NSW Site Auditor Scheme

Site Audit Statement

A site audit statement summarises the findings of a site audit. For full details of the site auditor's findings, evaluations and conclusions, refer to the associated site audit report.

This form was approved under the *Contaminated Land Management Act 1997* on 12 October 2017.

For information about completing this form, go to Part IV.

Part I: Site audit identification

Site audit statement no. **304**

This site audit is a:

☑ statutory audit

~~☑ non-statutory audit~~

within the meaning of the *Contaminated Land Management Act 1997*.

Site auditor details

(As accredited under the *Contaminated Land Management Act 1997*)

Name	**Rod Harwood**	
Company	**Harwood Environmental Consultants**	
Address	**Suite F, Building 38 Suakin Drive**	
	Mosman, NSW	**Postcode 2088**
Phone	**0438 200 055**	
Email	rod@harwoodenviro.com.au	

Site details

Address	**15-21 and 25-33 Brighton Avenue**	
	Croydon Park, NSW	**Postcode 2113**

Property description

(Attach a separate list if several properties are included in the site audit.)

Lot C DP440959, Lot 2A Section 2 DP3010, Lot A&B DP33356, Lot 1 DP123636

Lot 10, DP102819

Local government area **Canterbury-Bankstown Council**

Area of site (include units, e.g. hectares) 1.98 hectares

Current zoning **IN2 Light Industrial**

To the best of my knowledge:

☐ ~~the site **is** the subject of a declaration, order, agreement, proposal or notice under the Contaminated Land Management Act 1997 or the Environmentally Hazardous Chemicals Act 1985, as follows: (provide the no. if applicable)~~

- ☐ ~~Declaration no.~~
- ☐ ~~Order no.~~
- ☐ ~~Proposal no.~~
- ☐ ~~Notice no.~~

☑ the site **is not** the subject of a declaration, order, proposal or notice under the Contaminated Land Management Act 1997 or the Environmentally Hazardous Chemicals Act 1985.

To the best of my knowledge:

☐ ~~the site has been notified to the EPA under section 60 of the Contaminated Land Management Act 1997~~

☑ the site **has not** been notified to the EPA under section 60 of the Contaminated Land Management Act 1997.

Site audit commissioned by

Name **Andrew Shehadeh**

Company **Dyldam**

Address **L1, 74 Macquarie Street**

Parramatta, NSW **Postcode 2150**

Phone **(02) 8320 8285**

Email Andrew.shehadeh@dyldam.com.au

Contact details for contact person (if different from above)

Name *as above*

Phone *as above*

Email *as above*

Nature of statutory requirements (not applicable for non-statutory audits)

☐ ~~Requirements under the Contaminated Land Management Act 1997 (e.g. management order; please specify, including date of issue)~~

☐ ~~Requirements imposed by an environmental planning instrument (please specify, including date of issue)~~

☑ Development consent requirements under the *Environmental Planning and Assessment Act 1979* (please specify consent authority and date of issue)

Canterbury-Bankstown Council is currently re-zoning and is yet to issue a new DA

Proposal Number PP_2015_CANTE_004_00 refers

☐ ~~Requirements under other legislation (please specify, including date of issue)~~

Purpose of site audit

☐ **A1** To determine land use suitability

OR

☐ **A2** To determine land use suitability subject to compliance with either an active or passive environmental management plan

Intended uses of the land:

OR

(Tick all that apply)

☐ **B1** To determine the nature and extent of contamination

☐ **B2** To determine the appropriateness of:

- ☐ an investigation plan
- ☐ a remediation plan
- ☐ a management plan

☐ **B3** To determine the appropriateness of a site testing plan to determine if groundwater is safe and suitable for its intended use as required by the Temporary Water Restrictions Order for the Botany Sands Groundwater Resource 2017

☐ **B4** To determine the compliance with an approved:

- ☐ **voluntary management proposal** or
- ☐ **management order** under the *Contaminated Land Management Act 1997*

☑ **B5** To determine if the land can be made suitable for a particular use (or uses) if the site is remediated or managed in accordance with a specified plan.

Intended uses of the land: **High Density mixed Commercial and Residential**

Information sources for site audit

Consultancies which conducted the site investigations and/or remediation:

Environmental Investigations Australia (EIA)

Titles of reports reviewed:

- EI Australia (2016) *Preliminary Site Investigation; 15-33 Brighton Avenue, Croydon Park NSW* (EI Report E22142 AA_Rev0; dated 26 May, 2016);
- EI Australia (2018a) *Detailed Site Investigation; 25-33 Brighton Avenue, Croydon Park NSW* (EI Report E23775.E02_Rev0; dated 20 April, 2018); and
- EI Australia (2018b) *Detailed Site Investigation; 15-21 Brighton Avenue, Croydon Park NSW* (EIReport E23959.E02_Rev0; dated 10 September, 2018).
- EI Australia (2019) *Remedial Action Plan, 15-21 Brighton Avenue, Croydon Park NSW (*EIReport, E22142.E06_RevO; 30September, 2019)

Other information reviewed, including previous site audit reports and statements relating to the site:

None

Site audit report details

Title: Site Audit Report for SAS 304, 15-13 Brighton Street, Croydon Park, NSW

Date **06/03/2020**

Part II: Auditor's findings

Please complete either Section A1, Section A2 or Section B, not more than one section. (Strike out the irrelevant sections.)

- Use **Section A1** where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land uses **without the implementation** of an environmental management plan.
- Use **Section A2** where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land uses **with the implementation** of an active or passive environmental management plan.
- Use **Section B** where the audit is to determine:
    - (B1) the nature and extent of contamination, and/or
    - (B2) the appropriateness of an investigation, remediation or management plan[1], and/or
    - (B3) the appropriateness of a site testing plan in accordance with the *Temporary Water Restrictions Order for the Botany Sands Groundwater Source 2017*, and/or
    - (B4) whether the terms of the approved voluntary management proposal or management order have been complied with, and/or
    - (B5) whether the site can be made suitable for a specified land use (or uses) if the site is remediated or managed in accordance with the implementation of a specified plan.

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

Section A1

I certify that, in my opinion:

The **site is suitable** for the following uses:

(Tick all appropriate uses and strike out those not applicable.)

☐ Residential, including substantial vegetable garden and poultry

☐ Residential, including substantial vegetable garden, excluding poultry

☐ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry

☐ Day care centre, preschool, primary school

❑ Residential with minimal opportunity for soil access, including units

☐ Secondary school

☐ Park, recreational open space, playing field

❑ Commercial/industrial

☐ Other (please specify):

_____

OR

☐ I certify that, in my opinion, the site is not suitable for any use due to the risk of harm from contamination.

Overall comments:

_____

_____

_____

_____

_____

_____

Section A2

I certify that, in my opinion:

Subject to compliance with the **attached** environmental management plan[2] (EMP), the site is suitable for the following uses:

(Tick all appropriate uses and strike out those not applicable.)

☐ ~~Residential, including substantial vegetable garden and poultry~~

☐ ~~Residential, including substantial vegetable garden, excluding poultry~~

☐ ~~Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry~~

☐ ~~Day care centre, preschool, primary school~~

☐ ~~Residential with minimal opportunity for soil access, including units~~

☐ ~~Secondary school~~

☐ ~~Park, recreational open space, playing field~~

☐ ~~Commercial/industrial~~

☐ ~~Other (please specify):~~

_____

EMP details

Title _____

Author _____

Date _____ No. of pages _____

EMP summary

This EMP (attached) is required to be implemented to address residual contamination on the site.

The EMP: (Tick appropriate box and strike out the other option.)

☐ ~~requires operation and/or **maintenance** of active control systems[3]~~

☐ ~~requires maintenance of **passive** control systems only[3].~~

[2] Refer to Part IV for an explanation of an environmental management plan.
[3] Refer to Part IV for definitions of active and passive control systems.

Purpose of the EMP:

Description of the nature of the residual contamination:

Summary of the actions required by the EMP:

How the EMP can reasonably be made to be legally enforceable:

How there will be appropriate public notification:

Overall comments:

Section B

Purpose of the plan[4] which is the subject of this audit:

Remedial Action Plan – the remedial strategy is off-site disposal of impacted soils to licensed waste facilities. The remedial works will involve UPSS excavation and disposal and remediation of the asbestos-impacted filling materials.

I certify that, in my opinion:

(B1)

☑ The nature and extent of the contamination has been appropriately determined

☐ ~~The nature and extent of the contamination has not been appropriately determined~~

AND/OR (B2)

☑ The investigation, remediation or management plan is appropriate for the purpose stated above

☐ ~~The investigation, remediation or management plan is not appropriate for the purpose stated above~~

AND/OR (B3)

☑ The site testing plan:

☑ **is** appropriate to determine

☐ ~~**is not** appropriate to determine~~

if groundwater is safe and suitable for its intended use as required by the *Temporary Water Restrictions Order for the Botany Sands Groundwater Resource 2017*

AND/OR (B4)

☐ ~~The terms of the approved voluntary management proposal* or management order** (strike out as appropriate):~~

☐ ~~**have** been complied with~~

☐ ~~**have not** been complied with.~~

~~*voluntary management proposal no.~~

~~**management order no.~~

AND/OR (B5)

☑ The site can be made suitable for the following uses:

(Tick all appropriate uses and strike out those not applicable.)

☐ ~~Residential, including substantial vegetable garden and poultry~~

☐ ~~Residential, including substantial vegetable garden, excluding poultry~~

[4] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

- ❑ ~~Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry~~
- ❑ ~~Day care centre, preschool, primary school~~
- ☑ Residential with minimal opportunity for soil access, including units
- ❑ ~~Secondary school~~
- ❑ ~~Park, recreational open space, playing field~~
- ☑ Commercial/industrial
- ❑ ~~Other (please specify):~~

IF the site is remediated/~~managed~~* in accordance with the following plan (**attached**):

*Strike out as appropriate

Plan title **Remediation Action Plan, 15-33 Brighton Avenue, Croydon Park, NSW. (E22142.E06_Rev0)**

Plan author **Environmental Investigations Australia (EIA)**

Plan date **30th September, 2019** No. of pages **130**

SUBJECT to compliance with the following condition(s):

The additional comments suggested by the Auditor on pages 35 and 36 of the Site Audit Report (SAR).

Overall comments:

Part III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority (EPA) under the *Contaminated Land Management Act 1997.*

Accreditation no. 03-04

I certify that:

- I have completed the site audit free of any conflicts of interest as defined in the *Contaminated Land Management Act 1997,* and
- with due regard to relevant laws and guidelines, I have examined and am familiar with the reports and information referred to in Part I of this site audit, and
- on the basis of inquiries I have made of those individuals immediately responsible for making those reports and obtaining the information referred to in this statement, those reports and that information are, to the best of my knowledge, true, accurate and complete, and
- this statement is, to the best of my knowledge, true, accurate and complete.

I am aware that there are penalties under the *Contaminated Land Management Act 1997* for wilfully making false or misleading statements.

Signed 

Date **6/03/2020**

Part IV: Explanatory notes

To be complete, a site audit statement form must be issued with all four parts.

How to complete this form

Part I

Part I identifies the auditor, the site, the purpose of the audit and the information used by the auditor in making the site audit findings.

Part II

Part II contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remediation plan or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use or uses of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A1 or Section A2 or Section B of Part II, **not** more than one section.

Section A1

In Section A1 the auditor may conclude that the land is *suitable* for a specified use or uses OR *not suitable* for any beneficial use due to the risk of harm from contamination.

By certifying that the site is *suitable*, an auditor declares that, at the time of completion of the site audit, no further investigation or remediation or management of the site was needed to render the site fit for the specified use(s). **Conditions must not be** imposed on a Section A1 site audit statement. Auditors may include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

Section A2

In Section A2 the auditor may conclude that the land is *suitable* for a specified use(s) subject to a condition for implementation of an environmental management plan (EMP).

Environmental management plan

Within the context of contaminated sites management, an EMP (sometimes also called a 'site management plan') means a plan which addresses the integration of environmental mitigation and monitoring measures for soil, groundwater and/or hazardous ground gases throughout an existing or proposed land use. An EMP succinctly describes the nature and location of contamination remaining on site and states what the objectives of the plan are, how contaminants will be managed, who will be responsible for the plan's implementation and over what time frame actions specified in the plan will take place.

By certifying that the site is suitable subject to implementation of an EMP, an auditor declares that, at the time of completion of the site audit, there was sufficient information satisfying guidelines made or approved under the *Contaminated Land Management Act 1997*

(CLM Act) to determine that implementation of the EMP was feasible and would enable the specified use(s) of the site and no further investigation or remediation of the site was needed to render the site fit for the specified use(s).

Implementation of an EMP is required to ensure the site remains suitable for the specified use(s). The plan should be legally enforceable: for example, a requirement of a notice under the CLM Act or a development consent condition issued by a planning authority. There should also be appropriate public notification of the plan, e.g. on a certificate issued under s.149 of *the Environmental Planning and Assessment Act 1979*.

Active or passive control systems

Auditors must specify whether the EMP requires operation and/or maintenance of active control systems or requires maintenance of passive control systems only. Active management systems usually incorporate mechanical components and/or require monitoring and, because of this, regular maintenance and inspection are necessary. Most active management systems are applied at sites where if the systems are not implemented an unacceptable risk may occur. Passive management systems usually require minimal management and maintenance and do not usually incorporate mechanical components.

Auditor's comments

Auditors may also include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

Section B

In Section B the auditor draws conclusions on the nature and extent of contamination, and/or suitability of plans relating to the investigation, remediation or management of the land, and/or the appropriateness of a site testing plan in accordance with the *Temporary Water Restrictions Order for the Botany Sands Groundwater Source 2017*, and/or whether the terms of an approved voluntary management proposal or management order made under the CLM Act have been complied with, and/or whether the site can be made suitable for a specified land use or uses if the site is remediated or managed in accordance with the implementation of a specified plan.

By certifying that a site *can be made suitable* for a use or uses if remediated or managed in accordance with a specified plan, the auditor declares that, at the time the audit was completed, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use(s) of the site in the future.

For a site that *can be made suitable*, any **conditions** specified by the auditor in Section B should be limited to minor modifications or additions to the specified plan. However, if the auditor considers that further audits of the site (e.g. to validate remediation) are required, the auditor must note this as a condition in the site audit statement. The condition must not specify an individual auditor, only that further audits are required.

Auditors may also include **comments** which are observations in light of the audit which provide a more complete understanding of the environmental context to aid decision-making in relation to the site.

Part III

In **Part III** the auditor certifies their standing as an accredited auditor under the CLM Act and makes other relevant declarations.

Where to send completed forms

In addition to furnishing a copy of the audit statement to the person(s) who commissioned the site audit, statutory site audit statements must be sent to

- the **NSW Environment Protection Authority**: nswauditors@epa.nsw.gov.au or as specified by the EPA

  AND

- the **local council** for the land which is the subject of the audit.

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Contamination | Remediation | Geotechnical

Croydon 88 Pty Ltd

REMEDIATION ACTION PLAN

15-33 Brighton Avenue, Croydon Park NSW

Report E22142.E06_Rev 0
30 September 2019

REPORT DISTRIBUTION

Remediation Action Plan
15-33 Brighton Avenue, Croydon Park NSW

EI Report No.: E22142.E06_Rev0
Date: 30 September 2019

Copies	Recipient
1 Soft Copy (PDF – Secured, issued by email)	Croydon 88 Pty Ltd Level 1 / 74 Macquarie Street, Parramatta NSW 2150
Original (Saved to Digital Archives)	EI Australia Suite 6.01, 55 Miller Street, Pyrmont NSW 2009

Author	Technical Reviewer
	
WARWICK HAYES Environmental Scientist	**MALCOLM DALE** Senior Principal – Contaminated Land CEnvP (CL Specialist) Cert. No. 0853

Revision	Details	Date	Amended By
0	Original	30 September 2019	-

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EXECUTIVE SUMMARY

Background

This Remediation Action Plan (RAP) outlines the procedures that will be used to remediate the block of land identified as 15-33 Brighton Avenue, Croydon Park NSW ('the site'), to a condition suitable for residential land use with minimal access to soils.

The site is situated within the Local Government Authority of Canterbury Bankstown Council, covering a total area of approximately 14,700m^2. Six separate (adjoining) properties make up the site, all of which have been used for commercial purposes (**Figures 1** and **2**). The cadastral identifications are as follows:

- 15 Brighton Avenue: Lot C in Deposited Plan (DP) 440959 (approximately 980m^2);
- 17 Brighton Avenue: Lot 2A, Section 2 in DP 3010 (approximately 1500m^2);
- 19 Brighton Avenue: Lots A and B in DP 333556 (approximately 1500m^2);
- 21 Brighton Avenue: Lot 1 in DP 123636 (approximately 1500m^2);
- 23-25 Brighton Avenue: Lot 11 in DP 862370 (2426m^2); and
- 27-33 Brighton Avenue: Lot 10 in DP 1026819 (6770m^2).

Based on the findings from previous investigations completed by EI in 2016 and 2018, an underground petroleum storage system (UPSS) had been installed in the south western corner of the site, while localised areas of asbestos-, heavy metal- (copper and zinc) and recoverable hydrocarbon-impacted filling were present. Remediation was deemed necessary, prior to (or as part of) development of the property.

The aim of this RAP is to guide remediation works required to make the site suitable for residential use (with minimal access to soils). It has been prepared in support of a Development Application (DA) to Canterbury Bankstown Council and enable the developer to meet its obligations under the *Contaminated Land Management Act 1997* (CLM Act 1997), for the assessment and management of contaminated soil and/or groundwater.

