site across Mill Creek.

3.4 Australian and NSW Heritage Register

A search of the Australian Heritage Trust database and the NSW Heritage Inventory did not reveal any Heritage listed items at the site (**Appendix D**).

3.5 Council Records

3.5.1 Section 149 Certificate

The planning certificate for the site (Lot 101 DP1028645) from Sutherland Shire Council is included in **Appendix E**, and includes the following information regarding the site:

- The site is Zone 10 – Neighbourhood Centre;
- The land does not include or comprise critical habitat. The land is not in a conservation area. There are no items of environmental heritage identified on the site;
- The site is bushfire prone land as defined under the Environmental Planning and Assessment Act 1979;
- The site is not affected by a policy adopted by Council or any other public authority that restricts development of the land because of the likelihood of landslip, bushfire, tidal inundation, subsidence, acid sulphate or any other risk;
- The land is not subject to an investigation order or a remediation order within the meaning of the Contaminated Land Management Act 1997;
- The land is not subject to a voluntary investigation proposal (or voluntary remediation proposal) that is the subject of the Environment Protection Authority's agreement under Section 19 or 26 of the Contaminated Land Management Act 1997; and
- The land is not subject of a site audit statement within the meaning of the Contaminated Land Management Act 1997.

3.5.2 Development Application / Building Application (DA/BA) records

Sutherland Sire Council made available a number of files with DA/BA information for the site including the area bound by Heathcote Rd to the south, the Woronora River to the east and the military reserve to the north. Review of these files indicated that there were no DA/BA records pertaining to the site in particular.

On review of historical records of quarrying, waste disposal and other uses in offsite areas particularly to the south of the site, it is noted that:

- The area was quarried for hard rock, gravels and ballast. Records were available from 1968, but it is possible that quarrying activities were initiated before this time;
- Disposal of nightsoil, garbage, liquid (including dioxins) and solid waste was conducted in the area around Harrington's Quarry (located approximately 3km southwest of the site) from approximately 1950. Nightsoil disposal decreased in the 1980s;
- A concrete batching plant was built in 1984 on New Illawarra Rd; and
- Particular offsite areas were leased for use as pistol ranges, trail bike circuits or pony club grounds.

3.6 Workcover Dangerous Goods Licenses

A WorkCover search of the Stored Chemical Information Database (SCID) and the microfiche records held by WorkCover did not uncover any records pertaining to the site (**Appendix F**).

3.7 Site History Summary

Detailed site history based on historical records is discussed in the sections below. A summary of the site history is provided in **Table 3.1**.

Table 3.1 Summary Site History

Period	Activity	Source
1884	A crown grant of land was transferred to Henry Prince, William Henry Gritler, Henry Chetwood Doyle and William George Anslow.	Title documentation
1902	The site was transferred to Henry Prince, William Henry Gritler, Henry Chetwood Doyle and Henry Bertie Gritler, gentlemen.	Title documentation
1905	The site was transferred to Walter Frederick Elkington, an agent.	Title documentation
1908	The site was transferred to Alice Mary Furniss, wife of an engineer.	Title documentation
1917	The site was transferred to The Commonwealth of Australian	Title documentation
1961	The northwestern portion of the site appears to be part of the former Illawarra Rd, while the eastern portion of the site is vegetated.	Aerial photo (1961)
1970	The site is a vacant partially vegetated block with an apparently abandoned roadway running through the northwestern portion.	Aerial photo (1970)
1983	The site remains similar to the previous photograph.	Aerial photo (1983)
1984	The site was transferred to The State of NSW	Title documentation
1990	The site remains similar to the previous photograph, however the former Illawarra Rd is now a small access trail in the northwestern portion of the site.	Aerial photo (1990)
2002	The site remains similar to the previous photograph.	Aerial photo (2002)
2003	The site was transferred to the Gandangara Local Aboriginal Land Council	Title documentation
2005	The site remains similar to the previous photograph.	Aerial photo (2005)
2008	The site appears similar to the 2005 aerial photo.	Site inspection (March 2008)

3.8 Integrity Assessment

The data obtained from these historical sources has been found to be in general agreement. It is therefore considered that the information provided in this historical assessment has an acceptable level of accuracy.

4 Potential Contamination Issues

4.1 Potential Areas of Environmental Concern

Based on the review of historical information and site inspection conducted on 20 March 2008, the following areas of environmental concern have been identified (**Table 4.1**).

Table 4.1 Areas of Environmental Concern and associated Contaminants of Potential Concern

Area of Environmental Concern (AEC)	Contaminants of Potential Concern (COPC)
Asphalt and subgrade from the former roadway in the northwestern portion of the site	Heavy metals, TPH, PAHs
Fill material along the eastern site boundary and in the northwestern portion of the site	Heavy metals, TPH/BTEX, PAHs, OCP/OPPs, PCBs, asbestos
Fly tipped material along the eastern site boundary and in the northwestern portion	Heavy metals, TPH, PAHs, asbestos

4.2 Potentially Contaminated Media

The potentially contaminated media present at the site may include:

- Piles of dumped materials;
- Fill materials; and
- Shallow natural soils underlying fill material, or under any dumped materials.

Surface water is not identified as a potentially contaminated medium based on the absence of any water body which dissects the site, and the distance to the nearest water body.

Groundwater is not considered to be a potentially contaminated media based on the absence of significant contaminant sources identified at the site during the current and historical site uses. However, the potential for groundwater to be contaminated media is dependant upon the potential mobility of any soil contamination identified at the site.

4.3 Potential for Migration

Contaminants generally migrate from site via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff. The potential for contaminants to migrate is a combination of:

- The nature of the contaminants (solid/liquid and mobility characteristics);
- The extent of the contaminants (isolated or widespread);
- The location of the contaminants (surface soils or at depth); and
- The site topography, geology, hydrology and hydrogeology.

The potential contaminants identified as part of the site history review and site inspection are generally in solid form (eg. asbestos).

The majority of the site is vegetated which significantly reduces the potential for windblown contaminants to migrate from the site. The potential exists for windblown migration of dust from the unpaved access trail in the western portion of the site.

The potential for contaminants to migrate via surface water runoff from the site is considered low, based on the likely infiltration due to generally unsealed nature of surface soils.

The potential for contaminants (if present) to migrate via groundwater is considered low, based on the absence of significant contaminant sources identified at the site.

5 Sampling and Analysis Plan

5.1 Data Quality Objectives

Data quality objectives (DQOs) were developed for the investigation, as discussed in the following sections.

5.1.1 State the Problem

A Development Application is to be submitted to the Sutherland Shire Council (the Council) to propose to develop the site for mixed retail/commercial and residential use. The Council require a preliminary assessment of potential site contamination.

5.1.2 Identify the Decision

Based on the decision making process for assessing urban redevelopment sites detailed in DEC (2006), the following decisions must be made:

- Are there any unacceptable risks to likely future onsite receptors, posed by fly tipped materials or for soils?
- Are there any issues relating to the local area background soil concentrations that exceed appropriate soil criteria?
- Are there any impacts of chemical mixtures?
- Are there any aesthetic issues?
- Is there any evidence of, or potential for, migration of contaminants from the site?
- Is a site management strategy required?