Remediation Strategy

The preferred remedial strategy is off-site disposal of impacted soils to licensed waste facilities. Following approvals and site establishment, the main remediation works will include, but not necessarily be limited to:

- **Stage 1** – Additional Investigation for Data Gap Closure;
- **Stage 2** – Site Preparation;
- **Stage 3** – Ground Surface Inspection;
- **Stage 4** – UPSS Excavation and Disposal;
- **Stage 5** – Handling and Management of Fill Soil for Off-site Disposal;
- **Stage 6** – Site Validation and VENM Classification;
- **Stage 7** – Validation Report Preparation.

All wastes shall be transported to appropriate, EPA-licensed facilities, after formal classification. All excavated (remediation) areas shall be validated, to confirm that remaining site soils are suitable for the proposed land use. Site reinstatement with validated natural materials will be performed where required.

In summary, EI considers that the site can be made suitable for residential use with minimal access to soils, through the implementation of the works described in this RAP.

Should unexpected finds be discovered during the course of the remediation program, the procedures described under the Unexpected Finds Protocol and the Site Validation Plan will be implemented, until the remediation goals have been achieved and the land is deemed suitable for the intended use.

Following completion of the remediation and validation works a Site Validation Report will be prepared in accordance with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

1 INTRODUCTION

1.1 BACKGROUND

Mr Andrew Shehadeh of Dyldam (the Client) engaged EI Australia Pty Ltd (EI) to prepare a Remediation Action Plan (RAP) for the block of land identified as 15-33 Brighton Avenue, Croydon Park NSW ('the site').

The site is situated approximately 9km south west of the Sydney central business district, within the Local Government Authority of Canterbury Bankstown Council (**Figure 1**), covering a total area of approximately 14,700m^2 . Six separate (adjoining) properties make up the site, all of which have been used for commercial purposes (**Figure 2**). The cadastral identifications are as follows:

- 15 Brighton Avenue: Lot C in Deposited Plan (DP) 440959 (approximately 980m^2);
- 17 Brighton Avenue: Lot 2A, Section 2 in DP 3010 (approximately 1500m^2);
- 19 Brighton Avenue: Lots A and B in DP 333556 (approximately 1500m^2);
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- 23-25 Brighton Avenue: Lot 11 in DP 862370 (2426m^2); and
- 27-33 Brighton Avenue: Lot 10 in DP 1026819 (6770m^2).

Based on the findings from previous investigations completed by EI in 2016 and 2018, an underground petroleum storage system (UPSS) had been installed in the south western corner of the site, while localised areas of asbestos-, heavy metal- (copper and zinc) and recoverable hydrocarbon-impacted filling were present. Remediation was deemed necessary, prior to (or as part of) development of the property.

The aim of this RAP is to guide remediation works required to make the site suitable for residential use (with minimal access to soils). It has been prepared in support of a Development Application (DA) to Canterbury-Bankstown Council and enable the developer to meet its obligations under the *Contaminated Land Management Act 1997* (CLM Act 1997), for the assessment and management of contaminated soil and/or groundwater.

1.2 PROPOSED DEVELOPMENT

Based on the plans provided by the Client (**Appendix A**), the proposed development involves demolition of all existing structures, followed by the construction of multiple, 4 to 5 storeyed, mixed commercial and residential apartment buildings. Commercial apartments will occupy the ground floor of each building fronting Brighton Avenue. The development will include a one to two level, basement car parking facility, requiring excavation of site soils to approximately 6m below ground level (BGL).

1.3 OBJECTIVES

The main objectives of this RAP are to:

- Provide detailed procedures on how to carry out remediation works in a safe and environmentally friendly manner, while minimising impacts to human health (including site workers and the general public) and the environment; and
- Provide a sampling and analytical quality plan to be used for site validation.

1.4 SCOPE OF WORK

With the aim of achieving the above objectives, the scope of work for this RAP includes:

- Preview of the available data relevant to the remediation of the site, provided by the previous investigation reports;
- Definition of remediation goals and acceptance criteria;

- Technical evaluation of the remedial options for the site and selection of the most appropriate remedial strategy (or combination of strategies);
- Provision of information so that remedial works may be carried out in accordance with relevant laws and regulations;
- Provision of guidance on approvals and licences required for the remedial works, under current legislation (e.g. *State Environmental Planning Policy 55 - Remediation of Land*);
- Provision of information to assist the contractor in their preparation of a Work Health and Safety Plan and other site management/planning documents; and
- Development of a sampling, analysis and quality strategy for hotspot delineation and post-remedial validation.

This RAP also outlines measures for the excavation, stockpiling, management and disposal of spoil, water and sediment controls, as well as a contingency plan to handle any additional contamination that may be identified during the site remedial / validation works.

The measures provided in this RAP are designed to accompany site-specific management plans, such as a Construction Environment Management Plan (CEMP) and Work Health and Safety Plan (WHSP). These measures do not replace any other requirements for the site as a whole. A complete set of site specific management plans should be developed and adhered to. An outline of management measures to be addressed is provided in **Section 8.3**.

1.5 REGULATORY FRAMEWORK

The following regulatory framework and guidelines were considered during the preparation of this RAP:

Legislation

- *Contaminated Land Management Act 1997* (CLM Act 1997);
- *Protection of the Environment Operations Act 1997* (PoEO Act 1997) and associated regulations;
- *State Environment Protection Policy 55 - Remediation of Land (SEPP 55),* under the *Environmental Planning and Assessment Act 1997* (EP&A Act 1997);
- *Canterbury Development Control Plan 2012;*
- *Canterbury Local Environmental Plan 2012*; and
- *Work Health and Safety Act 2011* (WHS Act 2011) and associated codes of practice.

Guidelines

- DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination*;
- EPA (1995) *Sampling Design Guidelines*;
- EPA (2014a) *Technical Note: Investigation of Service Station Sites*;
- EPA (2014b) *Waste Classification Guidelines*;
- EPA (2017) *Guidelines for the NSW Site Auditor Scheme*;
- NEPC (2013) Schedule B(1) *Guideline on Investigation Levels for Soil and Groundwater* and Schedule B(2) *Guideline on Site Characterisation*; and
- OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites.*

1.6 DEVIATIONS FROM THIS RAP

This RAP is designed to provide some flexibility to vary the sequence and/or details of the actual site remediation and validation works to meet site constraints; however, a qualified Environmental

Scientist performing the roles of Environmental Management Coordinator and Remediation Supervisor should be appointed to the project to ensure that:

- Critical stages of the site remediation/validation process (including, but not limited to, induction of site personnel, marking of remediation areas, inspection of environmental monitoring systems, implementation of specified control measures, data gap closure and validation sampling) are appropriately implemented, with the relevant data collected for environmental reporting purposes; and
- Any deviations from the works specified in this RAP are properly documented and approved, as required under the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

Performing remedial works without the presence of a qualified environmental engineer/scientist when necessary may lead to project delays and extra costs, due to additional environmental investigation requirements to confirm the environmental status of the site.

Waste materials removed from the site without proper characterisation (i.e. classification assessment), may lead to regulatory action and potential penalties, as described under the *Waste Regulation 2014*, the *Protection of the Environment Operations Act 1997* and the *Contaminated Land Management Act 1997*.

2 SITE DESCRIPTION

2.1 PROPERTY IDENTIFICATION, LOCATION AND PHYSICAL SETTING

The site identification details and associated information are presented in **Error! Reference source not found.**, while the site locality is shown in **Figure 1**.

Table 2-1 Site Identification, Location and Zoning

Attribute	Description
Street Address	15-33 Brighton Avenue, Croydon Park NSW
Location Description	Approximately 9km south west of the Sydney central business district, bound by Brighton Avenue (west) and residential dwellings in all other directions.
Geographical Coordinates	North eastern corner of site (GDA94-MGA56): Easting: 325177.505; Northing: 6247758.513 (Source: http://maps.six.nsw.gov.au).
Site Area	Approximately 1.47 hectares (14,700m^2)
Lots and Deposited Plans (DP)	▪ 15 Brighton Avenue: Lot C in DP 440959; ▪ 17 Brighton Avenue: Lot 2A, Section 2 in DP 3010; ▪ 19 Brighton Avenue: Lots A and B in DP 333556; ▪ 21 Brighton Avenue: Lot 1 in DP 123636; ▪ 23-25 Brighton Avenue: Lot 11 in DP 862370; and ▪ 27-33 Brighton Avenue: Lot 10 in DP 1026819.
State Survey Marks	State Survey (SS) marks in close proximity to the site: SS75308D, located on the corner of Brighton Ave and Georges Road (north-east of the site); SS131351: located on the corner of Hampstead Road and The Crescent; and SS71393 / SS99220D on the corner of The Crescent and Kessell Ave (north-east of the site). (Source: http://maps.six.nsw.gov.au).
Local Government Authority	**Error! Unknown document property name.**
Parish	Leichhardt
County	Cumberland
Current Zoning	IN2 – Light Industrial (*Canterbury Local Environment Plan 2012*)

2.2 SURROUNDING LAND USE

The site is situated within an area of mixed uses on surrounding land as described in **Table 2-2**. The local sensitive receptors within close proximity to the site are also identified.

Table 2-2 Surrounding Land Uses

Direction	Land Use Description	Sensitive Receptors
North	Residential dwellings	Residential dwellings
South	Residential dwellings	Residential dwellings
East	Residential dwellings	Residential dwellings
West	Brighton Ave, followed by residential dwellings	Residential dwellings

Sensitive land uses, such as schools and childcare centres, were not in the vicinity the site (<200m).

2.3 REGIONAL SETTING

Local topography, (hydro)geology and soil landscape information are summarised in **Table 2-3**.

Table 2-3 Regional Setting Information

Attribute	Description
Ground Topography	The site slopes towards the south / south-west.
Site Drainage	Site drainage expected to be consistent with the general slope of the land. Stormwater likely to be collected by pit and pipe services of the municipal stormwater system, discharging into the Cooks River, located about 500m south of the site.
Regional Geology	With reference to the 1:100,000 scale *Sydney Geological Series Sheet 9130*, the site overlies and interface between Ashfield and Bringelly Shales. Ashfield Shale is described as black to dark-grey shale and laminite, while Bringelly Shale is described as shale, carbonaceous claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff.
Soil Landscapes	The Soil Conservation Service of NSW *Soil Landscapes of the Sydney 1:100,000 Sheet* (Chapman and Murphy, 2002) indicates that the site overlies a Blacktown soil landscape, which is described as gently undulating rises on the Wianamatta Group shales, with shallow to moderately deep (<100 cm) red and brown podzolic soils on crests, upper slopes and well drained areas; deep (150 – 300 cm) yellow podzolic soils and soloths on lower slopes and in areas of poor drainage.
Acid Sulfate Soil Risk	The *Canterbury LEP 2012 Acid Sulfate Soils Map* (Sheet_006) shows the site to be within a *Class 5* area with respect to acid sulfate soils (ASS). With reference to the *Prospect / Parramatta Acid Sulfate Soil Risk Map* (1:25,000 scale; Murphy, 1997), the site is located within an area of *No Known Occurrence*.
Nearest Surface Water Feature	Cooks River, located approximately 500m south of the site.
Groundwater Flow Direction	Anticipated to be southwards, towards Cooks River.

2.4 GROUNDWATER BORE RECORDS AND LOCAL GROUNDWATER USE

An online search for groundwater bores registered (licensed) with WaterNSW was conducted as part of the EI (2016) preliminary site investigation. There were no registered bores within a 500m radius of the site, indicating that local groundwater usage was low.

3 SITE CHARACTERISATION

3.1 PREVIOUS INVESTIGATION REPORTS

The following environmental reports provided information that assisted the preparation of this RAP:

- EI Australia (2016) *Preliminary Site Investigation; 15-33 Brighton Avenue, Croydon Park NSW* (EI Report E22142 AA_Rev0; dated 26 May, 2016);
- EI Australia (2018a) *Detailed Site Investigation; 25-33 Brighton Avenue, Croydon Park NSW* (EI Report E23775.E02_Rev0; dated 20 April, 2018); and
- EI Australia (2018b) *Detailed Site Investigation; 15-21 Brighton Avenue, Croydon Park NSW* (EI Report E23959.E02_Rev0; dated 10 September, 2018).

A summary of each investigation is provided in **Section 3.2** (**Table 3-1**) below. Refer also to **Figure 2**, as well as **Appendices B** and **C**.

3.2 SUMMARY OF PREVIOUS INVESTIGATION FINDINGS

Table 3-1 Previous Investigation Findings

Assessment Details	Project Tasks and Findings
Preliminary Site Investigation (EI, 2016)	
Objective	The main objective of this investigation was to appraise the potential for site contamination, on the basis of historical land uses and anecdotal and documentary evidence of possible pollutant sources.
Key Findings	At the time of this investigation, the site was occupied by six, separate commercial / industrial warehouses and one former residential dwelling, with unsealed and sealed areas surrounded the buildings. Historical records established that the land had been residential in nature up to the 1970s / 1980s. Commercial redevelopment took place thereafter, the activities including mechanical workshops for radiator and air conditioning units, storage and distribution of textile goods (linen / clothing), manufacturing and fitting of automotive exhaust systems, repair and warehousing of electrical equipment, a timber yard, storage of batteries, storage of boats and heavy machinery, a printing factory, bulk storage of building materials (including sandstone and tiles) and furniture, a motor mechanic workshop, assembly of toys and sporting goods and manufacturing of fibreglass components. Council archives had evidence of oil spillage on 17 Brighton Avenue, with "no precautionary methods in place to prevent discharge into the stormwater system". Despite this, the site was free of statutory notices and licencing agreements issued by the NSW Environment Protection authority (EPA), while SafeWork NSW had no records pertaining to the storage of dangerous goods on any of the allotments. Building materials containing (potential) hazardous materials were identified during the site walkover inspection, while filling materials of unknown origins were expected. A UPSS (diesel) was identified in the south western corner.
Conclusions and Recommendations	The conceptual site model (CSM) established that potential contaminating sources occurred at the site. Given the nature of the proposed redevelopment, EI recommended further investigations be conducted, to quantify any contamination risks and inform the selection of remedial and risk mitigation measures (if required). These included: ▪ a detailed soil and groundwater sampling program; and ▪ a hazardous materials survey for the site buildings (including their stored contents and wastes).
Detailed Site Investigation (EI, 2018a)	
Objective	The primary objective of this investigation was to determine the degree of any potential contamination on the southern part of the site (9196m^2), by means of intrusive sampling and laboratory analysis for relevant contaminants. If contamination was confirmed, secondary objectives were to evaluate the risks posed to human health and the environment and confirm whether remediation was warranted.

Assessment Details	Project Tasks and Findings
Key Findings	Soil profiling and sampling were conducted at twenty one borehole locations (BH1-BH21), constructed to a maximum depth of 6.4m BGL. The sampling regime followed a mixed judgemental and systematic (triangular grid) pattern, with allowance for structural obstacles. The sub-surface layers were comprised of heterogeneous (anthropogenic) fill materials (0.5-1.3m thickness), underlain by residual clays and sandstone / shale bedrock. Laboratory analytical results for the contaminants of potential concern (COPCs) in representative soil samples were found to comply with the adopted investigation (acceptance) levels, except for asbestos in the filling at locations BH3 and BH10M. One groundwater monitoring event (GME) was performed for this DSI, utilising the installed wells BH1M, BH4M, BH7M, BH10M and BH13M. Standing water levels (SWLs) ranged from 14.35 to 18.25m AHD (<2m BGL). The representative samples were found to contain concentrations of copper, nickel and zinc that exceeded the adopted groundwater investigation levels (GILs). However, they were considered representative of background conditions for the Sydney (urban) environment and therefore not posing any immediate risks.
Conclusions and Recommendations	EI concluded that widespread contamination was not present on this part of the site. The land could be remediated for mixed residential/commercial purposes, subject to the implementation of a RAP that addressed the removal of the diesel UPSS (i.e. the tank, bowser, feed lines and vent pipes), as well as all asbestos-impacted filling.
Detailed Site Investigation (EI, 2018b)	
Objective	The primary objective of this investigation was to determine the degree of any potential contamination on the northern part of the site (5480m^2), by means of intrusive sampling and laboratory analysis for relevant contaminants. If contamination was confirmed, secondary objectives were to evaluate the risks posed to human health and the environment and confirm whether remediation was warranted.
Key Findings	Soil profiling and sampling were conducted at fourteen borehole locations (BH101-BH114), constructed to a maximum depth of 8.2m BGL. The sampling regime followed a mixed judgemental and systematic (triangular grid) pattern, with allowance for structural obstacles. The sub-surface layers were comprised of heterogeneous (anthropogenic) clayey, gravelly, sand fill materials (0.3-1.3m thickness), underlain by residual clays of low to high plasticity and (weathered) shale bedrock. Laboratory analytical results for the COPCs in representative soil samples were found to comply with the adopted investigation (acceptance) levels, except: ▪ BH105_0.3-0.4 exceeded the ecological investigation level (EIL) for copper (150 mg/kg) and zinc (270 mg/kg); and ▪ BH108M_0.4-0.5 exceeded the EIL for zinc (210 mg/kg) and >C_{10}-C_{16} (F2) total recoverable hydrocarbons (TRH; 130 mg/kg). One GME was performed for this DSI, utilising the wells installed at BH101M, BH108M and BH112M. SWLs ranged from 2.98 to 3.90m BGL. The representative samples were found to contain concentrations of copper, nickel and/or zinc that exceeded the adopted GILs. However, they were considered representative of background conditions for the Sydney (urban) environment and therefore not posing any immediate risks.
Conclusions and Recommendations	EI concluded that widespread contamination was not present on this part of the site, with the land being seen as suitable for residential purposes (with minimal access to soils). Remediation was not deemed to be warranted, subject to the findings of recommended data gap closure investigations, namely the assessment of the quality of (fill) soils beneath buildings and pavements not accessible at the time of the DSI (e.g. 17 Brighton Avenue).

3.3 CONCEPTUAL SITE MODEL (CSM)

In accordance with NEPC (2013) *Schedule B2 - Guideline on Site Characterisation*, EI developed a conceptual site model (CSM), assessing plausible linkages between potential contamination sources, migration pathways and receptors. The CSM provides a framework for determining the reliability and useability of the collected data and identifying gaps in the site characterisation.

3.3.1 Subsurface Conditions

The lithology of the site was generalised as heterogeneous fill materials (0.3-1.3m thickness), underlain by residual clays and weathered shale bedrock.

3.3.2 Contamination Sources

The potential contamination sources were:

- Imported fill soils of unknown origin;
- Historic commercial activities (including a diesel UPSS in the south western corner); and
- Weathering of hazardous materials in the existing building fabrics, including asbestos-containing materials (ACMs), lead-based paints and metallic surfaces.

3.3.3 Chemicals of Concern

The following contaminants were of concern for site remediation (i.e. asbestos and UPSS) and data gap closure (i.e. further assessment of building footprints and pavements):

- **Soil (remediation areas)** - heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TRHs, volatile organic compounds (VOCs; including the monocyclic aromatic hydrocarbons benzene, toluene, ethylbenzene and xylenes (BTEX)) and asbestos.
- **Soil (building footprints and pavements)** - heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TRHs, VOCs (including BTEX), polycyclic aromatic hydrocarbons (PAHs), organochlorine and organophosphorus pesticides (OCPs/ OPPs), polychlorinated biphenyls (PCBs) and asbestos.

3.3.4 Potential Sources, Exposure Pathways and Receptors

The potential contamination sources, exposure pathways and human and environmental receptors that were considered relevant for this RAP are summarised in **Table 3-2**.

Table 3-2 Conceptual Site Model

Contaminated Media	Transport Mechanism	Exposure Pathway	Potential Receptor
Soils	Direct exposure to contaminated soils	Ingestion, dermal contact and inhalation Plant uptake	Future construction and maintenance workers Future tenants Ecological receptors
Groundwater	Direct exposure to contaminated groundwater (onsite)	Dermal contact and ingestion of contaminated groundwater	Future construction and maintenance workers Future tenants Ecological receptors
	Migration of contaminated groundwater (offsite)	Discharge of contaminants	Offsite receptors (unlicensed bores) Ecological receptors (Cooks River)

3.4 EXISTING SITE CONTAMINATION

Based on the information from the previous EI (2016, 2018a and 2018b) reports, the following contamination issues were of relevance to the site:

- A diesel UPSS in the south western site corner;

- Asbestos-impacted filling in the vicinities of investigation bores BH3 and BH10M.

This is subject to modification, depending on the findings from any further intrusive (data gap closure) investigations.

3.5 DATA GAPS

The current CSM was considered to appropriately identify contamination sources, migration mechanisms and exposure pathways, as well as potential onsite and offsite receptors. However, the following data gaps required closure as part of the site remediation / validation phase:

- delineation of the identified asbestos hotspots (i.e. BH3 in north western portion of 27-33 Brighton Avenue and BH10M in the south eastern portion of 27-33 Brighton Avenue, the latter coinciding with the south eastern site corner);
- further assessment of (beneath) the building footprints and pavements not accessible at the time of the investigation phase; and
- Waste classification of site (fill) soils, to assist the off-site disposal of (contaminated) materials during the remediation phase.

3.6 EXTENT OF REMEDIATION REQUIRED

Based on the available site characterisation data, removal of the diesel UPSS and remediation of the asbestos-impacted filling materials in the vicinities of investigation bores BH3 and BH10M were required to render the site suitable for residential use.

4 DATA QUALITY OBJECTIVES

In accordance with the US EPA (2006) *Data Quality Assessment* and the EPA (2017) *Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme*, Data Quality Objectives (DQO) will be used to confirm the quality of the data needed for the specific data requirements of the project. The DQO process for this RAP is documented in **Table 4-1**.

Table 4-1 Summary of Project Data Quality Objectives

DQO Step	Details
1. State the Problem Summarise the contamination problem that will require new environmental data, and identify the resources available to resolve the problem; develop a conceptual site model.	The site is to be developed for residential purposes (multiple, 4 to 5 storeyed, mixed commercial and residential apartment buildings, with 1 to 2 level basement). The previous DSIs identified a UPSS and asbestos-contaminated filling, contributed by various potential sources listed in **Section 3.3.3**. A CSM has been developed (**Section 3**). Validation (and any additional / data gap closure investigation) sampling must provide supportive information on the environmental conditions of the site, to determine its suitability for the proposed development.
2. Identify the Goal of the Study (Identify the decisions) Identify the decisions that need to be made on the contamination problem and the new environmental data required to make them.	Based on the objectives outlined in **Section 1.3,** the following decisions are identified: • Has the nature, extent and source of any soil, vapour and/or groundwater impacts been defined? • What impact do the (hydro)geological conditions have on the fate and transport of any impacts that may be identified? • Does the level of impact coupled with the fate and transport of identified contaminants represent an unacceptable risk to identified human and/or environmental receptors on- or off-site? • Will soils and groundwater require further remediation and/or special management before the site can be used for residential purposes?
3. Identify Information Inputs (Identify inputs to decision) Identify the information needed to support any decision and specify which inputs require new environmental measurements.	Inputs to the decision making process include: • The previous investigations, summarised in **Section 3**; • National and state guidelines made or approved by the NSW EPA under Section 105 of the CLM Act 1997; • Additional soil sampling and laboratory analytical results for waste classification purposes and/or data gap closure; • Sampling from stockpiled soil material for waste classification assessment; • Soil validation sampling of remedial excavation surfaces; • Laboratory analytical results of soil validation samples; and • Assessment of analytical results in relation to the remediation criteria. At the end of the remediation, a decision must be made regarding whether the environmental conditions are suitable for the proposed development, or if additional investigation or remedial works are required to make the site suitable.
4. Define the Boundaries of the Study Specify the spatial and temporal aspects of the environmental media that the data must represent to support decision.	**Lateral** – The cadastral boundaries of the site (**Appendix A**). **Vertical** – From the existing ground surface, underlying fill and natural soil horizons, to the base of the proposed basement and any locally deeper areas (for piling, service trenches etc.). **Temporal** – Results are valid on the day of data and sample collection and remain valid as long as no changes occur on-site and/or contamination (if present) does not migrate on-site or on to the site from off-site sources.

DQO Step	Details
5. Develop the Analytic Approach (Develop a decision rule) To define the parameter of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing from alternative actions.	Laboratory analytical results will be accepted if: • All contracted laboratories are accredited by NATA for the analyses undertaken; • All detection limits fall below the remediation criteria; • Analyte concentrations in rinsate (i.e. blank) samples do not vary significantly from concentrations in the distilled water used for equipment rinsing; • Relative percentage differences (RPDs) for duplicate samples are within accepted limits; and • Laboratory QA/QC protocols and results comply with NEPM requirements. Further decisions are also required following the additional (data gap closure) assessment. This may require updating of the RAP to include additional soil areas and/or groundwater remediation / management.
6. Specify Performance or Acceptance Criteria (Specify limits on decision errors) Specify the decision-maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data.	Specific limits for this project are to be in accordance with the National and NSW EPA guidance, and appropriate indicators of data quality and standard procedures for field sampling and handling. This should include the following points to quantify tolerable limits: • The null hypothesis for the remediation of soils is that the 95% UCL for each contaminant of concern exceeds the adopted remediation criterion; • The acceptance of the site as validated will be based on the probability that: – Each 95% UCL will satisfy the given criterion, hence, a limit on the decision error will be 5% that a conclusive statement may be incorrect; and – Each standard deviation is less than 50% of the relevant remediation acceptance criterion; and – No single result exceeds the acceptance criterion by 250% or more; and • Soil concentrations for chemicals of concern that are below investigation criteria made or approved by the NSW EPA will be treated as acceptable and indicative of suitability for the proposed land use(s).
7. Develop the Detailed Plan for Obtaining Data (Optimise the design for obtaining data) Identify the most resource-effective sampling and analysis design for general data that are expected to satisfy the DQOs.	Written instructions will be issued to guide field personnel in the required fieldwork activities. Soil remedial excavation is to be performed as per **Section 7**, within areas pertaining to any contamination hot spots identified previously and during additional investigations. Soil validation sampling is to be completed as per the methodology prescribed in **Section 9**. Validation sampling procedures will be implemented to optimise data collection for achieving the DQOs. Review of the results will be undertaken to determine if further excavation and/or additional sampling is warranted. Additional investigations would be necessary where soil concentrations are found to exceed remediation criteria endorsed by the NSW EPA, relevant to the proposed land use(s).

5 REMEDIATION GOALS AND CRITERIA

5.1 REMEDIATION GOALS

The remediation goals for this RAP are consistent with NSW EPA *SEPP 55* guidelines and Council's contaminated land policy, and include:

- Identifying the data gaps that require closure and could be performed as part of the site remediation / validation phase;
- Meeting the conditions of the planning consent, to render the site suitable for the proposed land use(s);
- Demonstrating that the proposed remediation strategy for the site is environmentally justifiable, practical and technically feasible;
- Adopting clean-up criteria appropriate for the future use of the site to mitigate possible impacts to human health and the environment;
- Mitigating possible off-site migration of contaminants (including migration in existing utilities such as the sewer, stormwater and other subsurface pipes or service trenches);
- Consideration of the principles of ecologically sustainable development, in line with Section 9 of the *Contaminated Land Management Act 1997*;
- Minimising waste generation under the *Waste Avoidance and Resource Recovery Act 2001*;
- Remediating all contamination within the site so there are no unacceptable risks to on- and off-site receptors;
- Remediating the site to a condition where any residual contamination does not require long-term management using an environmental management plan (EMP); and
- Demonstrating that the plans for management of remediation work consider work health and safety, environmental management, community relations and contingencies.

5.2 REMEDIATION CRITERIA

5.2.1 Soil and Groundwater Remediation (Validation) Criteria

In accordance with the proposed mixed residential / commercial development, the soil and groundwater remediation criteria outlined in **Table 5-1** will be adopted. These are based on NEPC (2013) *Schedule B1 Guideline on Investigation Levels for Soil and Groundwater*.

Table 5-1 Soil and Groundwater Remediation Criteria

Environmental Media	Adopted Guidelines	Rationale
Soil	NEPC (2013) Soil HILs, HSLs, EILs, ESLs and Management Limits for TRHs	**Soil Health-based Investigation Levels (HILs)** All soil samples to be assessed against the NEPC (2013) *HIL-B* thresholds for residential sites with minimal access to soils. **Soil Health-based Screening Levels (HSLs)** The NEPC (2013) *HSL-A* /B thresholds for vapour intrusion will be applied to assess potential human health impacts from residual vapours resulting from petroleum, BTEX and naphthalene. Soil asbestos results to be assessed against the NEPC (2013) *HSL-B* thresholds for "all forms of asbestos". **Ecological Investigation / Screening Levels (EILs / ESLs)** Soil samples from proposed landscaped and recreational areas to be assessed against the NEPC (2013) *EILs* and/or *ESLs*, for guidance purposes. **Management Limits for Petroleum Hydrocarbons** Should the *HSLs* and/or *ESLs* be exceeded for petroleum hydrocarbons, soil samples will be assessed against the corresponding NEPC (2013) *Management Limits*, to assess propensity for phase-separated hydrocarbons (PSH), fire and explosive hazards and adverse effects on buried infrastructure.
Groundwater	NEPC (2013) GILs for Marine Waters	**Groundwater Investigation Levels (GILs) for Freshwater** NEPC (2013) provides GILs for slightly-moderately disturbed aquatic ecosystems, which are based on the ANZG (2018) *Trigger Values* for 95% level of protection of aquatic ecosystems. The *99% Trigger Values* to be applied for the bio-accumulative metals cadmium and mercury. The marine criteria were considered relevant as the closest surface water receptor was Cooks River (tidally influenced).
	NEPC (2013) Groundwater HSLs for Vapour Intrusion	**Health-based Screening Levels (HSLs)** The NEPC (2013) *HSLs* for vapour intrusion will be used to assess potential human health impacts from residual petroleum, BTEX and CVOC contamination.

The adopted soil and groundwater remediation criteria are tabulated in **Appendix D** (**Table D-1, Table D-2, Table D-3** and **Table D4**). Conformance with the soil remediation criteria will have been attained when soil validation samples from similar lithology and depth show contaminant concentrations that are below the specified thresholds, or, as a minimum, the 95% upper confidence limit (UCL) mean concentration for each contaminant in the soil remediated area (i.e. across the excavated surface) is below the respective threshold.

6 REMEDIATION TECHNOLOGY

6.1 REGULATORY OVERVIEW

Volume 1, Section 16 of the NEPC (2013) guidelines indicates that the preferred hierarchy for site remediation options and/or management should be:

- On-site treatment of the contamination, so that it is destroyed or the associated risk is reduced to an acceptable level; and
- Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or, if the above are not practicable:
- Consolidation and isolation of the soil on site by containment with a properly designed barrier; and
- Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material; or
- Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.

When deciding which option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option.

For this site, a number of remediation options were reviewed to examine the suitability of each method, the surrounding properties, geological and hydrogeological limitations and the following considerations:

- Development requirements (residential, with minimal access to soils);
- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to material and infrastructure limitations;
- Remedial timetable;
- Defensible method to ensure the land is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

6.2 REMEDIAL TECHNOLOGIES REVIEW

A number of soil (and groundwater) remediation options were reviewed to examine the suitability of each method, with due regard for the surrounding land uses, as well as the geological and hydrogeological limitations.

Brief discussion on the various remediation technology options is provided in **Appendix E**. Each of the available remediation technologies, are summarised in terms of their suitability for treatment of soils and groundwater in **Table 6-1**.

Table 6-1 Remedial Technology Review - Soils

Remediation methodology	Description	Advantages	Disadvantages	Suitability
No Action	'No Action' can be considered if: • there is no measurable contamination; • contaminant concentrations are below assessment guidelines; • contaminants are not mobile; or • exposure to contaminated soils is unlikely.	No remediation costs Creates minimal disturbance to the site Retains material on-site	Not applicable to the kind of contamination encountered within the site. Contamination would remain *in situ* allowing potential vapour intrusion and off-site migration of contamination and impacts on groundwater. Would pose limitations on land use options. May require an EMP and ongoing monitoring.	Not Suitable – the key objective of the remedial strategy is to make the site suitable for residential use. ACMs must be dealt with.
On-site bioremediation	Excavated soils are thoroughly broken down and aerated, mixed with microorganisms and nutrients, stockpiled and aerated in above ground enclosures.	Cost effective if soils are utilised on-site. Lower disposal costs. Limited requirement to import fill material to site. Retains material on-site.	Significant area required to land farm material. Undefined remediation timeframe. Potential for odour problems. Not suitable for asbestos contamination.	Note Suitable – soils impacted with heavy metals and asbestos would not be remediated. Insufficient area is available across the site for this method (once basement excavation commences).
In-situ treatment	*In-situ* treatment of impacted soils within the smear zone and saturated zone using *in-situ* treatment methods such as soil vapour extraction, injection of oxidising agents etc.	Creates minimal disturbance to the site (no excavation). Cost effective for large scale site remediation of light to mid-weight petroleum hydrocarbons. Potential to simultaneously remediate dissolved phase hydrocarbons in site groundwater.	Not applicable to the kind of contamination encountered within the site. Expensive establishment costs. Potential for odour problems. Requires detailed design, pilot trials and management.	Not suitable – this method is designed for widespread, volatile hydrocarbon impacted soils. Since the present dataset provides evidence of other (non-volatile) contamination, this is not considered to be an economically viable option.

Remediation methodology	Description	Advantages	Disadvantages	Suitability
Consolidation and/or capping	Risk minimisation approach where impacted soils are managed on-site by capping the ground surface with a clean, impermeable layer of fill material, or polymeric membrane.	Effectively removes risk to human health by eliminating exposure pathways.	Importance of capping / membrane materials. Contamination would remain *in situ* allowing potential off-site migration of contamination and impacts on groundwater. Would pose limitations on land use options. Typically requires an EMP and ongoing monitoring.	Suitable – will meet the key project objective to make the land suitable for residential use, at least for residual (non-volatile) contamination. Best suited as a secondary option, in combination with the following, especially where waste disposal costs become an issue.
Excavation and off-site disposal	Excavate impacted materials. Transport directly to a licensed landfill facility. Reinstate site with imported clean fill material.	Fast – impacted material removed immediately, significantly reducing potential for impact to groundwater. No storage or treatment problems. Reduced vapour/odour issues as impacted materials removed from site. Minimal design and management costs.	Transfer of waste to another location (licensed waste facility). High costs associated with the disposal of waste soils and importation of clean backfill. Requires waste classification prior to disposal, keeping of thorough waste records, waste tracking and reporting. Sustainability issues related with disposal to landfill.	Suitable – will meet the key project objective to make the land suitable for residential use. This will remove potentially leachable contamination sources and prevent vertical migration to the groundwater system. Bulk excavation required for 1 to 2 level basement construction.
Natural attenuation	Allowing the contaminants to biodegrade naturally following removal of the contamination source.	No remedial excavation of site. Retains materials on site. Sustainable, cost effective remediation method.	Slow process. Not applicable to metal contamination. Potential for contamination to further impact on the groundwater aquifer and nearby environmental receptors. Typically requires an EMP and ongoing monitoring.	Not Suitable – this approach is primarily suited to addressing groundwater contamination; the approach would not address the identified soil impacts.

Further consideration may be required to assess whether the groundwater and/or impacted soils around any hotspots require further management or remediation if volatile hydrocarbons are recorded at levels suggesting vapour intrusion into ground floors of residential properties.