5.1.3 Identify Inputs to the Decision

Inputs to the decisions are:

- Site condition information and site historical information; and
- Soil analytical data.

The requirement for the collection of groundwater analytical data will be assessed based on the results of the soil data.

5.1.4 Define the Study Boundaries

The site is described as Lot 101 DP1028645, Barden Ridge, as shown in **Figure 2**. The study targeted the areas of environmental concern identified in **Table 4.1**.

The vertical extent of the investigation was approximately 0.3m bgs.

Due to the nature of potential contaminants identified seasonality was not assessed as part of this investigation.

5.1.5 Develop a Decision Rule

Soil analytical data was assessed against DECC endorsed criteria including:

- *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 (NEPC 1999)
- *Contaminated Sites: Guidelines for Assessing Service Station Sites,* NSW EPA, 1994 (EPA 1994)

The decisions rules adopted to answer the decisions identified in **Section 5.1.2** are summarised in **Table 5.1**.

Table 5.1 Summary of Decision Rules

Decision Required to be Made	Decision Rule
1. Are there any unacceptable risks to onsite future receptors: - for fly tipped materials? - for soils?	Soil analytical data was compared against DECC endorsed criteria. Statistical analyses of the data in accordance with relevant guidance documents was undertaken, if appropriate, to facilitate the decisions. The following statistical criteria was adopted with respect to soils: Either: the reported concentrations are all below the site criteria; Or: the average site concentration for each analyte must be below the adopted site criterion; no single analyte concentration exceeds 250% of the adopted site criterion; and the standard deviation of the results must be less than 50% of the site criteria. And: the 95% upper confidence limit (UCL) of the average concentration for each analyte must be below the adopted site criterion[5]. If the statistical criteria stated above are satisfied, the answer is No. If the statistical criteria are not satisfied, the answer is Yes.
2. Are there any issues relating to the local area background soil concentrations that exceed appropriate soil criteria?	If the 95% UCL of surface soils exceeds published background concentrations (NEPC 1999), the answer is Yes. Otherwise, the answer is No.
3. Are there any chemical mixtures?	Are there more than 1 group of contaminants present which increase the risk of harm? If there is, the answer is Yes. Otherwise, the answer is No.
4. Are there any aesthetic issues?	If there are any unacceptable odours or soil discolouration, the answer is Yes. Otherwise, the answer is No.
5. Is there any evidence of, or potential for, migration of contaminants from the site?	Are contaminants present at concentrations exceeding published background concentrations (NEPC 1999) AND leachate testing results (SPLP) exceed the ANZECC/ARMCANZ (2000) criteria? If yes, the answer is Yes. Otherwise, the answer is No.
6. Is a site management strategy required?	Was the answer to any of the above decisions Yes? If yes, a site management strategy is required. If no, a site management strategy is not required.

5.1.6 Specify Limits of Decision Error

This step is to establish the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data.

Specific limits for this project are in accordance with the appropriate guidance from the NSW DECC, NEPC (1999), ANZECC/ARMCANZ (2000), DEC (2007), appropriate indicators of data quality (DQIs used to assess quality assurance / quality control) and standard JBS Environmental procedures for field sampling and handling.

To assess the usability of the data prior to making decisions, the data was assessed against pre-determined Data Quality Indicators (DQIs) for completeness, comparability, representativeness, precision and accuracy. The acceptable limit on decision error is 100% compliance with DQIs.

[5] *Sampling Design Guidelines.* (NSW EPA,1995)

The pre-determined Data Quality Indicators (DQIs) established for the project are discussed below in relation to precision, accuracy, representativeness, comparability and completeness (PARCC parameters), and are shown in **Table 5.2**.

- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is assessed by calculating the Relative Percent Difference (RPD) of duplicate samples.
- **Accuracy** - measures the bias in a measurement system. The accuracy of the laboratory data that is generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.
- **Representativeness** –expresses the degree which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.
- **Comparability** - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples; ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- **Completeness** – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.

Table 5.2 Summary of Quality Assurance / Quality Control Program

Data Quality Objective	Frequency	Data Quality Indicator
Precision		
Blind duplicates (intra laboratory)	1 / 20 samples	<50% RPD[1]
Blind duplicates (inter laboratory)	1 / 20 samples	<50% RPD[1]
Accuracy		
Surrogate spikes	All organic samples	70-130%
Laboratory control samples	1 per lab batch	<LOR
Matrix spikes	1 per lab batch	70-130%
Representativeness		
Sampling appropriate for media and analytes		-
Samples extracted and analysed within holding times.	-	pH (7 days), organics (14 days), inorganics (6 months)
Trip spike	1 per sampling event	70-130% recovery
Trip blank	1 per sampling event	<LOR
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All samples
Standard analytical methods used for all analyses	All Samples	All samples
Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples
Limits of reporting appropriate and consistent	All Samples	All samples
Completeness		
Soil description and COCs completed and appropriate	All Samples	All samples
Appropriate documentation	All Samples	All samples
Satisfactory frequency and result for QC samples	All QA/QC samples	-
Data from critical samples is considered valid	-	Critical samples valid

(1) If the RPD between duplicates is greater than the pre-determined data quality indicator, a judgement will be made as to whether the excess is critical in relation to the validation of the data set or unacceptable sampling error is occurring in the field.

5.1.7 Optimise the Design for Obtaining Data

Various strategies for developing a statistically based sampling plan are identified in EPA (1995)[6], including judgemental, random, systematic and stratified sampling patterns.

Systematic sampling is not appropriate based on the identified areas of environmental concern, the site access and the vegetation cover. The potential for contaminants to exist in areas with thick vegetation and difficult site access is lower than the potential for contaminants adjacent to easily accessible tracks and roads. The random sampling pattern is not considered appropriate for similar reasons.

Based on the proposed mix of land uses, a stratified sampling plan has been adopted targeting areas proposed for more sensitive receptors (children's playground), with fewer samples collected from areas under the proposed commercial building footprint.

Based on the site history, judgemental sampling has been used to target areas of environmental concern within the stratified sampling program.

Soil samples were collected from 10 locations across the site (as shown in **Table 5.3**), targeting areas with the greatest potential for contamination from the former roadway (the western portion of the site), and by fly tipping (the external perimeter and access tracks). The sampling strategy resulted in 4 samples within the proposed outdoor area on the western site boundary, which coincides with the location of the main area of environmental concern, the former roadway. Based on the proposed footprint of the site development and the minimal soil access afforded, the sampling strategy is considered appropriate to provide preliminary indications of potential contamination at the site.

5.2 Soil Sampling Methodology

Soil samples across the site were collected via hand auger decontaminated between sample locations. Samples were collected from the surface (0-0.1m) and 0.3m to identify any indications of broad impact due to previous or current site use.

Sufficient sample material was collected to allow both field and laboratory analyses. Additional samples were collected from any soil horizons, which exhibit staining, odours, or other physical evidence of potential contamination.

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indications of contamination were noted on field sheets. Collected soil samples were immediately transferred to laboratory supplied sample jars. The sample containers were transferred to an esky for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form was completed and forwarded with the samples to the testing laboratory.

Not all soil samples collected were analysed. Samples were analysed in accordance with the analytical schedule (**Section 5.3**). All samples remain at the primary laboratory for a period of three months if future analysis (provided analysis of analytes is within holding times) is required following the receipt of sample results.

[6] *Sampling Design Guidelines.* NSW EPA. September 1995. (EPA 1995)

5.3 Laboratory Analyses

JBS Environmental used Envirolab Service Pty Ltd (Envirolab) as the primary laboratory for the required analyses. The secondary laboratory used for the works was SGS Environmental (SGS). Both laboratories are NATA registered for the required analyses. In addition, the laboratories were required to meet JBS Environmental's internal QA/QC requirements. Laboratory analysis of samples was conducted with reference to COPCs listed in **Table 5.3**.

Table 5.3 Analytical Schedule

Media	No. of Sampling Locations	No. of Analyses (incl QA/QC Samples)
Asphalt and subgrade from the former roadway in the western portion of the site	3 (S6, S7, S8)	Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) – 3 samples TPH/BTEX – 2 samples PAHs – 4 samples Asbestos – 1 sample
Fill material along the eastern site boundary and in the western portion of the site	4 (S1, S2, S5, S9)	Heavy metals – 6 samples TPH/BTEX – 6 samples PAHs – 6 samples OCPs/OPPs – 4 samples PCBs – 4 samples Asbestos – 1 sample TCLP/SPLP PAHs and metals – 1 sample
Fly tipped material along the eastern site boundary and in the western portion	3 (S3, S4, S10)	Heavy metals – 3 samples TPH/BTEX – 1 sample Asbestos – 3 samples

6 Assessment Criteria

6.1 Regulatory Guidelines

The investigation was undertaken with consideration to aspects of the following guidelines, as relevant:

- *Contaminated Sites: Guidelines for Assessing Service Station Sites,* NSW EPA, 1994 (EPA 1994)
- *Contaminated Sites: Sampling Design Guidelines,* NSW EPA, 1995 (EPA 1995)
- Contaminated Sites: Guidelines for the Vertical Mixing of Soil on Former Broad-Acre Agricultural Land, NSW EPA, 1995 (EPA 1995b)
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, NSW EPA, 1997 (EPA 1997)
- *Contaminated Sites: Guidelines for Assessing Banana Plantation Sites,* NSW EPA, 1997 (EPA 1997b)
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, 2nd Edition,* NSW EPA, 2006 (DEC 2006)
- *Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report,* NSW EPA, 1999 (EPA 1999)
- *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 (NEPC 1999)
- *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites,* Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, 1992 (ANZECC/NHMRC 1992)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4, 2000 (ANZECC/ARMCANZ 2000)
- *Australian Drinking Water Guidelines,* National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, 2004 (NHMRC/NRMMC 2004)
- *Composite Sampling,* Lock, W. H., National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, (NEHF 1996)
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards,* Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, June 2002 (EnHealth 2002)
- *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination,* NSW DEC, March 2007 (DEC 2007)

6.2 Soil Criteria

Based on the proposed mixed retail/commercial and residential use, and the proposed children's playground, a stratified sampling approach was adopted. The site was divided into two portions (as shown in **Figure 2**), including the proposed outdoor area including the children's playground (the northern portion), and those areas underneath the proposed footprint of the retail development (the central and southern portions).

In accordance with the decision process for assessment of urban redevelopment sites (DEC 2006), soil analytical results were compared against:

- Health-based soil investigation levels for standard residential use (HIL-A) and the phytotoxicity based investigation levels (PBILs) for samples within the proposed outdoor area. These criteria were considered appropriate based on the proposed children's playground in this portion of the site.
- Health-based soil investigation levels for residential use with minimal soil access (HIL-D) for samples underneath the proposed building footprint. These criteria were considered appropriate as they are more conservative than the commercial/industrial (HIL-F) which were also relevant (**Table 6.1**).

Table 6.1 Soil Criteria (all units in mg/kg)

	Limit of Reporting	Laboratory Method	Health-Based Investigation Level (residential) (NEHF – A)[1]	Ecological-based Investigation level	Health-Based Investigation Level (residential, minimal soil access) (NEHF – D)[3]	Health-Based Investigation Level (commercial/ industrial) (NEHF – F)[4]
METALS						
Arsenic	4.0	ICP-AES (USEPA 200.7)	100	20[2]	100	500
Cadmium	1.0	ICP-AES (USEPA 200.7)	20	3[2]	20	100
Chromium (VI)	1.0	ICP-AES (USEPA 200.7)	100	1[2]	100	500
Copper	1.0	ICP-AES (USEPA 200.7)	1000	100[2]	1000	500
Nickel	1.0	ICP-AES (USEPA 200.7)	600	60[2]	600	3,000
Lead	1.0	ICP-AES (USEPA 200.7)	300	600[2]	300	1,500
Zinc	1.0	ICP-AES (USEPA 200.7)	7000	200[2]	7000	35,000
Mercury (inorganic)	0.1	ICP-AES (USEPA 200.7)	15	1[2]	15	75
PETROLEUM HYDROCARBONS						
C6 – C9 Fraction	25	Purge Trap-GCMS (USEPA8260)	65[5]	-	65[4]	-
C10 – C36 Fraction	250	Purge Trap-GCFID (USEPA8000)	1000[5]	-	1000[4]	-
BTEX						
Benzene	1.0	Purge Trap-GCMS (USEPA8260)	1[5]	-	1[5]	1[5]
Toluene	1.0	Purge Trap-GCMS (USEPA8260)	130[5]	1.4[5]	130[5]	130[5]
Ethylbenzene	1.0	Purge Trap-GCMS (USEPA8260)	50[5]	3.1[5]	50[5]	50[5]
Total Xylenes	3.0	Purge Trap-GCMS (USEPA8260)	25[5]	14[5]	25[5]	25[5]
POLYCYCLIC AROMATIC HYDROCARBONS						
Benzo(a)pyrene	0.05	GCMS (USEPA8270)	1	-	1	5
Total PAHs	1.55	GCMS (USEPA8270)	20	-	20	100
ORGANOCHLORINE PESTICIDES						
Aldrin + Dieldrin	0.2	GCECD (USEPA8140,8080)	10	-	10	50
Chlordane	0.1	GCECD (USEPA8140,8080)	50	-	50	250
DDT + DDD + DDE	0.3	GCECD (USEPA8140,8080)	200	-	200	1,000
Heptachlor	0.1	GCECD (USEPA8140,8080)	10	-	10	50
PCBs						
PCBs (total)	0.9	GCECD (USEPA8140,8080)	10	-	10	50
OTHER						
Asbestos	Presence	PLM / Dispersion Staining	No fibres observed using NATA accredited analysis			

[1] Column 1 (NEHF - A), Health-based Investigation Levels (DEC 2006)
[3] Column 5 (PBIL), Soil Investigation Levels for Urban Redevelopment Sites (DEC 2006)
[3] Column 2 (NEHF - D), Health-based Investigation Levels (DEC 2006)
[4] Column 4 (NEHF - F), Health-based Investigation Levels (DEC 2006)
[5] Table 3 (EPA 1994)

7 Quality Assurance / Quality Control

7.1 Soil QA/QC Results

The QA/QC results for soil are summarised in **Table 7.1** and discussed in **Section 7.2** below. Detailed QA/QC results are included the laboratory reports in **Appendix H**.