6.3 PREFERRED REMEDIATION OPTION

Based on the assessed remedial technologies (including their relative cost effectiveness), the proposed development (residential with minimal accessible soils) and the potential risks to human health and the environment, the preferred remedial option for the site is:

- Off-site disposal of UPSS infrastructure and impacted soils to licensed waste facilities.

All wastes shall be transported to appropriate, EPA-licensed facilities, after formal classification. All excavated (remediation) areas shall be validated.

The alternative option of consolidation / capping of contamination shall be considered as a secondary option, in combination with the above, especially where waste disposal costs become an issue.

6.4 SITE PREPARATION, LICENCES AND APPROVALS

6.4.1 Consent Requirements

In accordance with the EPA (1998) *SEPP 55 - Remediation of Land*, the category of the remediation works defines whether consent is required prior to their commencement. Under *SEPP 55*, works where there is the potential for significant environmental impact are classed as Category 1 and require development consent. Category 2 works pose a low potential for environmental impact and do not therefore require prior consent. The determination for the subject site is outlined in **Table 6-2**.

Table 6-2 Remediation Works Category Determination

Significant Environment Impact	Yes/No	Category
Designated Development or State Significant Development	No	2
Critical or threatened species habitat	No	2
Significant impact on threatened species, populations, ecological communities or their habitats	No	2
In area identified environmental significance, such as scenic areas, wetlands (see list*)	No	2
Comply with a policy made under the contaminated land planning guidelines by the council	Yes	2
Is work ancillary to designated development	Yes	2

* Environmental significance list - coastal protection, conservation or heritage conservation, habitat area, habitat protection area, habitat or wildlife corridor, environment protection, escarpment, escarpment protection or escarpment preservation, floodway, littoral rainforest, nature reserve, scenic area or scenic protection, or wetland.

Based on the above assessment, the proposed remediation works for the site are considered Category 2 and will not require development consent. Category 2 works do, however, require notification to the consent authority; therefore, Council must be notified 30 days before commencement of the works. The 30-day limit does not prevent Council intervention after that time for a breach of the EPA Act 1997 or non-compliance with *SEPP 55*. The notification also serves as the basis for updating Council records on properties in the local government area and must:

- Be in writing;
- Provide contact details for the notice;
- Briefly describe the remediation work;
- Show why the work is considered category 2 remediation work;
- Specify the property description and street address on which the remediation work is to be carried out;

- Provide a location map; and
- Provide estimates for commencement and completion dates of the work.

Provision of an RAP, as well as an indication of work commencement and completion dates in writing, is usually sufficient to meet the requirements of this notification.

6.4.2 Development Consent and Control Plans

All works should be in accordance with the *Canterbury DCP 2012* and any consent conditions issued by Canterbury-Bankstown Council for the proposed (approved) development.

6.4.3 Other Licence Requirements

The appointed contractor should prepare an appropriate CEMP and WHSP, as well as any other plans required under the Council DA and DCP. Where asbestos removal is required, the contractor must be appropriately licensed to perform such works, which must be conducted in accordance with a specific Asbestos Management Plan (AMP).

7 REMEDIATION WORKS

7.1 REMEDIATION STRATEGY

Following approvals and site establishment, the main remediation works will include, but not necessarily be limited to:

- **Stage 1** – Additional Investigation for Data Gap Closure;
- **Stage 2** – Site Preparation;
- **Stage 3** – Ground Surface Inspection;
- **Stage 4** – UPSS Excavation and Disposal;
- **Stage 5** – Handling and Management of Fill Soil for Off-site Disposal;
- **Stage 6** – Site Validation and VENM Classification;
- **Stage 7** – Validation Report Preparation.

Contingent Action

Should unexpected finds be discovered during the course of the remediation program, or should any phase of validation identify high level, residual contamination requiring additional remediation, then the procedures described under the Unexpected Finds Protocol (**Section 8.6**) and/or the Validation Plan (**Section 9**) will be implemented. This will continue until the remediation goals have been achieved and the site is deemed suitable for the intended land use.

7.2 REMEDIATION METHODOLOGY

7.2.1 Stage 1 – Additional Investigation for Data Gap Closure

Supplementary investigations to close the data gaps identified in **Section 3.5** are to be implemented. This will involve:

- Inspection and soil sampling of (building) areas with ACMs on the surface, if encountered;
- Soil sampling at a density that ultimately complies with the minimum density recommended under the EPA (1995) *Sampling Design Guidelines*, focusing on the former building footprints and pavements (e.g. 17 Brighton Avenue);
- Delineation of the asbestos-impacted areas (i.e. the vicinities of EI (2018a) sampling locations BH3 and BH10M);

  A minimum of four sampling locations is recommended per hotspot (within 2-5m radius)
- Sample analyses for the identified contaminants of concern (**Section 3.3.3**).

7.2.2 Stage 2 – Site Preparation

Notice will be given to Council at least 30 days prior to the commencement of remediation works. A list of all required work permits will be obtained from Council and arrangements are to be made to obtain the necessary approvals from the relevant regulatory authorities.

The site will be prepared in accordance with the requirements of the Site Management Plan outlined in **Section 8**. The property developer will also need to implement a Construction Environmental Management Plan (CEMP), Work Health and Safety Plan (WHSP) and Asbestos Management Plan (AMP) prior to any works. Frameworks for CEMP, WHSP and AMP requirements are outlined in **Section 8**. Establishment of environmental controls, site access, security, fencing and warning

signage and the preparation of the CEMP, WHSP and AMP are required prior to works commencement. A project plan should also be developed to outline engineering design for excavation support (if required), water treatment requirements and design, staging of excavation works, stockpiling, waste stabilisation, waste material loading, traffic management and waste tracking.

As part of the preparation phase, a remediation workshop will be conducted with the appointed contractor(s) to further develop any remedial measures, excavation plans and environmental management requirements.

Also prior to commencing work, each contractor is to prepare a staging or project plan that outlines the basic stages of the remediation works. The staging plan should include, but not necessarily be limited to:

- Staging of areas to be excavated;
- Areas designated for waste segregation, screening and storage (stockpiling), amenities, soil and groundwater treatment (if required);
- Truck movement to allow loading and mitigate impacts to surrounding land users and council infrastructure; and
- Proposed environmental mitigation measures.

7.2.3 Stage 3 – Ground Surface Inspection

After site preparation, including the removal of any pavements, an inspection of the exposed ground surface must be undertaken by qualified persons, to survey for underground tanks (i.e. ground penetration radar by a licensed services locator), confirm the absence of ACMs (e.g. fragments) and check for evidence (previously unidentified hotspots) of potential contamination. At least one underground tank is present in the south western site corner.

Emphasis shall be given to former building area(s) and pavements. Additional characterisation of soils will be performed, as deemed appropriate. The analytical results would be combined with the existing data set to assist the waste classification of site (fill) soils designated for disposal, as well as evaluation against human-health acceptance criteria applicable for residential exposure settings with minimal access to soil.

7.2.4 Stage 4 – UPSS Excavation and Disposal

Based on the investigation phase findings, at least one UPSS is present on the site, in the south western site corner (**Section 3.2**). The *Site Preparation* and *Ground Surface Inspection* stages will assist in establishing whether any other (abandoned) systems are present.

Any underground tank infrastructure, including tanks, anchors, fuel feed lines, air vent pipes and direct or remote fill points will require decommissioning and removal as part of the site remediation process.

Decommissioning

Residual fuel and flammable liquids, and fuel/solvent/water mixtures may be present within the tank and product lines. Any liquid waste remaining within site infrastructure should firstly be drained and classified for disposal purposes, as defined in EPA (2014a/b). The liquid waste must be removed from site by a licensed liquid waste transporter and disposed to a suitably licensed liquid waste facility. The contractor shall provide appropriate documentation for waste disposal.

A SafeWork NSW licensed and experienced tank removal contractor must be engaged to manage the tank and infrastructure removal process, in accordance with the Australian Standard for the removal and disposal of underground petroleum storage tanks (AS4976 - 2008), SafeWork NSW guidelines

and the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2019* (the 'UPSS Regulation'). SafeWork NSW should be notified within 7 days of the removal of any UPSS. Where buried UPSSs are discovered, these will be targeted for decommissioning and offsite destruction in accordance with SafeWork NSW guidelines and the UPSS Regulation.

The contractor is to record the condition of any tanks and associated infrastructure, and provide documentary evidence on destruction of the USTs for final validation report.

Remedial Soil Excavations

Following decommissioning and removal, contaminated soils may be found in vicinity of the tank and associated lines, including the former bowser area. Such materials will require separate management from the remainder of the site, via remedial excavations, followed by waste classification and off-site disposal. The general procedure is as below.

- Any infrastructure, residual product and liquid in the excavation area should be removed in accordance with the procedure described above. Localised deep excavations (sumps) may be created within the area to allow perched groundwater to drain to the sumps. The accumulated liquid will be removed by an appropriately licenced liquid waste removal contractor for appropriate disposal and /or recycling, after on-site treatment (if necessary).
- "Chase-out" excavation of walls and base of the area, with regular field screening of soil headspace samples using a calibrated photoionisation detector (PID). Materials exhibiting unusual odour, staining and / or PID reading >30ppm will be stockpiled separately for waste classification. Excavation should not jeopardise the stability of adjoining properties and structures. The open excavation pits should be clearly demarcated with star pickets and tapes.
- "Chase-out" excavation should continue until all walls and base of the excavation are observed to be free of odour and staining and PID reading of headspace sample are less than 30ppm. Validation samples will be collected for laboratory analysis, from the base and side walls of the final remedial excavations, in accordance with EPA (2014a) *Technical Note: Investigation of Service Station Sites.* Further details are discussed in **Section 9**.
- Spoils from remedial excavations are to be stockpiled separately from other site fill / soils, for *ex-situ* waste classification assessment. General management requirements of stockpiles on site are described in **Section 8.2**.
- Stockpiles resulting from remedial excavations will be visually inspected, sampled and analysed for waste classification in accordance with Section 7.5 of Schedule B2 in NEPC (2013) and EPA (2014b) *Waste Classification Guidelines*:
    - Collection of one sample per 25m^3 of stockpiled materials, up to 250m^3. A minimum of three samples is required for any stockpile. For stockpiles >250m^3 but <2500m^3 in size, a statistical analysis approach may be used with the collection of 10 samples.
    - The analytical suite for waste classification will include the 8 priority metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TRHs, BTEX, PAHs, OCPs, OPPs PCBs and asbestos, and any additional chemicals of potential concern that may be identified during site remediation (e.g. CVOCs).
- Waste classification certificates will be prepared for stockpiles, which will be transported and disposed to appropriately licensed waste landfill facilities, according to their classification. General material handling and management requirements are discussed in **Section 8.2**. Waste disposal documentation will be maintained by the site contractor and provided to the environmental consultant for reporting purposes.

- Validation of voids following remedial excavation of UPSS and associated contaminated soil should be undertaken according to the validation plan provided in **Section 9**.

7.2.5 Stage 5 – Handling and Management of Fill Soil for Offsite Disposal

Waste classifications for individual, excavated fill stockpiles will be determined from previous investigation results and additional sampling and testing to confirm which materials are classified as *Hazardous Waste* / *Restricted Solid Waste* / *Special Waste - Asbestos Waste* / *General Solid Waste*.

The procedure for the assessment and offsite disposal of near-surface (topsoil) fill, including that from the vicinities of BH3 and BH10M, will be as follows:

1. Site fill will be screened to remove coarse (>75 mm fraction) materials.
2. The coarse fraction will be inspected for ACM, with manual removal and bagging of ACM fragments if identified, followed by loading onto licensed transport vehicles and appropriate offsite recycling or disposal as construction / demolition waste (Note: Any collected ACM will be double-bagged and assigned for appropriate disposal by a licensed asbestos contractor as *Special Waste – Asbestos Waste*).
3. After the removal of the coarse >75 mm screened fraction, remaining fill soils will be stockpiled as individual (physically separate) stockpiles each containing not more than 250m^3 of fill.
4. Fill materials will be stored on impermeable surfaces (such as remaining hardstand or a plastic liners) and re-assessed to produce final waste classifications, which will be used to determine the appropriately licensed waste landfill facility able to receive the materials.
5. Any fill exhibiting heavy staining and/or odours is to be isolated from other excavated materials, for separate waste classification sampling and testing.
6. A waste classification assessment will be performed on each fill stockpile using the following procedure:
    - Collect one sample per 25m^3 of stockpiled material for the fill/soils produced by any excavation;
    - Collect one intra-laboratory duplicate for every 10 primary samples collected and one inter-laboratory duplicate for every 20 primary samples collected;
    - Collect one rinsate blank per sampling round;
    - Using NATA-registered laboratory methods, analyse each sample for eight heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TRHs, VOCs (including BTEX and CVOCs), PAHs, OCPs, OPPs, PCBs and asbestos identification, with TCLP testing of the two highest metals and PAH results for leachability assessment; and
    - Prepare a Waste Classification Certificate for each category of soil waste, to enable appropriate off-site disposal of all fill stockpiles.
7. After waste characterisation sampling (while waste classification testing is taking place), fill stockpiles should be protected from wind to avoid airborne dispersion of dust.
8. Ensuring that the waste fill/soil stockpiles are kept separate in order to maintain the integrity of each separate waste stream, stockpiles will be loaded, transported and disposed offsite to waste landfill facilities that are appropriately licensed to receive the materials corresponding to the documented waste classifications.

9. In accordance with the *Waste Regulation 2014*, waste movements will be tracked and disposal receipts (dockets) will be maintained by the site manager, with copies provided to the appointed Environmental Consultant for final reporting purposes.

Remedial excavations should be conducted under the supervision of a suitably qualified environmental professional. Appropriate dust control measures must be implemented during excavation of soil material at the site, as described in **Section 8**. Should odours be significant enough to cause nuisance at a site boundary, then measures for odour control must be adopted, as described under the unexpected finds protocol in **Section 8.6**.

Hotspot Remediation

Localised hotspots of soil contamination (e.g. BH3 in north western portion of 27-33 Brighton Avenue and BH10M in the south eastern portion of 27-33 Brighton Avenue) will be remediated using the following procedure:

1. Mark out the hotspot area (as determined by Stage 1 delineation works). The extent of the impact should be marked in a way to withstand external conditions and should be readily identifiable during the entire remedial works program, to enable contaminated soil chase-out excavations and revalidation, if necessary.
2. Plant, machinery and / or other equipment used for the excavation works should be dedicated to the individual excavation, and should be clean and free of all solid materials prior to the start of remedial excavation works.
3. Hotspot fill/soils, which have been classified under the same waste category will be excavated and directly loaded onto the same transport vehicle.
4. Under the *NSW Waste Regulations 2014*, different waste streams must be kept separate. **Hotspot soils with different waste classifications cannot be loaded onto the same waste transport vehicle, for landfill disposal purposes.**
5. Should the temporary stockpiling of excavated, contamination hotspot soils be necessary, soils from different areas must be stockpiled separately and isolated from all other excavated materials, on an impermeable surface (such as a plastic liner). Stockpiles should also be protected from wind to avoid airborne dispersion of dust.
6. Any soils with heavy staining and/or exhibiting odours are to be isolated from other excavated materials, for additional waste classification sampling and testing.
7. Validation samples will be collected from excavation surfaces (minimum four walls and one base) for laboratory analysis of the contaminant (or group of contaminants) for which the respective area is being remediated (BH3 and BH10M remediation areas: asbestos).
8. Should any wall or base validation sample from any hotspot remedial excavation be found to contain contaminant concentrations that exceed the adopted soil validation criteria, additional chase-out excavations will be conducted to remove more fill from the area of residual impacts, followed by resampling for revalidation testing.
9. When all wall and base validation samples show results that are below the adopted validation criteria, the hotspot area will be deemed as effectively remediated.

7.2.6 Stage 6 – Site Validation and VENM Classification

Validation of In Situ Natural Soils

All contaminated (fill) soil needing to be remediated must be removed from the site and a validation assessment of freshly exposed soil must be completed prior to the commencement of further bulk excavation works. Natural soil is potentially classifiable as *virgin excavated natural material* (VENM); however, inspection and validation by near surface sampling and analysis are required. A validation plan is outlined in **Section 9**.

Where impact is identified in natural soils, the impact would be remediated and validated in accordance with the remedial excavation procedures described in Stage 5 above (**Section 7.2.5**). The resulting spoils will be assessed and classified in accordance with EPA (2014b) *Waste Classification Guidelines*.

Validation of Imported Backfill Soils

Should reinstatement (backfilling) of remedial excavations require importation of soils from off-site source(s), the imported materials must be certified as meeting the VENM classification, prior to importation. To deem soils suitable for use on the subject site, the following confirmation procedure should be undertaken:

- All imported soils brought to the site should be certified as VENM by the supplier;
- No soil or rock is to be imported onto the site for backfilling purposes, unless the supporting documentation is approved and the materials are inspected by the appointed environmental consultant; and
- Where certification cannot be provided, the imported materials must be validated in accordance with the procedure outlined in **Section 9.1**.

Validation of Local Groundwater

At least one groundwater monitoring event (GME) is to be undertaken during the remedial program, in order to assess the local conditions and inform any additional remediation and management measures required during the excavation program. The GME should involve sampling and analysis of water in the existing / protected monitoring wells (southern wells: BH1M, BH4M, BH7M, BH10M and BH13M; northern wells: BH101M, BH108M and BH112M); otherwise, new groundwater monitoring well(s) may need to be installed for this purpose. A SAQP for the/each GME is provided in **Table 7-1**.