Table 7.1 - Soil QA/QC Results Summary

Data Quality Objective	Results	DQI met?
Precision		
Soil Blind duplicates (intra laboratory)	29 – 80% RPD	Partial[1]
Soil Blind triplicates (inter laboratory)	21 - 40% RPD	Yes
Trip spike	86 - 109%	Yes
Trip blank	<LOR	Yes
Accuracy		
Surrogate spikes	72 - 135% Rec	Partial[1]
Matrix spikes	57 - 135% Rec	Partial[1]
Representativeness		
Sampling appropriate for media and analytes	All sampling conducted in accordance with JBS procedures	Yes
Laboratory blanks	<LOR	Yes
Samples extracted and analysed within holding times.	All samples were extracted and analysed within 7 days of sampling, with the exception of asbestos, which was analysed within 10 days of sampling.	Yes
Comparability		
Standard operating procedures used for sample collection & handling	A single field staff member used same standard operating procedures throughout works	Yes
Standard analytical methods used	Standard analytical methods used as listed in **Table 6.1**.	Yes
Consistent field conditions, sampling staff and laboratory analysis	Sampling was conducted by the field staff using standard operating procedures in the same conditions throughout the works. Primary and secondary labs remained consistent throughout the investigation.	Yes
Limits of reporting appropriate and consistent	Limits of reporting were consistent and appropriate.	Yes
Completeness		
Soil description & COCs completed	All bore logs and COCs were completed appropriately.	Yes
Appropriate documentation	All appropriate field documentation is included in the Appendices.	Yes
Satisfactory frequency/result for QC samples	The QC results are considered adequate for the purposes of the investigation.	Yes
Data from critical samples is considered valid	Data from critical samples is considered valid.	Yes

[1] See discussion of DQI exceedances below.

7.2 Soil QA/QC Discussion

Field duplicates had relative percentage differences (RPDs) generally within the acceptable range of less than 50%, with the exception of chromium in primary sample S1-0.1 and duplicate sample QC1, which had an RPD of 80%.

The elevated RPD noted for chromium is due primarily to the reported concentrations being close to the limit of reporting. The elevated RPD is not considered to affect the conclusions of the investigation as the remaining RPDs are within the acceptable range.

Surrogate spikes were detected slightly outside the target range for terphenyl (surrogate for PAHs) (135%). The surrogate spike recovery above the target range is not considered to affect the analytical dataset significantly, as it may indicate a slight over-reporting of PAHs. Across the site, PAHs were generally reported at low concentrations with the exception of S9-0.1, which reported B(a)P and PAHs above the adopted criteria for that portion of the site.

Matrix spikes were detected slightly below the target range for several OCPs (ranging from 57-59%). The decreased matrix spike recovery in this case is not considered to affect the analytical dataset significantly, as OCPs across the site were consistently reported below the laboratory limit of reporting.

7.3 QA/QC Conclusion

The field sampling and handling procedures produced QA/QC results which indicate that the soil data is of an acceptable quality and is suitable for use in site characterisation.

The NATA certified laboratory results sheets indicate that the project laboratory was generally achieving levels of performance within its recommended control limits during the period when the samples from this program were analysed.

On the basis of the results of the field and laboratory QA/QC program, the soil data is of an acceptable quality upon which to draw conclusions regarding the environmental condition of the site.

8 Discussion of Soil Results

8.1 Field Observations

Geology encountered at the site during the field works is summarised below. Soil descriptions are included in **Table A**.

Aesthetic issues identified at the site include small areas of remnant asphalt remaining in the western portion of the site, and dumped material present along the eastern site boundary, and within the western portion.

There was no other visual or olfactory evidence of contamination identified during the collection of soil samples.

Shallow silty sand fill material was identified near the eastern and northern site boundaries, adjacent to the Old Illawarra and New Illawarra Rds. The fill was underlain by natural sandy soil between 0.1 and 0.25m bgs.

Natural soils were typically found to consist of loose brown or grey silty sand with sandstone cobbles present. Bedrock, consisting of sandstone was typically found to be shallow, and observed outcropping in several areas.

8.2 Soil Analytical Results

The soil sampling locations are shown on **Figure 2** and summarised laboratory results are presented in **Tables B** and **C**. Detailed laboratory reports and chain of custody documentation is provided in **Appendix G**.

The summary laboratory results are discussed in the following sections.

8.2.1 Metals

There were no concentrations of any heavy metals reported above the adopted health based criteria for either standard residential use with gardens and accessible soil (HIL-A), or for residential use with limited access to soils (HIL-D) in any soil sample selected for analysis.

There were no heavy metal concentrations reported exceeding the phytotoxicity-based investigation levels (PBILs) in any soil sample.

Based on the analytical results, heavy metals are not considered to pose a contaminant issue in soil at the site.

8.2.2 TPH/BTEX

There were no reported concentrations of TPH /BTEX compounds above the human health and ecologically based threshold criteria detected at the site. On this basis, TPH/BTEX compounds are not considered to pose a contamination issue in soil at the site.

8.2.3 PAHs

B(a)P (2.7mg/kg) and PAHs (27.3mg/kg) were detected in S9-0.1 above the HIL-A criteria adopted for the northern portion of the site (1mg/kg and 20mg/kg, respectively). Statistical criteria for B(a)P adopted in the decision rule (**Section 5.1.5**) was not satisfied as the maximum concentrations for B(a)P was greater than 250% of the adopted criteria. In addition, the data set available contained too few samples to calculate a representative 95% UCL for both B(a)P and PAHs.

The sample was collected from silty sand at the surface at S9, which targeted the former road. The elevated PAHs are likely due to trace amounts of asphalt remaining in the surface soil in this location, after the removal of the asphalt surface. The identified soil impact is considered likely to be shallow, and is not expected to extend beyond 0.1m bgs.

Other samples collected from the surface soils of the former roadway reported PAHs below the adopted criteria, or below the LOR. Leachate analysis conducted on one sample indicates that the PAHs sourced by asphalt on the former roadway are not leachable.

On this basis, the elevated B(a)P and PAHs identified in sample location S9 pose a contamination issue in the northern portion of the site.

There were no reported concentrations of PAHs above the adopted HIL-D criteria in any sample collected from the central and southern portions of the site. On this basis, PAH compounds are not considered to pose a contamination issue in these portions of the site.

8.2.4 OCP/OPP/PCBs

There were no reported concentrations of OCP/OPP/PCBs above the laboratory LOR in any sample. On this basis, OCP/OPP/PCB compounds are not considered to pose a contamination issue in soil at the site.

8.2.5 Asbestos

Asbestos was not identified in any soil sample analysed from the site, nor were fibre cement fragments identified in any fly tipped material, or on the surface across the site.