Table 7-1 SAQP for Groundwater Investigation

Item	Description
Groundwater Sampling Location and Methodology	Utilise existing monitoring wells – to be protected during the site demolition and preparation stages. New groundwater monitoring wells, if necessary, should be constructed, developed and sampled in accordance with NSW EPA endorsed standards. The low-flow sampling method should be used where possible.
Rationale	The proposed sampling program will involve wells located inside the site boundary, to enable assessment of potential influence from the site on migrating groundwater quality and delineation of the point of contamination.
Well Development	All groundwater monitoring wells should be developed prior to sampling.
Analytical Suite	Heavy metals, TRHs, VOCs (including BTEX and CVOCs) and PAHs.
Sample Handling, Transport and Tracking	Containers will be labelled with individual and unique identification including Project No., Sample No., date and time of sampling. Collected samples will be stored in chilled, enclosed and secure containers for transport to laboratories. Chain of custody documentation will be completed to ensure that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to the environmental laboratory.
Sample Containers and Holding Times	Sample handling, transportation and tracking should be in accordance with NEPC (2013) and typically will comprise: • TRHs (>C_{10}-C_{40}) and PAHs – 1 litre amber glass / acid-washed and solvent-rinsed bottle / refrigeration 4ºC / 7 days; • TRH (C_6-C_{10}), VOCs and BTEX – two, 40ml glass vials / pre-preserved with dilute hydrochloric acid, Teflon-sealed / refrigeration 4ºC / 7 days; and

Item	Description
	• Metals – one, 250mL, HDPE bottle / pre-preserved with dilute nitric acid (1mL) / refrigeration 4ºC / 6 months. Samples for metals analysis will be field filtered with 0.45 µm pore-size filters.
Field QA/QC	Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the program to ensure sampling precision and accuracy, which will be assessed through the analysis of 5% field duplicate/replicate samples. Appropriate sampling procedures will be undertaken to prevent cross contamination, in accordance with NEPC (2013). This will ensure: • standard operating procedures are followed; • site safety plans are developed prior to works commencement; • split duplicate field samples are collected and analysed; • samples are stored under secure, temperature controlled conditions; • chain of custody documentation is employed for the handling, transport and delivery of samples to the contracted environmental laboratory; and • groundwater originating from the site area is disposed in accordance with relevant regulatory guidelines. Field QA/QC will include one pair of intra-laboratory and inter-laboratory duplicates to be tested every 20 primary samples, as well as VOC trip blank and trip spike samples and equipment wash (rinsate) blank samples per batch.
Laboratory QA/QC	All samples will be analysed by NATA-accredited laboratories. The contract laboratory will conduct in-house QA/QC procedures involving routine analysis of: • method blanks; • spike recoveries; • laboratory duplicates; • calibration standards and blanks; • QC statistical data; and • control standards and recovery plots.
Achievement of Data Quality Objectives	Data quality indicators to be achieved are listed in **Section 9-1**. An assessment of the overall data quality should be presented in the final validation report, in accordance with the EPA (2017) *Guidelines for the NSW Site Auditor Scheme*.

Subject to the findings from the groundwater investigation, further assessment (e.g. more GMEs) may be necessary to achieve site validation.

7.2.7 Stage 7 – Validation Report Preparation

A site validation report will be prepared in accordance with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and EPA (2017) *Guidelines for the NSW Site Auditor Scheme*, as described in **Section 9.2**.

7.3 REMEDIATION SCHEDULE

An estimated schedule for the remedial works is detailed below in **Table 7-2**. The proposed schedule is based on the remedial works being completed as outlined in this RAP and is dependent on Council approval of any DA and conditions of consent.

Table 7-2 Indicative Site Remediation Schedule

Timeframe	Action
Start	Approval of Remediation Plan

Timeframe	Action
Week 1/3	Stage 1 – Additional Investigation for Data Gap Closure
Week 4/5	Stage 2 – Site Preparation
Week 6	Stage 3 – Ground Surface Inspection
Week 7/8	Stage 4 – UPSS Excavation and Disposal
Week 9/16	Stage 4 – Handling and Management of Fill Soil for Offsite Disposal
Week 16/17	Stage 5 – Site Validation and VENM Classification
Week 18/22	Stage 6 – Validation Report Preparation

7.4 REMEDIATION HOLD POINTS

Specific hold-points in the remediation work will be dependent on data gap closure and other specific sampling and analysis tasks, as well as approvals required by the conditions of DA consent and the appointed site auditor. They are designed to minimise remediation risks and identify the outcome/criteria that need to be met for the hold-point to be removed. Those deemed applicable for this RAP are outlined in **Table 7-3.**

Table 7-3 Remediation Hold Points

Remediation Phases	Tasks	Hold-point	Requirement
Preliminaries and Site Establishment	Preparation of CEMP, WHSP and AMP	Submission of plans / reports for approval	Council to approve works Auditor to approve report
General Clean-up	Additional investigations Inspection for USTs and unexpected finds	Unexpected finds may identify unknown contamination that requires further assessment before excavation	Depending on investigation findings
Excavation of UPSS and Fill/Surficial Soils	Waste classification (*in-situ* or stockpile) Determine need for soil treatment if concentration high Establishment of groundwater treatment system (if req'd)	Waste classification Treatment system set-up	Depending on results, laboratory turnaround time and inspections
Reporting	Final report on remediation and validation sampling	Report preparation and submission	Auditor and Council sign-off

7.5 REMEDIAL CONTINGENCIES

It is anticipated that the proposed remedial technologies should be effective in dealing with the contamination present; however, other remedial contingencies may be required should any of the scenarios detailed in **Table 7-4** arise.

Table 7-4 Remedial Contingencies

Scenario	Remedial Contingencies/Actions Required
Highly contaminated soils not identified during previous investigation are	Follow the unexpected finds protocol as detailed in **Section 8.6** of this

Scenario	Remedial Contingencies/Actions Required
encountered, particularly at site boundaries	RAP. Work to be suspended until the Environmental Project Manager can further assess impacted soils/ materials and associated risks.
Additional UPSSs are encountered at the site	Systems to be removed and the excavations appropriately validated and backfilled by experienced contractor. Tank removal works reported by appropriate environmental consultant in accordance with EPA (2014a) *Technical Note: Investigation of Service Station Sites* and Australian Standard AS4976 (2008). Follow the unexpected finds protocol as detailed in **Section 8.6** of this RAP.
Highly impacted sludges are uncovered	The leachability of heavy metals and hydrocarbons will need to be assessed before disposal options are considered. Follow the unexpected finds protocol as detailed in **Section 8.6** of this RAP.
Significant (buried) asbestos wastes are encountered	Work to be suspended and asbestos work removed by a suitably qualified contactor, in accordance with SafeWork NSW regulations. Follow the unexpected finds protocol as detailed in **Section 8.6** of this RAP.
Residual soil impacts remain on-site between site boundary and final excavation	Review/assess soil conditions. Carry out site-specific second tier risk assessment (if required). Review/assess potential vapour hazard. If there is a vapour risk additional remedial measures may be required including installation of a vapour barrier or passive or active vapour extraction system.
Contaminated groundwater (including LNAPL or DNAPL) encountered	Review of groundwater conditions on site, may require further groundwater investigations / remediation and longer-term management plan. Any dewatering may require approval under the *Water Management Act 2000*. Remedial measures may include, source removal, natural attenuation, bioremediation, PSH recovery using active pumping (including hydraulic control), installation of a groundwater permeability barrier or similar or in-situ oxidation or stabilisation.
Groundwater contaminant plume is identified and is migrating off-site or there are increases in concentration due to increased infiltration (following demolition)	Review contaminant increase and analytes. Review active remediation alternatives (if necessary). Ensure down-gradient monitoring is undertaken. Carry out fate and transport modelling (if required) and assess the need for further action.
Contamination is identified near heritage items or significant trees (if identified)	Stop work. Review contaminant concentrations and risks to heritage items / flora. Assess human health and environmental risks if contamination remains in place. Review natural attenuation options.
Changes in proposed basement excavation depth	Review the remediation works completed for the site.
Changes in proposed future land uses at the site	Review the remediation works completed for the site.

8 SITE MANAGEMENT

8.1 RESPONSIBILITIES AND CONTACTS

Responsibilities for the various parties involved with the remedial program are outlined in **Table 8-1**.

Table 8-1 Site Management Responsibilities

Responsible Party	Details	Responsible for:
Principal Project Manager (PPM)	Dyldam	Overall management of the site remedial activities, particularly with respect to policy and operational procedures.
Property Owner	Dyldam	Implementation of and compliance with the RAP. Notification to contractors of the existence of an RAP. Provision of copies of the current RAP. Provision of copies of the RAP to accompany the Development Application (DA). Notification of the site conditions to the NSW Environmental Protection Agency (EPA) under the duty to report contamination under the *Contaminated Land Management Act 1997* (if required). Registration of details of Site Audit Statement and RAP on the certificate of title with NSW Land and Property Information (if required).
Environmental Management Coordinator (EMC) / Remediation Supervisor	TBA	Ensuring that the site remediation works are carried out in an environmentally responsible manner. Liaising between the appointed Environmental Consultant and Council providing regular updates and informing of any problems encountered. Ensuring that all environmental protection measures are in place and are functioning correctly during site remediation works. Reporting any environmental issues to owner.
Demolition, Earthworks or Remediation Contractor(s)	TBA	Ensuring that all operations are carried out as identified in the RAP (demolition and remediation), as directed by the PPM and EMC. Inducting all employees, subcontractors and authorised visitors on procedures with respect to site works, WHSP and environmental management procedures. Reporting any environmental issues to EMC. Maintaining site induction, site visitor and complaint registers. Ensuring that fugitive emissions and dust potentially leaving the confines of the site are suitably controlled and minimised. Ensuring that suspended matter or contaminants in water potentially leaving the site are minimised and suitably controlled, so as not to pollute the environment. Ensuring that vehicles are cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas. Ensuring that noise and vibration levels at the site boundaries comply with the legislative requirements.

Responsible Party	Details	Responsible for:
Environmental Consultant	TBA	Ensuring that all operations are carried out as identified in the RAP (demolition and remediation). Advising Council and/or the Site Auditor should a scenario arise requiring deviation from the procedures and requirements detailed in this RAP. Drafting the validation report.
Qualified Independent Consultant / EPA-accredited Site Auditor	TBA	Reviewing proposed remediation strategies and ensuring remediation is technically feasible, environmentally justifiable and consistent with relevant legislation and guidelines. Review of actions taken demolition, earthworks or remediation contractor. Ensure all works have complied with the RAP and remedial procedures.

8.2 MATERIALS HANDLING AND MANAGEMENT

Table 8-2 summarises the measures that should be implemented in respect of materials handling during excavation and remediation works at the site.

Table 8-2 Materials Handling and Management Requirements

Item	Description/ Requirements
Earthworks contractors	Excavation of fill materials should be completed by a suitably qualified contractor to ensure: • All site staff are aware of the environmental and health and safety requirements to be adhered to; • There is no discernible release of dust into the atmosphere as a consequence of the works; • There is no discernible release of contaminated soil into any waterway as a consequence of the works; and • There are no pollution incidents, health impacts or complaints.

Item	Description/ Requirements
Stockpiling of materials	All stockpiles will be maintained as follows: • Should the temporary stockpiling of excavated, contaminated soils be necessary, soils from different areas must be stockpiled separately and isolated from other excavated materials. Stockpiles should also be protected from wind to avoid airborne dispersion of asbestos. • Stockpiles must be located on sealed surfaces such as concrete hardstand, asphalt, or high density polyethylene plastic sheeting. • Should stockpiles comprising contaminated soils be placed on bare soils, these stockpiles should be placed on yet to be remediated areas. • Excavated soils should be stored in an orderly and safe condition (≤2m height). • Stockpiles should be battered with sloped angles to prevent collapse. • Stockpiles should be covered after being lightly conditioned by sprinkler to prevent dust blow and control odours. • Should the stockpiles remain *in-situ* for over 24 hours, silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion (runoff). • Stockpiles will be strategically located to mitigate environmental impacts while facilitating material handling requirements. • Any soils with heavy staining and/or exhibiting odours are to be isolated from other excavated materials, for additional waste classification sampling and testing. • Air emission controls should be developed in the CEMP for the site. For example, in areas impacted by hydrocarbon, a hydrocarbon mitigation agent such as BioSolve®, Pinkwater®, or Anotech (or equivalent product selected by the contractor) in combination with the fine mist spray should be deployed during disturbance and stockpiling of the materials. Regular boundary monitoring for air emission should be undertaken during remediation works.
Loading of material	Loading of stockpiles / materials will be as follows: • Measures shall be implemented to ensure no contaminated material is spilled onto public roadways or tracked off-site on vehicle wheels. Such measures should include the use of a wheel washing/cleaning facility, placed before the egress point on the site, and should be able to handle all vehicles and plant operating on-site. • Residue from the cleaning facility should be collected, and either dewatered on site in a contained / bunded area or disposed as a slurry to an approved facility. Such residue will be deemed contaminated unless proven otherwise.
Transport of materials	• Prior to being assigned to an appropriate waste disposal facility, all waste fill/soils should be classified in accordance with the EPA (2014b) *Waste Classification Guidelines*. If prior immobilisation treatment of the waste soils is required, disposal consent will be obtained from the NSW EPA prior to spoil transport. All trucks transporting soils from the site are to be covered with tarpaulins (or equivalent). • Transport of contaminated material off the site is to be via a clearly distinguished haul route designated by the site traffic management plan. • All haulage routes for trucks transporting soil, materials, equipment and machinery shall comply with all road traffic rules, minimise noise, vibration and odour to adjacent premises, utilise state roads and minimise use of local road. • All deliveries of soil, materials equipment or machinery should be completed during the approved hours of remediation and exit the site in a forward direction. • Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents and approvals. • Waste must be transported less than 150km from the source (*POEO (Waste) Regulation 2014*) and landfills are required to be licensed for the category of waste they are scheduled to receive.

Item	Description/ Requirements
Material tracking	Materials excavated from the site should be tracked from the time of their excavation until their disposal. Tracking of the excavated materials should be completed by recording the following: • Origin of material; • Material type; • Approximate volume and/or weight; and • Truck registration number. Disposal locations will be determined by the remediation contractor. Locations, waste disposal documentation (weighbridge dockets) and the above listed information must be provided to the remediation consultant for reporting.
Material visual inspection prior to validation sampling	Following the completion of remedial works as specified within this RAP, the following applies: • A suitably qualified environmental scientist should undertake a visual inspection of the work area. If visual observations indicate contamination, the earthworks contractors should rectify any issues arising from the inspection (i.e. further excavation or 'chasing out' until soils show no evidence of contamination based on visual inspection and/or odours). • Following completion of the visual inspection, validation sampling of soils should be completed. Validation sampling is discussed in **Section 9**. Only following satisfactory validation will remedial works be deemed completed.

8.3 MANAGEMENT MEASURES

All work must be undertaken with due regard to the minimisation of environmental effects and to meet all statutory environmental and safety requirements (**Section 8.5**). A CEMP should be developed for the site works by the site contractor/builder, which takes into account relevant guidance including, but not necessarily limited to:

- DA Conditions of Consent;
- *Canterbury Development Control Plan 2012*; and
- *Managing Urban Stormwater, Soils and Construction*, Volume 1: 4th edition (March 2004) – often referred to as the 'Blue Book'.

Overall site management requirements related to the remedial works are presented in **Table 8-3**.

Table 8-3 Site Management Measures

Category	Measure
Demolition (including Asbestos Management)	Appropriate measures shall be taken to ensure that demolition works are completed in accordance with SafeWork NSW standards and codes of practice. Any asbestos identified should be managed in accordance with SafeWork NSW codes of practice and Australian Standards.
Site Stormwater Management and Control	Appropriate measures shall be taken to ensure that potentially contaminated water does not leave the site. Such measures will include: • diversion and isolation of any stormwater from any contaminated areas; • provision of sediment traps including geotextiles or hay bales; and • discharge of any water to drains and water bodies must meet the appropriate effluent discharge consent condition under the *Protection of the Environmental Operations Act 1997*.
Soil Management	Appropriate measures shall be taken during soil excavations to reduce nuisance dust and odours. Soils will be disposed in accordance with the NSW *Protection of*

Category	Measure
	the Environment Operations (Waste) Regulation 2014.
Dust and Odour	Control of dust and odour during the course of the remediation works shall be maintained by the contractor to ensure no nuisance dust or odours are received at the site boundary according to requirements of the *Canterbury DCP 2012*. Action levels and specific control measures would be described in the site CEMP and may include, but will not necessarily be limited to the following: • site wide water spraying, as/when appropriate, to eliminate wind-blown dust; • use of mist sprays, and/or sprinklers on stockpiles, fill screening areas and loaded fill to lightly condition the material; • use of tarpaulin or tack-coat emulsion or sprays to prevent dust blow from stockpiles or from vehicle loads; • covering of stockpiles or loads with polythene or geotextile membranes; • restriction of stockpile heights to ≤2m 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 with the CEMP requirements and undertaking immediate remedial measures to rectify any cases of excessive dust or odour (e.g. use of misting sprays or odour masking agent). EI notes the Council Contaminated Land Policy requires that no odours shall be detected at any boundary of the site during remediation works by an authorised Council Officer relying solely on sense of smell. Should significant odours be detected, during site remediation, additional control measures for odour control may be required under the Council contaminated land policy, being: • use of appropriate covering techniques such as plastic sheeting to cover excavation faces; • use of fine mist sprays / hydrocarbon mitigation agent on the impacted areas/materials (examples of mitigation agents include BioSolve® Pinkwater®, or Anotech, however a similar product may be selected by the contractor); and • adequate maintenance of equipment and machinery to minimize exhaust emissions. Records of volatile emissions and odours shall be logged, kept on-site and made available to Council Officers on request.
Noise and Vibration	Noise and vibration will be restricted to reasonable levels. All plant and machinery used on site will be noise muffled to ensure that noise emissions do not breach statutory levels as defined within the *Canterbury DCP 2012*.
Hours of Operation	Working hours will be restricted to those specified by Council, which are normally defined as being 7am to 5pm weekdays and 8am to 1pm Saturdays; no Sunday or public holiday works permitted. These hours may differ from DA conditions and DA conditions specified for the site must be adhered to.