Based on this, asbestos is not considered to pose a contamination issue at the site.

8.3 Material Classification

A material classification of the surface soils has been conducted. The classification is based on current analytical results and documentation is included in **Appendix H**.

Based on the results of this investigation, and subject to the limitations in **Section 10**:

- Asphalt containing materials are classified as Inert Waste in accordance with the DEC (2004) Guidelines (Table 1); and
- The surface soils across the site are classified as Inert Waste in accordance with the DEC (2004) Guidelines (Table A4).

9 Conclusions and Recommendations

9.1 Conclusions

Based on the findings of this investigation and subject to the limitations in **Section 10**, the following conclusions are made:

- The residual asphalt materials in the northern portion of the site contain levels of PAHs which require remediation in order to make this portion of the site suitable for the proposed use (ie. children's playground).
- The remainder of the site did not report any concentrations of metals, TPH/BTEX, OCP/OPPs, PCBs or asbestos which requires remediation for the proposed uses.
- No background soil concentrations were identified across the site which exceed the adopted site criteria.
- The potential for migration of contaminants from the site via surface water or groundwater is considered to be low based on the non-leachable nature of the minor soil contamination identified, and the likely depth to groundwater within the hard sandstone at the site.
- The site can be made suitable for the proposed commercial/residential uses subject to the successful remediation and validation of the identified PAH impacted residual asphalt materials in the northern portion of the site.

9.2 Recommendations

It is recommended that a Remedial Action Plan be prepared and implemented to address the identified PAH contaminated asphalt materials in the northern portion of the site.

10 Limitations

This report has been prepared for use by the client who commissioned the works in accordance with the project brief only and has been based in part on information obtained from other parties. The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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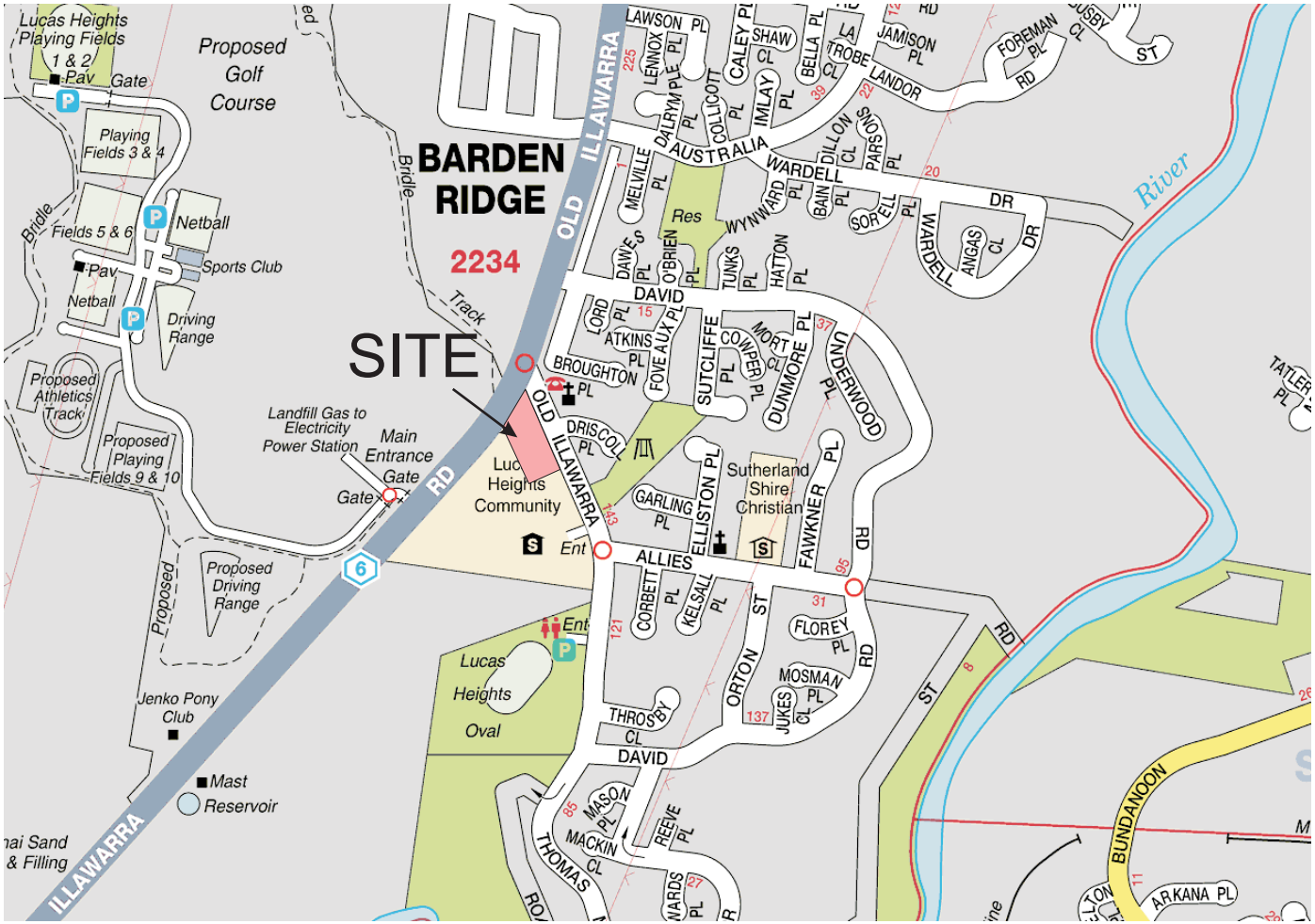
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements and site history, not on sampling and analysis of all media at all locations for all potential contaminants.

Limited sampling and laboratory analyses were undertaken as part of the investigations, as described herein. Ground conditions between sampling locations may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the sites, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS Environmental Pty Ltd reserves the right to review the report in the context of the additional information.