Category	Measure
Community Engagement	Community engagement should be carried out in accordance with Schedule B(8) of NEPC (2013). Prior to the commencement of any remediation works at the site, every owner and occupier of any land located either wholly or partly within 100m of the boundary of the premises (including local council and the RMS) should be notified at least 30 days in advance. The notice should include: • advice of demolition and excavation work to be carried out on the premises; • state the time and date such work is to commence; • indicate that the works are being conducted to minimise any risk of site contamination impacting on off-site receptors; • provide appropriate site signage at an easily readable location on the site fencing, including site contact name and phone number to be contacted should any matter arise; and • provide contact information and procedure for registering any complaints.
Incident Management and Community Relations	While various environmental management and occupational safety plans will be developed to protect human health and the environment, incidents may occur which pose a risk to the various stakeholders. To mitigate these risks and ensure that a suitable response is carried out quickly, a response plan to any incident that may occur on site should be prepared and various responsibilities assigned. The site WHSP and CEMP should document these procedures and responsibilities, and incident contact numbers should be maintained in an on-site register. All other relevant emergency contact numbers such as Police, Fire Brigade, and Hospital should be listed in the WHSP and posted on-site for easy access.

8.4 CONTINGENCY MANAGEMENT

Contingency plans for anticipated problems that may arise on-site during the course of the site preparation works comprising demolition and remediation are presented in **Table 8-4**.

Table 8-4 Contingency Management

Anticipated Problems	Corrective Actions
Chemical / fuel spill	Stop work, notify above site project manager. Use accessible soil or appropriate absorbent material on site to absorb the spill (if practicable). Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Leaking machinery or equipment	Stop work, repair failed control measure.
Failure of erosion or sedimentation control measures	Stop activities, contact the site project manager. Follow the unexpected finds protocol as detailed in **Section 8.6** of this RAP. Prepare a management plan if required, to address the issue.
Excessive rainfall	Collect samples and assess against relevant criteria from the EPA (2014b) *Waste Classification Guidelines*, to enable disposal options to be formulated.
Water in excavations	Stop the identified leak (if possible). Clean up the spill with absorbent material. Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Excessive Dust	Use water sprays to suppress the dust or stop site activities generating the dust until it abates.
Excessive Noise	Identify the source, isolate the source if possible, modify the actions of the source or erect temporary noise barriers if required.

Anticipated Problems	**Corrective Actions**
Excessive Odours / Vapours	Stage works to minimise odours/vapours. If excessive organic odours/vapours are being generated, stop work and monitor ambient air across site with a PID. Implement control measures including respirators for on-site workers, use of odour suppressants, wetting down of excavated material. No nuisance odours shall be detected at any site boundary during remedial works. Should odour emissions be detected at or beyond the site boundary, it is recommended, as part of the CEMP and community consultation procedure, that the Remediation Contractor and the Principal Project Manager: • Notify the owners and occupiers of premises adjoining and across the road from the site regarding potential odour issues. Notification should be in writing. This is also required by the Council Contaminated Land Policy. • In the notification, as well as on street signage, provide contact details of the site personnel for anyone who may be concerned by odour emission during the remediation. • Temporarily pause site works to allow for excess odour to subside to a level acceptable by off-site receptors, should it be necessary, after implementation of the above-listed control measures. • Record logs for volatile emissions and odours. Such records should be kept on-site and made available for inspection on request. In regard to off-site impact from petroleum vapour, EI notes that odour is generally detected at concentrations much lower than what will constitute a health-based risk. Measures listed above for odour control (**Table 8-3**) may also be applied for vapour control. Ensure sediment and surface water controls are operating correctly. If possible divert surface water away from active work areas or excavations.
Equipment failures	Ensure that spare equipment is on hand at site, or that the failed equipment can be serviced by site personnel or a local contractor.
Identification of cultural or building heritage items	Stop work and notify site project manager. Follow the unexpected finds protocol as detailed in **Section 8.6** of this RAP. Prepare action or conservation plan as required.
Unearthing unexpected materials, fill or waste	Stop activities, contact the site project manager. Follow the unexpected finds protocol as detailed in **Section 8.6** of this RAP. Prepare a management plan if required, to address the issue.
Complaint Management	Notify Client, Project Managers and Environmental Consultant (if required) following complaint. Report complaint as per management procedures. Implement control measures to address reason of complaint (if possible). Notify complainant of results of remedial actions.

8.5 WORK HEALTH AND SAFETY PLAN

As required by the NSW *Work Health and Safety Act 2011*, a WHSP should be prepared by the Principal Contractor (**Section 8.1**). Its purpose is to manage the health and safety of site workers and nearby residents, and address such issues as site security, exclusion zones, excavation safety, vibration, noise, odour and dust levels. The plan should address the risks during the remediation works and cover site-specific requirements associated with the contaminants present within the site soils and groundwater.

The officer responsible for implementing health and safety procedures should induct all site personnel so they comply with the requirements of this document. It is the contractor's responsibility to ensure that all other permits, approvals, consents or licences are current. A brief summary of hazards and mitigation measures relevant to the remedial works in **Table 8-5.**

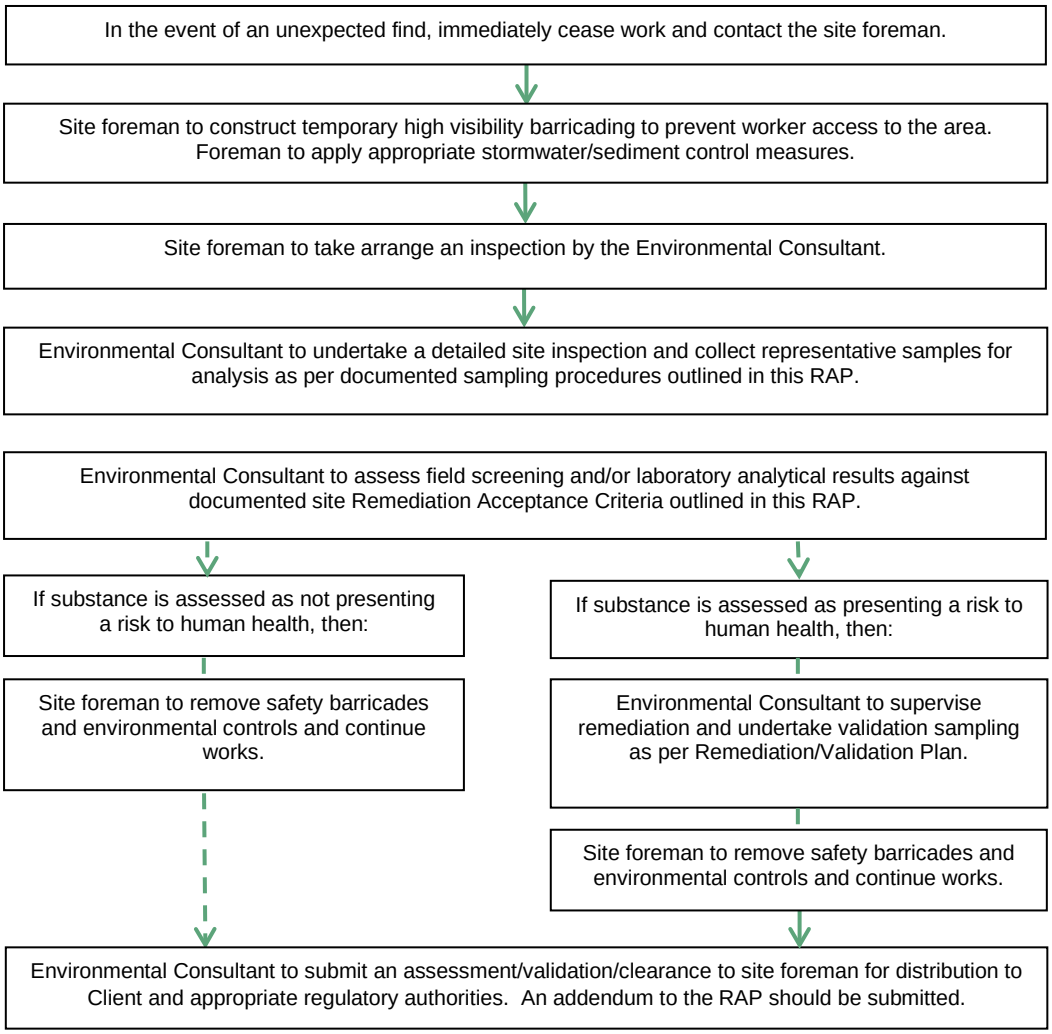
Table 8-5 Remedial Hazards

Anticipated Problems	Corrective Actions
Chemical Hazards	Contaminated sites have chemical substances that may present a risk to human health and the environment. Chemicals of concern and associated risks are as detailed within the CSM (**Section 3.3**). The site specific WHSP should set out controls to mitigate potential risks.
Physical Hazards	The following hazards are associated with conditions that may be created during site works: • deep excavations; • heat exposure; • buried services; • noise, vibration and dust; • fugitive emissions (strong odours, vapours); • electrical equipment; and • the operation of heavy plant equipment.
Personal Protective Equipment and Monitoring	Personnel should, wherever possible, avoid direct contact with potentially contaminated material. Workers are to ensure that surface waters or groundwater are not ingested and that direct skin contact with soil and water is avoided. Standard PPE with the addition of disposable P2 dust masks will be sufficient for the prescribed remedial works.

8.6 UNEXPECTED FINDS PROTOCOL

Should unexpected finds be encountered, the approach in **Table 8-6** is to be followed.

Table 8-6 Unexpected Finds Protocol



A contingent asbestos assessment procedure is described below:

Asbestos Assessment Procedure (if required):

In addition to the above, should asbestos be identified in soil during any walkover inspection or site-wide soil investigation / validation, further assessment for asbestos should be carried out prior to disturbance of site soils. The assessment procedure is described below:

1. Follow the Unexpected Finds Protocol and notify the appointed environmental consultant.
2. The appointed consultant to design an investigation program to delineate asbestos impacts in soil in accordance with relevant, EPA endorsed, asbestos assessment guidelines.
3. An AMP to be prepared by the appointed remediation contractor for the remedial works program.
4. Areas impacted by asbestos should be segregated from the remainder of the site, and marked by prominent features that withstands weathering (e.g. star picket and danger tape).

5. Undertake separate waste classification assessments for areas impacted by asbestos and the remainder of the site.
6. Soils from asbestos-impacted areas will need to be excavated and disposed separately from the remainder of the site. Should temporary stockpiling be required, the material handling and management requirements in **Section 8.2** should be followed.
7. Validate underlying materials after complete removal of asbestos-impacted soils. Validation samples should be analysed for asbestos using a gravimetric method.

9 VALIDATION SAMPLING AND ANALYSIS QUALITY PLAN

The remediation of an impacted soil area will be deemed acceptable based on the achievement of the following validation objectives:

- ***Remedial Excavations*** – Validation of all remedial excavation areas where infrastructure or contaminated soils have been removed will involve sampling and analysis to ensure that contaminant concentrations are below the *Remediation Acceptance Criteria* (**Section 5.2**). The sampling frequency will be in accordance with the NEPC (2013) and EPA (1995) sampling design guidelines and all tests shall be performed by NATA-accredited environmental analytical laboratories.

- ***Backfill Materials*** – Should backfilling be required, validation of imported fill materials used for the backfilling of remediated areas will be undertaken, to verify their suitability for the proposed land use.

- ***Groundwater*** – Concentrations in groundwater are to be within the adopted GILs (**Section 5.2**), or (if exceeding) the regional background concentrations, or (if exceeding) demonstrated to not constitute unacceptable human-health and ecological risks to both on and off site receptors.

9.1 VALIDATION SOIL SAMPLING METHODOLOGY

Soil validation sampling will be in accordance with the procedure described in **Table 9-1**.

Table 9-1 Validation Sample Collection and Handling Procedures

Action	Description
Sample Collection	Soil validation sampling will be directly from the exposed surface of excavation, or from the material brought to the surface by the excavator bucket. Sampling data shall be recorded to comply with routine chain of custody requirements.
Sampling Frequency	***Hotspot and Residual Fill Validation Sampling*** Any fill remaining at the site will be tested at a frequency of 1 sample per 500m^2 to verify its condition. Four wall and one base samples (minimum) for any hotspot validation. "Chase-out" excavation areas will require one sample every 25m^2, and/or a minimum one sample per 5m lineal distance. ***UST pits*** • USTs <4m in length: One sample in the centre of the UST footprint and one sample from each of the four walls. • USTs between 4-10m in length: One sample beneath each end of the UST footprint and two samples from each of the four walls. • USTs >10m in length: One sample beneath each end of the UST footprint and three samples from each of the four walls. • Fuel bowser, bowser foundation and remote fill points / box: One sample in the footprint of each bowser foundation / remote fill point / fill box. • Fuel feed lines: One sample every 5m along the footprint of the feed line. • "Chase-out" excavation areas including inspection pits, wash bay, mechanical hoists, metal / TRH / VOC (BTEX) / PAH hotspots etc. Base: minimum one sample every 25m^2, with additional samples to be collected in areas showing visual or olfactory signs of contamination. Walls: minimum one sample per 5m lineal distance.

Action	Description
	Natural Soil Validation (Stage 6) Surface of the exposed natural soils should be inspected first by a qualified person to confirm removal of fill materials (hotspot and basement excavation areas, at least). There should be no visible asbestos-containing materials or other foreign materials remaining on the excavation surface. Soil samples to be collected in a 25m x 25m systematic grid (approximately 24 samples) across the entire, final site surface, in accordance with EPA (1995) *Sampling Design Guidelines*. Note, data gap closure samples (**Section 7.2.1**) could be utilised for this part of the validation. ***Validation of Imported Backfill Materials*** Materials being imported to the site should be certified as VENM, or suitable for the proposed land use. If certification cannot be provided, the materials should be tested at a frequency of 1 sample per 25m^3, up to a volume of 250m^3. A minimum of three samples is required for any volume of imported fill from the same source. For imported materials >250m^3 in volume, the sampling frequency may be reduced by applying statistical analysis, provided a minimum of ten samples is collected.
Analytical Suite	All validation samples should be field screened for soil vapour with a calibrated PID. ***UPSS Excavations (Stage 4)*** Heavy metals, TRHs and VOCs (including BTEX), at least. ***Hotspot Fill (Remedial) Excavations (Stage 5)*** Heavy metals, TRHs and asbestos, at least. VOCs (including BTEX), PAHs, OCPs, OPPs and PCBs, in addition to the above minimum suite, will be included for validation of site-wide / data gap closure samples. ***Natural Soil Validation and VENM Classification (Stage 6)*** Heavy metals (arsenic, cadmium chromium, copper, lead, mercury, nickel and zinc), TRHs, BTEX, PAHs, pH, electrical conductivity and foreign materials. Asbestos: Gravimetric method (NEPC, 2013) if asbestos observed on surface (Stage 3) or if reported in fill (Stages 1 and 4-5). Otherwise presence/absence protocol. Materials remaining in areas of accessible soils or deep soil areas intended for landscaping should also be tested for physicochemical parameters of pH, cation exchange capacity and clay content to enable calculation of site specific added contaminant limits (ACLs) for EIL verification and assessment of ecological risk. ***Validation of Residual Fill (Stage 5)*** Heavy metals (arsenic, cadmium chromium, copper, lead, mercury, nickel and zinc), TRHs, BTEX, PAHs, OCPs, OPPs, PCBs and asbestos. Any additional contaminants of concern identified during additional site investigation and remediation should be added to the above analytical suites.
Sampling, Handling, Transport and Tracking	The use of stainless steel sampling equipment. All sampling equipment (including hand tools or excavator parts) to be washed in a 3% solution of phosphate free detergent, followed by a rinse with potable water prior to each sample being collected. Direct transfer of the sample into new glass jars or plastic bags is preferred, with each plastic bag individually sealed to eliminate cross contamination during transportation to the laboratory. Soils will be classified in-field with respect to lithological characteristics and evaluated on a qualitative basis for odour and visual signs of contamination. Soil classifications will be based on the Unified Soil Classification System (USCS) and Australian Standard (AS) 1726-1993. The recommendations provided in Section 7.3 of Schedule B2 in NEPC (2013) will used as a general guideline for recording field observations during the validation phase. Label sample containers with individual and unique identification including Project No., Sample No., Sampling depth, date and time of sampling. Place sample containers into a chilled, enclosed and secure container for transport to the laboratory.