Figures



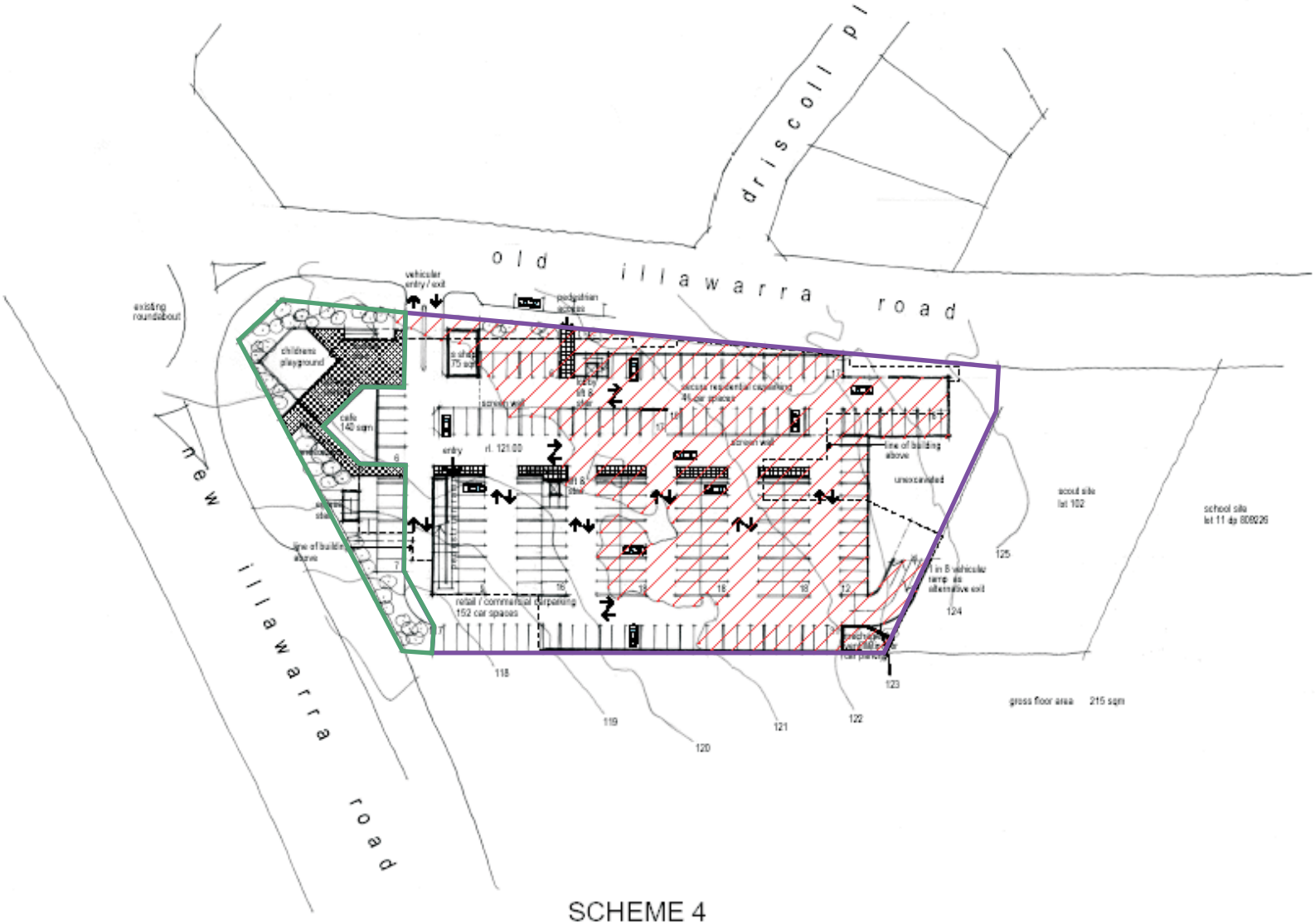
JBS ENVIRONMENTAL

0 500m

Approximate scale

Figure 1 **Site Location**
Lot 101 DP1028645, Barden Ridge NSW

Department of Lands (2008)
Note- All locations shown are approximate only



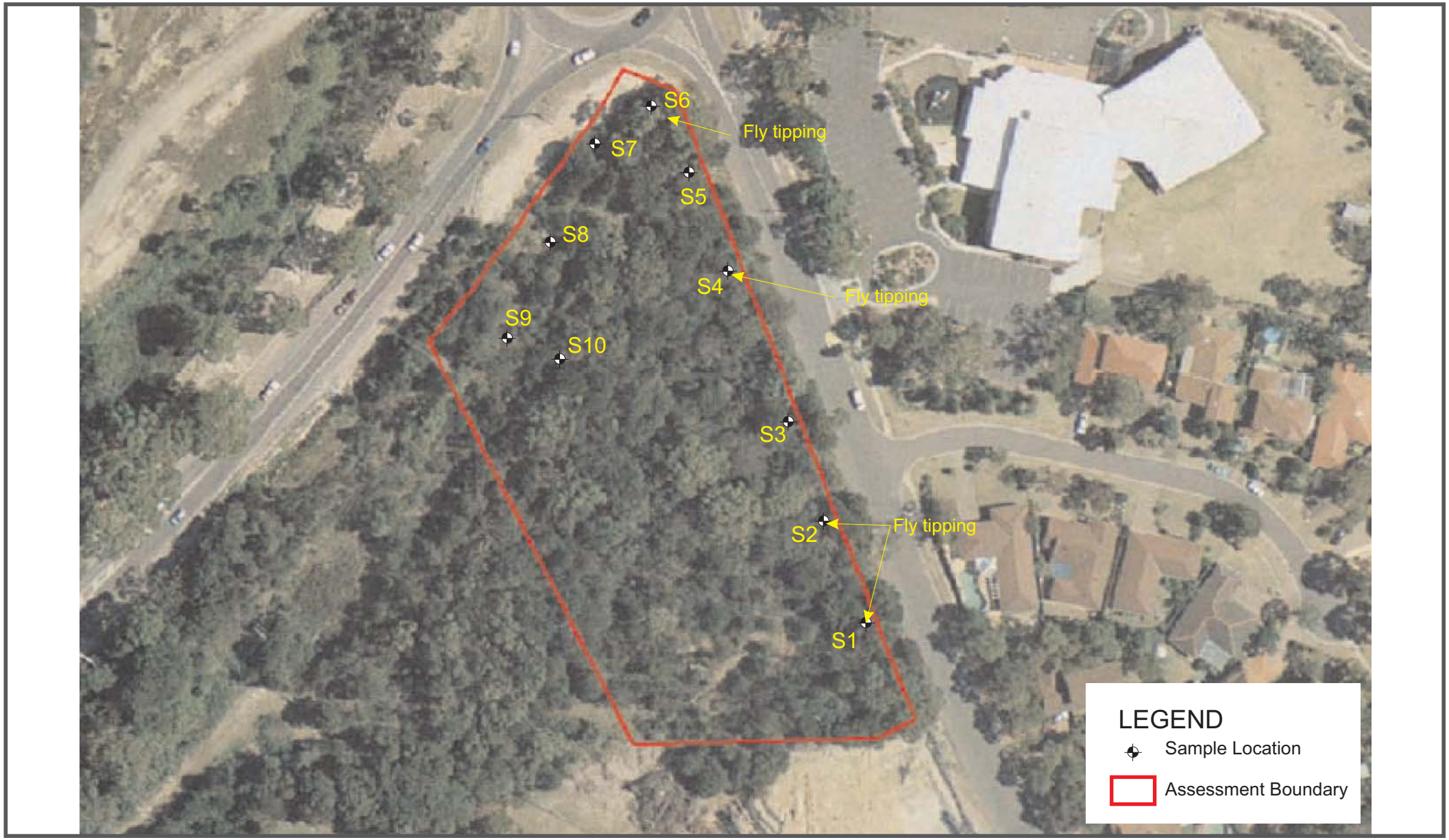
JBS ENVIRONMENTAL

Figure 2 Proposed Site Layout
(plan provided by Arben management)
Legend

Northwestern portion

Central and Southeastern portion

SCHEME 4
CARPARKING
LOWER GROUND FLOOR PLAN
LOT 101 DP 1028645
NEW ILLAWARRA ROAD + OLD ILLAWARRA ROAD
BARDEN RIDGE, NSW
FOR GANDANGARA LOCAL ABORIGINAL LAND COUNCIL
05090 SK4.01B