Action	Description
	Provide chain of custody documentation to ensure that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to the environmental laboratory.
Sample Containers and Holding Times	Metals - 250g glass jar / refrigeration 4ºC / 6 months (maximum holding period). TRH/VOC - 250g glass jar / refrigeration 4ºC / 14 days (maximum holding period). PAH/OCP/OPP/PCB - 250g glass jar / refrigeration 4ºC / 14 days (maximum holding period). Asbestos - up to a 10 Litre resealable plastic (polyethylene) bag / no refrigeration / indefinite holding time.
Field QA/QC	Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling program to ensure sampling precision and accuracy. Appropriate sampling procedures will be undertaken to prevent cross contamination, in accordance with EI's Standard Operating Procedures Manual. This will ensure: • standard operating procedures are followed; • site safety plans are developed prior to works commencement; • split duplicate field samples are collected and analysed; • samples are stored under secure, temperature controlled conditions; • chain of custody documentation is employed for the handling, transport and delivery of samples to the contracted environmental laboratory; and • contaminated soil, fill or groundwater originating from the site area is disposed in accordance with relevant regulatory guidelines. Field QA/QC will include one pair of intra-laboratory and inter-laboratory duplicates to be tested every 20 primary samples, as well as one VOC trip blank sample and one equipment wash (rinsate) blank sample per sample batch.
Laboratory Quality Assurance and Quality Control	All samples will be analysed by NATA-accredited laboratories. The contract laboratory will conduct in-house QA/QC procedures involving the routine analysis of: • method blanks; • spike recoveries; • laboratory duplicates; • calibration standards and blanks; • QC statistical data; and • Control standards and recovery plots.
Achievement of Data Quality Objectives	Data quality indicators to be achieved are listed in **Table 9-2**. An assessment of the overall data quality should be presented in the final validation report, in accordance with the EPA (2017) *Guidelines for the NSW Site Auditor Scheme*.

Table 9-2 DQIs for Validation Assessment

Data Quality Objective	Data Quality Indicator	Acceptable Range
Precision - A quantitative measure of the variability (or reproducibility) of data	Field: Analysis of field duplicates	<30% RPD. RPDs that exceed this range may be considered acceptable where: • Results are less than 10 times the limits of reporting (LOR); • Results are less than 20 times the LOR and the RPD is less than 50%; and • Heterogeneous materials or volatile compounds are encountered.
	Laboratory: Analysis of laboratory duplicates	Prescribed by the laboratories
Accuracy - A quantitative measure of the closeness of reported data to the "true" value	Field: Rinsate blanks Trip blanks (laboratory prepared) Calibration of instruments against known standards	< Laboratory LOR
	Laboratory: Analysis of laboratory control spike, matrix spike, reagent blanks / method blanks and surrogate spikes	Prescribed by the laboratories
Representativeness - The confidence (expressed qualitatively) that data are representative of each medium present onsite	Field: Trip blanks (laboratory prepared) Trip spikes (laboratory prepared) Appropriate media sampled according to SAQP Each media identified in SAQP sampled Appropriate sample collection methodologies, handling, storage and preservation techniques used Consistency between field observations and laboratory results.	< Laboratory LOR Spike recovery 70-130%
	Laboratory: Method blanks Conformance with specified holding times	Prescribed by the laboratories
Comparability - The confidence (expressed qualitatively) that data may be considered to be	Field: Same sampling methods Climatic conditions (temperature, rainfall, wind) Same type of samples collected (filtered, size, fractions)	-

Data Quality Objective	Data Quality Indicator	Acceptable Range
equivalent for each sampling and analytical event	Laboratory: Same sample analytical methods used (including clean-up) Same sample PQLs Same laboratories (NATA-accredited) Same units	-
Completeness - A measure of the amount of useable data from a data collection activity	Field: Each critical location sampled Samples collected at targeted locations and depth SAQP appropriate and complied with Experienced sampler Field documentation correct	Compliance with this RAP
	Laboratory: All critical samples analysed according to SAQP and proposal All analytes analysed according to SAQP in proposal Appropriate methods and PQLs Sample documentation complete Sample holding times complied with	Compliance with this RAP

9.2 VALIDATION REPORTING

All fieldwork, waste disposal (tipping) dockets, chemical analysis, discussions, conclusions and recommendations will be documented in a validation report for the site.

The validation report will be prepared in general accordance with requirements of the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme* and will confirm the site has been remediated to a suitable standard for the proposed development (residential with minimal access to soils).

The Site Validation Report will be submitted for Auditor / Council review at the completion of the remediation works program.

10 CONCLUSIONS

This RAP has been prepared to guide remediation works at 15-33 Brighton Avenue, Croydon Park NSW, based on currently available information on site characterisation and the proposed future (mixed residential / commercial) land use.

The preferred remedial strategy is off-site disposal of impacted soils to licensed waste facilities. Following approvals and site establishment, the main remediation works will include, but not necessarily be limited to:

- **Stage 1** – Additional Investigation for Data Gap Closure;
- **Stage 2** – Site Preparation;
- **Stage 3** – Ground Surface Inspection;
- **Stage 4** – UPSS Excavation and Disposal;
- **Stage 5** – Handling and Management of Fill Soil for Off-site Disposal;
- **Stage 6** – Site Validation and VENM Classification;
- **Stage 7** – Validation Report Preparation.

All wastes shall be transported to appropriate, EPA-licensed facilities, after formal classification. All excavated (remediation) areas shall be validated, to confirm that remaining site soils are suitable for the proposed land use. Site reinstatement with validated natural materials will be performed where required.

In summary, EI considers that the site can be made suitable for residential use with minimal access to soils, through the implementation of the works described in this RAP.

Should unexpected finds be discovered during the course of the remedial program, or should any phase of the validation identify high level, residual contamination requiring additional remediation, then the procedures described under the Unexpected Finds Protocol (**Section 8.6**) and/or the Validation Plan (**Section 9**) will be implemented. This will continue until the remediation goals have been achieved and the site is deemed suitable for the intended land use.

Following completion of the remediation and validation works a Site Validation Report will be prepared in accordance with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

11 STATEMENT OF LIMITATIONS

This report has been prepared for the exclusive use of Dyldam (the Client), whom is the only intended beneficiary of EI's work. The scope of this RAP is limited to that agreed with Mr Andrew Shehadeh of Dyldam.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on limited investigations of conditions, with specific sampling locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

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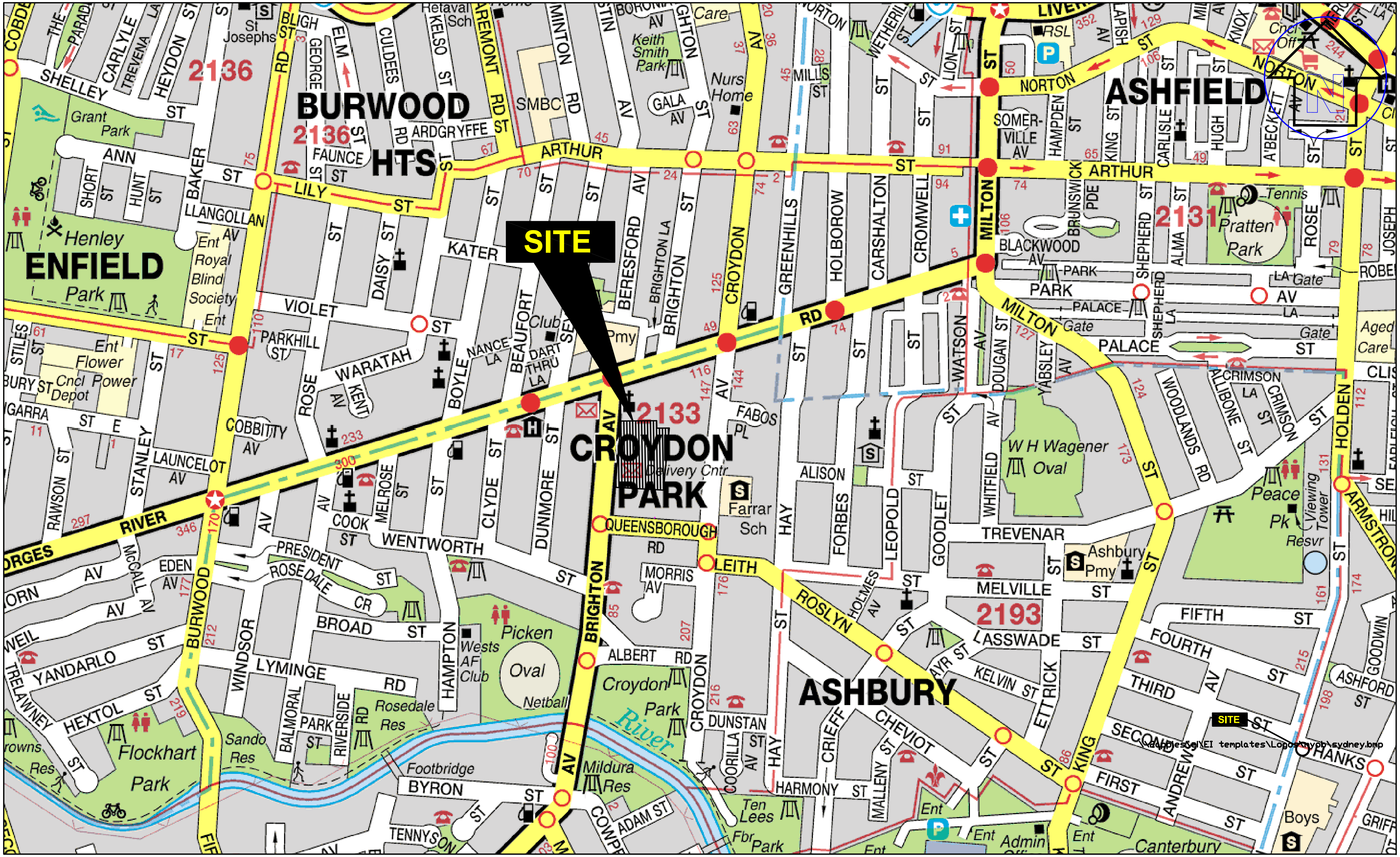
ABBREVIATIONS

ACM	Asbestos-containing Material
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AST	Above-ground Storage Tank
B(a)P	Benzo(a)Pyrene
BGL	Below Ground Level
BH	Borehole
BTEX	Benzene, Toluene, Ethyl benzene, Xylene
COPCs	Contaminants of Potential Concern
CSM	Conceptual Site Model
CT	Contaminant Thresholds
CVOCs	Chlorinated Volatile Organic Compounds
DP	Deposited Plan
DQO	Data Quality Objectives
DSI	Detailed Site Investigation
EIL	Ecological Investigation Level
EPA	Environment Protection Authority
EMP	Environmental Management Plan
ENM	Excavated Natural Material
ESL	Ecological Screening Level
GIL	Groundwater Investigation Level
GME	Groundwater Monitoring Event
HIL	Health-based Investigation Level
HSL	Health-based Screening Level
NSW	New South Wales
OEH	Office of Environment and Heritage, NSW (formerly DEC, DECC, DECCW)
PAHs	Polycyclic Aromatic Hydrocarbons
PID	Photo-ionisation Detector
ppm	Parts Per Million
PSH	Phase Separated Hydrocarbons
PSI	Preliminary Site Investigation
QA / QC	Quality Assurance / Quality Control
RAP	Remediation Action Plan
SIL	Soil Investigation Level
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
UPSS	Underground Petroleum Storage System
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VENM	Virgin Excavated Natural Material
VOC	Volatile Organic Compounds

FIGURES



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Approx Scale:	N.T.S

Croydon 88 Pty Ltd
Remediation Action Plan
15-33 Brighton Avenue, Croydon Park, NSW
Site Locality Plan

Figure: 1

Project: E22142.E06

LEGEND

- Approximate location of Diesel bowser
- Approximate location of Diesel UST
- Approximate site boundary
- Approximate borehole location (EI, 2018a)
- Approximate monitoring well location (EI, 2018a)
- Approximate borehole location (EI, 2018b)
- Approximate monitoring well location (EI, 2018b)
- Approximate asbestos hotspot location
- Approximate proposed borehole location

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Croydon 88 Pty Ltd
Remediation Action Plan
15-33 Brighton Avenue, Croydon Park NSW

Site Plan

Figure: 2

Project: E22142.E06_Rev0

APPENDIX A
SITE SURVEY AND PROPOSED DEVELOPMENT PLANS

ae design partnership
architecture urban design planning

Brighton Avenue Croydon Park

Urban Design Strategy & Preferred Design Option

For Dyldam Pty Ltd, April 2016

Prepared for:
Dyldam

Contents

AE Design Partnership has prepared this document for the sole use of Dyldam.

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AE Design Partnership may also have relied upon information provided by Dyldam and other third parties to prepare this document.

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BRIGHTON AVENUE

1.0 Introduction

1.1 Executive Summary

This Urban Design Report has been prepared by AE Design Partnership on behalf of Dyldam Pty Ltd. The subject site is located at 27-33 Brighton Avenue Croydon Park (the Site).

The Site is located within Canterbury Local Government Area. The Site is located in a predominantly residential area near corner two arterial roads Brighton Avenue and Georges River Road.

This Report includes a brief analysis of the Site and its context. AE Design Partnership's task is to demonstrate the best built form outcome for the Site taking into account the existing and the proposed controls and to determine any further changes to the controls that are warranted. AE Design Partnership has developed an urban design strategy for the Site in regards to its built form, open space, amenity, public domain, access and streetscape character.

The proposed design option is documented with a set of 2D and 3D envelopes for the subject Site. Additionally, lots located immediately north of the Site 15, 17, 19, 21 and 23-25 Brighton Avenue Croydon Park are included for the purpose of building envelope testing.

The Report also includes indicative floor plans to demonstrate functioning of the proposed building envelopes and the internal residential arrangement with regards to primary controls from the State Environmental Planning Policy 65 Apartment Design Guide.

Street view of the Site No. 27-33 Brighton Avenue and the adjacent site No. 15-25 Brighton Avenue (northern site).

1.2 Objectives

The objectives for this project are to:

- Analyse the Site, its immediate and local context to understand the built form, open space and public domain aspects of the area;
- Formulate urban design strategy for the Site;
- Provide development options derived using the previously formulated design strategy;
- Compare all development options in terms of height of buildings, floor space ratio, gross floor area, solar access performance and indicative number of apartments;
- Present the Urban Design Strategy and the Preferred Design Option to Council (5 storey building envelopes);
- Collate Council feedback; and
- Summarise all of the above including building envelopes and indicative floor plans, as the basis for a Planning Proposal to be submitted to Council.

Cooks River and surrounding parklands located 500m from the Site.

Brighton Avenue is a 30m wide street with a single travel + a parking lane in each direction. A bicycle lane is has been provided within the parking lane. The 30m width also accommodates a large median and wide footpaths on both sides of the street.

A mix of 1-2 storey detached houses and 3 storey residential flat buildings located across the Site on Brighton Avenue.

Footpaths on both sides of Brighton Avenue are approximately 7m wide, adjacent to a 3.3m wide parking lane and a 3.5m travel lane. The central median is within the variable residual street width.

View of Cooks River and Picken Oval from Cooks River Bridge, located 500m south of Site.

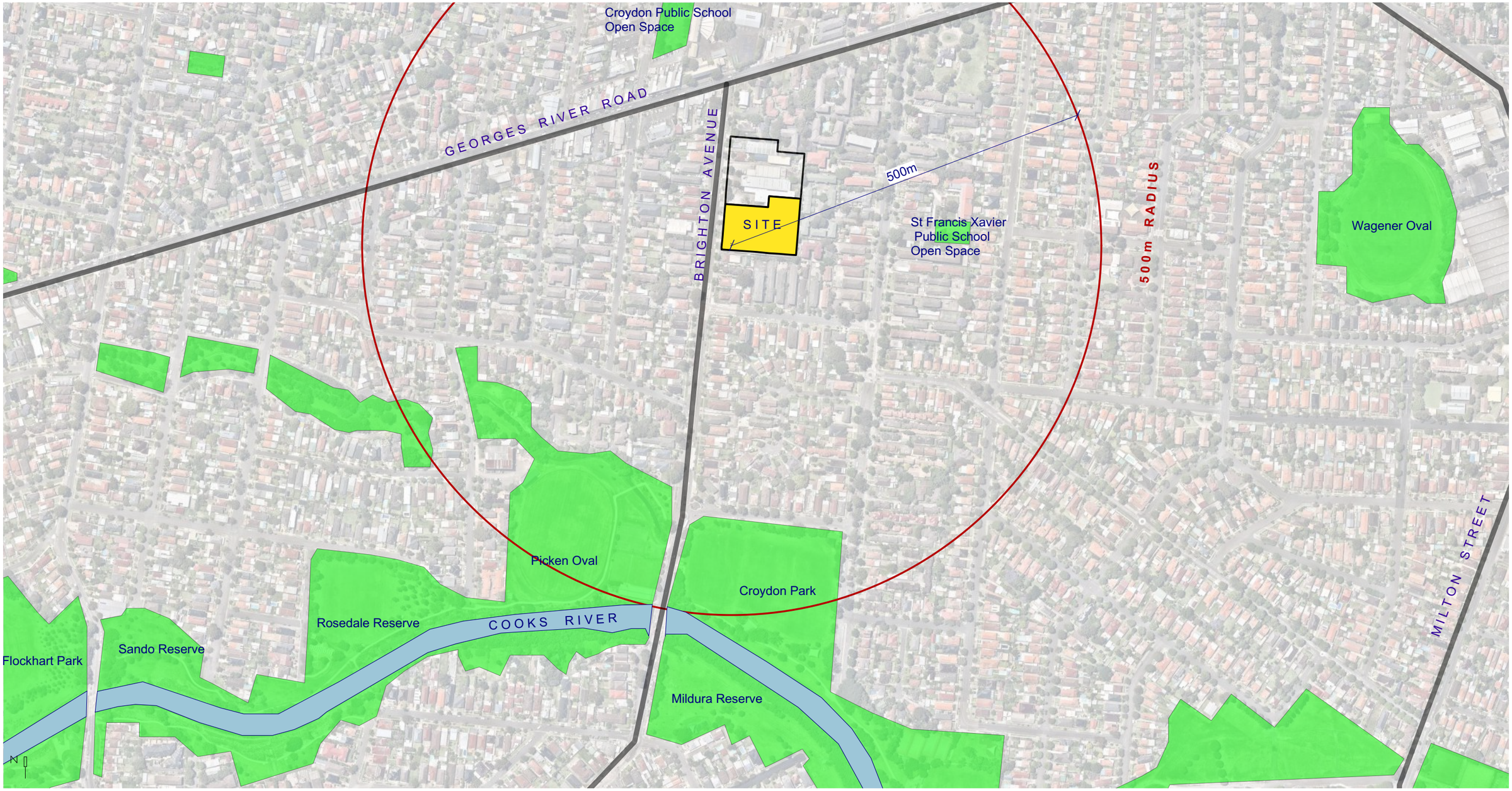
Croydon Public School and Croydon Park shops located at the corner of Brighton Avenue and Georges River Road, approximately 70m from the Site.