JBS ENVIRONMENTAL

0 100m

Approximate scale

Figure 3 **Current Site Layout and Sampling Locations Lot 101 DP1028645, Barden Ridge, NSW**

Department of Lands (2008)
Note- All locations shown are approximate only

Tables

Job No. 40517
Lot 101 DP1028645, Barden Ridge
Table A - Soil Sample Register

Sample id	Sample Depth	Date	Sample Description	Analytes
S1-0.1	0.1m	20/03/2008	Grey sand, dry, loose fine, well sorted, some leaf litter	Heavy metals TPH, BTEX, PAHs, OCP/OPPs, PCBs
S1-0.3	0.3m	20/03/2008	Grey and brown sand with sandstone cobbles dry, loose fine, well sorted	
S2-0.1	0.1m	20/03/2008	Light brown sand, homogenous, dry, loose, well sorted, some leaf litter	Heavy metals, TPH, BTEX and PAHs, TCLP/SPLP metals and PAHs
S2-0.3	0.3m	20/03/2008	Light brown sand with some sandstone cobbles, homogenous, dry, loose	
S3-0.1	0.1m	20/03/2008	Sandy fill, with topsoil and leaf littler, heterogenous, dry, loose, poorly sorted	Heavy metals, asbestos
S3-0.3	0.3m	20/03/2008	Light brown sand with some sandstone cobbles, heterogenous, dry, loose, well sorted	
S4-0.1	0.1m	20/03/2008	Light brown sand fill, homogenous, dry, loose, well sorted, some leaf litter	Heavy metals, asbestos
S4-0.3	0.3m	20/03/2008	Yellow sand fill, heterogenous, dry, loose, fine trace asphalt, sandstone cobbles	
S5-0.1	0.1m	20/03/2008	Brown sand, heterogenous, dry, loose, poorly sorted, som leaf litter and mulch, some sandstone cobbles	Heavy metals TPH, BTEX, PAHs, OCP/OPPs, PCBs, asbestos
S5-0.3	0.3m	20/03/2008	Brown sand, heterogenous, dry, loose, poorly sorted, some sandstone cobbles	
S6-0.1	0.1m	20/03/2008	Light brown sand, homogenous, dry, loose, well sorted, some leaf litter	Heavy metals, PAHs
S6-0.3	0.3m	20/03/2008	Light brown sand, homogenous, dry, loose, well sorted	
S7-0.1	0.1m	20/03/2008	Brown sandy silt, homogenous, dry, soft, small sandstone pebbles, trace leaf litter	Heavy metals, PAHs
S7-0.3	0.3m	20/03/2008	Yellow sand, homogenous, dry, soft, medium dense, well sorted, some cobbles of sandstone	
S8-0.1	0.1m	20/03/2008	Silty brown fill, homogenous, dry, soft, trace asphalt	Heavy metals, TPH, BTEX, PAHs, asbestos
S8-0.2	0.3m	20/03/2008	Brown silty sand, homogenous, dry, well sorted	TPH, BTEX, PAHs
S9-0.1	0.1m	20/03/2008	Light brown silty sand, trace asphalt, homogenous dry, loose, fine	Heavy metals TPH, BTEX, PAHs, OCP/OPPs, PCBs
S9-0.3	0.3m	20/03/2008	Light brown silty sand, homogenous dry, loose, fine	
S10-0.1	0.1m	20/03/2008	Light brown/grey sand, homogenous, dry, loose, well sorted	Heavy metals, TPH, BTEX, PAHs
S10-0.3	0.3m	20/03/2008	Light brown/grey sand, homogenous, dry, loose, well sorted	
QA/QC				
QA1	-	20/03/2008	Duplicate of S1-0.1	Heavy metals, TPH, BTEX, PAHs, OCP/ OPPs, PCBs
QA1A	-	20/03/2008	Triplicate of S1-0.1	Heavy metals, TPH, BTEX, PAHs
TRIP BLANK	-	20/03/2008	Trip blank	BTEX
TRIP SPIKE	-	20/03/2008	Trip spike	BTEX

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Table B - Summary Soil Results

Notes:

(1) Phytotoxicity Based Investigation Levels (Column 5, DEC 2006)
(2) Residential with gardens and accessible soil (Column 1, DEC 2006)
(3) Commercial/Industrial (Column 4, DEC 2006)
(4) Threshold concentrations for sensitive land use - soils (Table 3. NSW EPA 1994)
(5) Commercial or Industrial (Column 4, DEC 2006)
(6) Threshold concentrations for sensitive land use - soils (Table 3. EPA 1994)

bold above PBIL
bold above HIL (A) / Threshold Concentrations
bold above HIL (D) / Threshold Concentrations

All units in mg/kg unless indicated.

FILE REF: G:\JBS Environmental\Projects\Arben Management\40517 Barden Ridge Commercial\Reports\[40517 Soil Summary Tables.xls]Table B - Summary Results Soil

Sample number	Metals								BTEX				TPH		PAHs		Organochlorine Pesticides				OPPs	PCBs	Asbestos
	Arsenic	Cadmium	Chromium (Total)	Copper	Lead	Mercury	Nickel	Zinc	Benzene	Toluene	Ethyl-benzene	Xylenes	C6 - C9	C10 - C36	Benzo (a) pyrene	Total PAHs	Aldrin + Dieldrin	Chlordane	Heptachlor	DDT + DDD + DDE	OPPs	Total PCBs	Asbestos
LOR	4.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0	0.5	0.5	1.0	3.0	25	250	0.05	1.55	0.2	0.2	0.1	0.3	0.8	0.6	-
Landuse criteria (mg/kg)																							
PBIL (1)/ TC (6)	20	3	400 (CrIII)	100	600	1	60	200	-	1.4	3.1	14	-	-	-	-	-	-	-	-	-	-	-
Residential (NEHF - A) (2) / TC (6)	100	20	12% (CrIII)	1000	300	15	600	7000	1	130	50	25	65	1000	1	20	10	50	10	200	-	10	NIL
Residential (NEHF - D) (3)	400	80	48% (CrIII)	4,000	1,200	60	2,400	28,000	-	-	-	-	65	1000	4	80	40	200	40	800	-	40	NIL
Parks/Open Space (HIL - E) (4)	200	40	24% (CrIII)	2,000	600	30	600	14,000	-	-	-	-	65	1000	2	40	20	100	20	400	-	20	NIL
Commercial/ Industrial (HIL - F) (5)	500	100	60% (CrIII)	5,000	1,500	75	3,000	35,000	-	-	-	-	65	1000	5	100	50	250	50	1000	-	50	NIL
Northern Portion (Children's playground)																							
S6-0.1	5.4	<1	9.5	12	26	<0.1	5.8	42	-	-	-	-	-	-	<0.05	<1.55	-	-	-	-	-	-	-
S7-0.1	4.9	<1	19	4.5	13	<0.1	1.7	11	-	-	-	-	-	-	<0.05	<1.55	-	-	-	-	-	-	-
S8-0.1	<4	<1	10	37	16	<0.1	34	74	<0.5	<0.5	<1	<3	<25	<250	0.09	0.89	-	-	-	-	-	-	NIL
S8-0.2	-	-	-	-	-	-	-	-	<0.5	<0.5	<1	<3	<25	<250	<0.05	<1.55	-	-	-	-	-	-	-
S9-0.1	<4	<1	4.7	15	34	<0.1	1.8	80	<0.5	<0.5	<1	<3	<25	430	**2.7**	**27.3**	<2	<2	<1	<3	<8	<6	-
Central and southern portions (Remainder of site)																							
S1-0.1	<4	<1	4.2	3.5	16	<0.1	1.4	12	<0.5	<0.5	<1	<3	<25	<250	<0.05	<1.55	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6	-
S2-0.1	<4	<1	12	2	12	<0.1	<1	9.4	<0.5	<0.5	<1	<3	<25	<250	<0.05	<1.55	-	-	-	-	-	-	-
S3-0.1	<4	<1	10	7.4	49	<0.1	3.2	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NIL
S4-0.1	<4	<1	7.5	<1	5.8	<0.1	<1	3.7	-	-	-	-	-	-	-	-	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6	-
S5-0.1	4.4	<1	6.2	13	20	<0.1	1.7	17	<0.5	<0.5	<1	<3	<25	<250	<0.05	<1.55	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6	NIL
S10-0.1	<4	<1	7.3	3.7	22	<0.1	1.1	26	<0.5	<0.5	<1	<3	<25	<250	0.09	0.59	-	-	-	-	-	-	-
QA/QC																							
QA1 (duplicate of S1-0.1)	<4	<1	1.8	2.2	12	<0.1	<1	8.8	<0.5	<0.5	<1	<3	<25	180	<0.05	<1.55	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6	-
QA1A (triplicate of S1-0.1)	<3	<0.3	3.4	2.6	13	<0.05	0.93	9.7	<0.5	<0.5	<0.5	<1.5	<20	<120	<0.05	<1.85	-	-	-	-	-	-	-
Trip Spike	-	-	-	-	-	-	-	-	86%	103%	106%	109%	-	-	-	-	-	-	-	-	-	-	-
Trip Blank	-	-	-	-	-	-	-	-	<1	<1	<1	<3	-	-	-	-	-	-	-	-	-	-	-

Note: Different Investigation Levels were adopted for the two distinct parts of the site, according to the proposed landuses

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Table C - Relative Percentage Difference Calculations

FILE REF: G:\JBS Environmental\Projects\Arben Management\40517 Barden Ridge Commercial\Reports\[40517 Soil Summary Tables.xls]Table B - Summary Results Soil

		Metals								BTEX				TPH		PAHs		Organochlorine Pesticides				OPPs	PCBs
	Sample ID	Arsenic	Cadmium	Chromium (Total)	Copper	Lead	Mercury	Nickel	Zinc	Benzene	Toluene	Ethyl-benzene	Xylenes	C6 - C9	C10 - C36	Benzo (a) pyrene	Total PAHs	Aldrin + Dieldrin	Chlordane	Heptachlor	DDT + DDD + DDE	OPPs	Total PCBs
Laboratory LOR		3.0	1.0	1.0	1.0	1.0	0.05	1.0	1.0	0.5	0.5	0.5	1.5	25	-	0.05	1.55	0.2	0.2	0.1	0.3	0.1	0.6
Blind Duplicate Pairs																							
Original	S1-0.1	<4	<1	4.2	3.5	16	<0.1	1.4	12	<0.5	<0.5	<1	<3	<25	<250	<0.05	<1.55	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6
Duplicate	QA1 (duplicate of S1-0.1)	<4	<1	1.8	2.2	12	<0.1	<1	8.8	<0.5	<0.5	<1	<3	<25	180	<0.05	<1.55	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6
RPDs (Dup.)		NA	NA	**80%**	46%	29%	NA	NA	31%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Original	S1-0.1	<4	<1	4.2	3.5	16	<0.1	1.4	12	<0.5	<0.5	<1	<3	<25	<250	<0.05	<1.55	<0.2	<0.2	<0.1	<0.3	<0.8	<0.6
Duplicate	QA1A (triplicate of S1-0.1)	<3	<0.3	3.4	2.6	13	<0.05	0.93	9.7	<0.5	<0.5	<0.5	<1.5	<20	<120	<0.05	<1.85	-	-	-	-	-	-
RPDs (Dup.)		NA	NA	27%	30%	21%	NA	40%	21%	NA	NA	NA	NA	NA	NA	NA	NA	-	-	-	-	-	-

bold Exceeds target of 30-50%
Note: RPDs were not calculated for analytes which had reported results below detection limits

Appendix A

Aerial Photographs

Appendix B

Title Records

Appendix C

DECC Records

Appendix D

Heritage Records

Appendix E

Council Records

Appendix F

Workcover (Dangerous Goods) Records

Appendix G

Laboratory Reports and Chain of Custody Documentation

Appendix H

Preliminary Material Classification

Appendix G –Material Classification

A material classification of the surface soils based on current analytical results is presented below.

A summary of the analytical results and classification of the surface soils is provided in **Appendix A**. Detailed laboratory reports and chain of custody documentation is provided in **Appendix B**.

Table 1 – Classification of Surface Soils (excluding asphalt containing material)

Element		95% UCL (mg/kg)	Max. TCLP (mg/L)	Classification by Element[1]	Overall Classification
Metals	Arsenic	3.7	<0.05	INERT	**INERT**
	Cadmium	<1	<0.01	INERT	
	Chromium	11.5	0.02	INERT	
	Lead	28.6	<0.01	INERT	
	Mercury	<0.1	<0.0005	INERT	
	Nickel	19.5	<0.02	INERT	
BTEX	Benzene	<0.5	-	INERT	
	Toluene	<0.5	-	INERT	
	Ethyl-benzene	<1	-	INERT	
	Xylenes	<3	-	INERT	
TPH	C6 - C9	<25	-	INERT	
	C10 - C36	253	-	INERT	
OCP	Aldrin + Dieldrin	<0.2	-	N/A	
	Chlordane	<0.2	-	N/A	
	DDT + DDD + DDE	<0.3	-	N/A	
PCBs	Total PCBs	<0.6	-	INERT	
PAHs	Total PAHs	<1.55	<0.016	INERT	
	B(a)P	<0.05	<0.001	INERT	
Asbestos	Fibres in soil	No asbestos fibres detected in soil.		N/A	

Notes:
[1] DEC (2004) *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-liquid Wastes*

Based on the results of this investigation, and subject to the limitations in **Appendix A**, the following conclusions are made:

- Asphalt containing materials are classified as Inert Waste in accordance with the DEC (2004) Guidelines (Table 1); and
- The surface soils across the site are classified as Inert Waste in accordance with the DEC (2004) Guidelines (Table A4).

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	Cathy Roberts	Andrew Lau	Andrew Lau		3/4/2008