2.0 Analysis

2.1 Local Context

The Site is located near corner of two arterial roads Brighton Avenue and Georges River Road. Brighton Avenue connects the Site to Cooks River and the surrounding parklands (Croydon Park, Picken Oval and Mildura Reserve) located within a 500m walking radius from the Site.

Brighton Avenue is an arterial road which connects the Site with Campsie, Clemton Park, Bexley, and further with M5 South Western Motorway and Princes Highway towards south. Georges River Road is also an arterial road which connects Croydon Park with Burwood, Enfield, Strathfield, Lakemba, Punchbowl, and further with M5 South Western Motorway towards west. Georges River Road connects with City West Link via Ashfield Haberfield towards east.



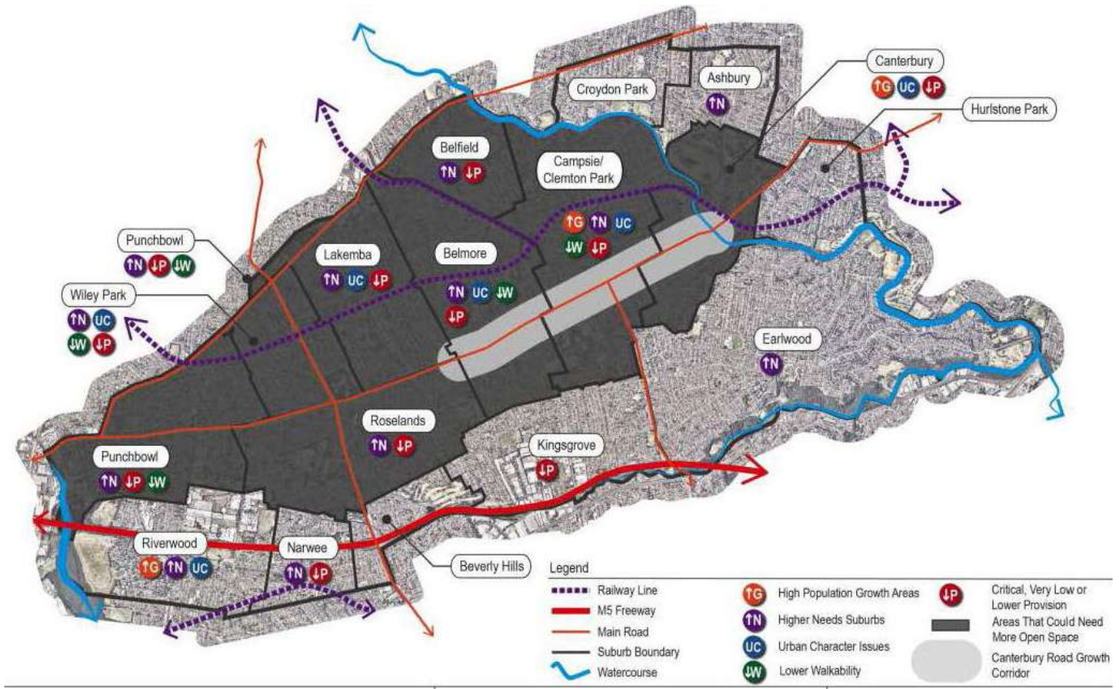
Suburb Provision Analysis
Considers Benchmarks and Industry Thinking
Does not consider potential additional open space being provided (e.g. linked to population growth or to address gaps)

Suburb	Provision (Hectares)	Suburb Land Area Hectares	% of Land Area		Hectares Per 1,000 People				OVERALL PROVISION FINDING
					2011 144,709	2021 161,508	2031 181,459		
ASHBURY	12.4	98	12.7%		3.75	3.74	3.33		GOOD PROVISION
BELFIELD	7.4	119	6.2%		1.50	1.44	1.28		LOWER PROVISION
BELMORE	11.9	282	4.2%		0.90	0.84	0.74		VERY LOW PROVISION
BEVERLY HILLS	19.8	84	23.6%		11.59	10.80	9.62		LOWER WITHOUT GOLF COURSE *
CAMPSIE-CLEMTON PARK	13.3	366	3.6%		0.56	0.45	0.40		CRITICALLY LOW
CANTERBURY	22.7	197	11.5%		3.51	2.12	1.89		LOWER AS POPULATION GROWS
CROYDON PARK	12.9	95	13.6%		2.86	2.78	2.47		RELATIVELY GOOD
EARLWOOD	103.3	562	18.4%		5.83	5.60	4.99		GOOD PROVISION
HURLSTONE PARK	11.4	106	10.8%		2.63	2.49	2.21		RELATIVELY GOOD
KINGSGROVE	12.6	226	5.6%		2.03	2.00	1.78		LOWER PROVISION
LAKEMBA	12.9	218	5.9%		0.79	0.76	0.68		VERY LOW PROVISION
NARWEE	6.7	86	7.8%		1.97	1.84	1.64		LOWER PROVISION
PUNCHBOWL	17.4	263	6.6%		1.49	1.38	1.23		LOWER PROVISION
RIVERWOOD	60.3	243	24.8%		11.33	8.57	7.63		GOOD PROVISION
ROSELANDS	5.2	274	1.9%		0.45	0.42	0.38		CRITICALLY LOW PROVISION
WILEY PARK	9.2	136	6.8%		0.92	0.90	0.80		VERY LOW PROVISION
CANTERBURY LGA	341.3	3355	10.2%		2.36	2.11	1.88		LOWER PROVISION IN FUTURE

*Note that without the golf course the provision in Beverly Hills is only 2.6 hectares (which represents 1.52 hectares per 1,000 in 2011 and 1.26 hectares per 1,000 people in 2031)

Provision Analysis	Ha/1,000	Land Area	Colour Code
Good Provision	More than 3ha/1000	More than 12.5%	
Relatively Good Provision	2-3 ha per 1,000	10-12%	
Lower Provision	1-2 ha per 1,000	5-9%	
Very Low Provision	0.5 – 1 ha per 1,000	2-4.9%	
Critically Low Provision	Less than 0.5 ha /1,000	Less than 2%	

An excerpt from City of Canterbury's Open Space Review (July 2015) endorsed by the Council



An excerpt from City of Canterbury's Open Space Review (July 2015) - Croydon Park excluded from the areas that could need more open space. The areas requiring more open space are shown in dark grey.

The parklands shown on Page 5 Local Context Analysis serve as recreational spaces for the local residents. Croydon Park currently has a 'Good Provision' of open space as per Canterbury Council's Open Space Needs Review endorsed by the Council (dated July 2015) with 13.6% of Land Area. This provision is at the rate of 2-3ha per 1,000 people and considered as 'Relatively Good Provision' with regards to the residential density. Therefore, a publicly accessible open space as recommended by the Department of Planning's Gateway Determination (September 2015) is not required to be provided on the Site.

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2.2 Site Context

- The Site is located in a predominantly residential area. The subject site and lots located to its north are isolated industrial lots surrounded by R4 High Density Residential zoning.
- There are 3 to 4 storey residential flat buildings located east and south of the Site.
- The area west of Site across Brighton Avenue predominantly includes 1-2 storey detached houses.
- Croydon Park retail strip, Croydon Park Public School and Uniting Church buildings are located at the corner of Brighton Avenue and Georges River Road, 70m north of Site.
- The Site has a 61.5m frontage to Brighton Avenue and 102m depth. The site area is approximately 6,770m^2

Key

- Site
- Residential Flat Buildings
- Detached Houses
- Commercial / Retail
- Public Buildings
- Industrial Buildings (to be demolished)
- X — Height of Buildings (number of storeys)

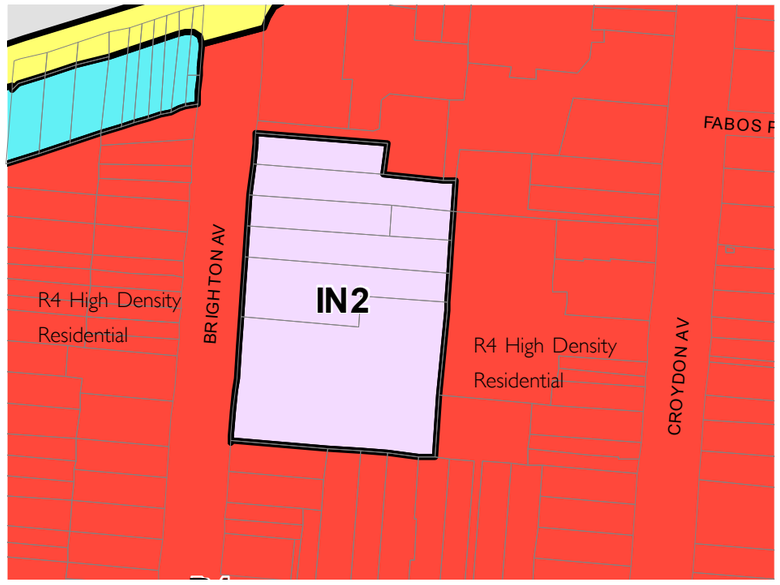
N 0 5 10 25 50m

1:1000@A3

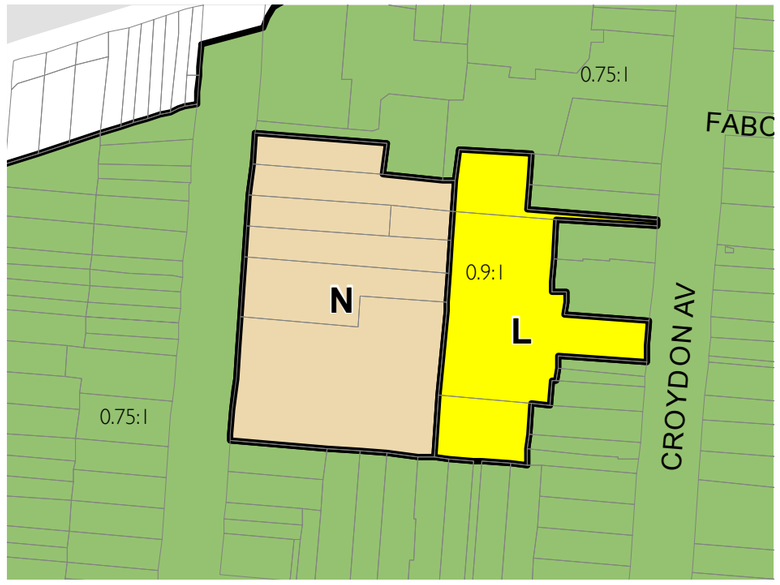
2.3 Planning Context

- The Site (including the northern site) is currently zoned in isolation as IN2 Light Industrial, whilst surrounded by R4 High Density Residential zone.
- A floor space ratio of 0.9:1 with a building height limit of 11.5 applies to the lots located along east and 0.75:1 with a building height limit of 8.5m applies to the remaining area.
- The site does not contain any heritage listed items and is not located within a Heritage Conservation Area.

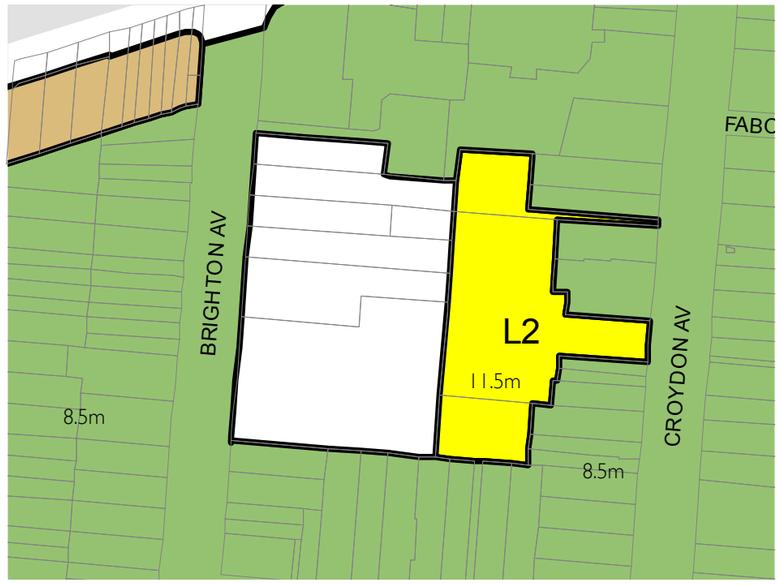
An exerpt from a previously lodged Planning Proposal for the Site to change the zone to R4 High Density, increase building height limit to 26m and increase FSR to 2.5:1, August 2013.



Zone



FSR



HoB

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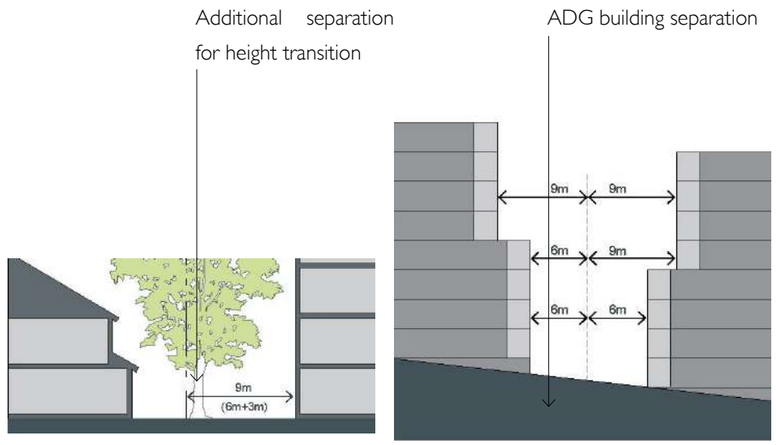
URBAN DESIGN STRATEGY

3.0 Urban Design Strategy

Building Envelopes

- The proposed building envelopes to have a maximum depth of 17m between glass line, consistent with the Apartment Design Guidelines.
- Maximum length of 45m is to apply to building envelopes addressing Brighton Avenue.
- Building envelopes should to be aligned to have a north-south orientation increasing direct solar access to the street and courtyard. A north-south building orientation will generate faster moving shadows and hence reduce the extent of overshadowing hours.
- A desirable building separation, as per SEPP 65 Apartment Design Guide - Building Separation is to be provided to allow adequate sunlight and natural ventilation between buildings.
- The in-between courtyard spaces are to be provided with an acceptable level of residential amenity including visual and acoustic privacy, daylight access and a desirable outlook for buildings with internal address.
- Building separation to be increased by an additional 3m along the eastern and southern boundaries to create building height transition. (The buildings adjacent to east and south of the Site are 2 to 3 storeys. These sites are currently zoned as R4 High Density Residential).



Building Separation

Street Connectivity

- A 3m street setback is to be provided from Brighton Avenue. This setback will be consistent with the existing residential flat buildings along Brighton Avenue.
- The pedestrian entry to the foyer should be clearly defined.
- Most apartments should address Brighton Avenue and improve casual street surveillance, whilst having a north-south orientation and allowing direct solar access in to the street and courtyard.
- Ground floor apartments to have direct street access.

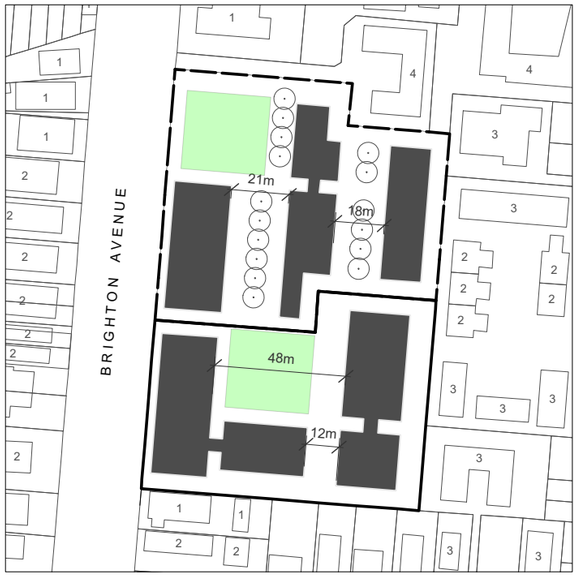
Building Height

A building height of 5 storeys is considered for the purpose of building envelope testing.

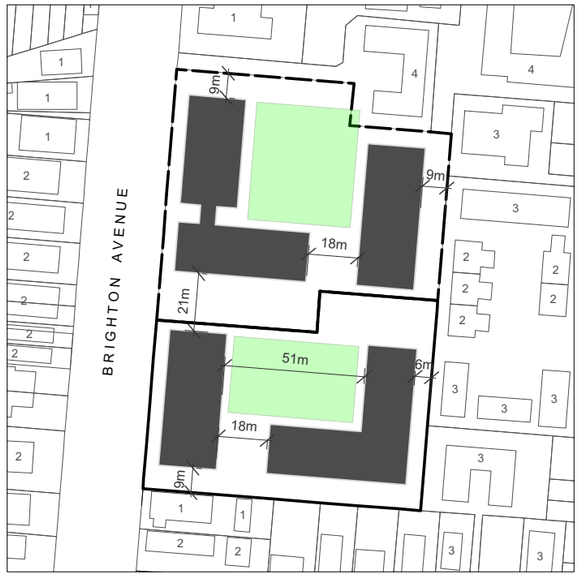
Street Connectivity

Site Layout Configurations

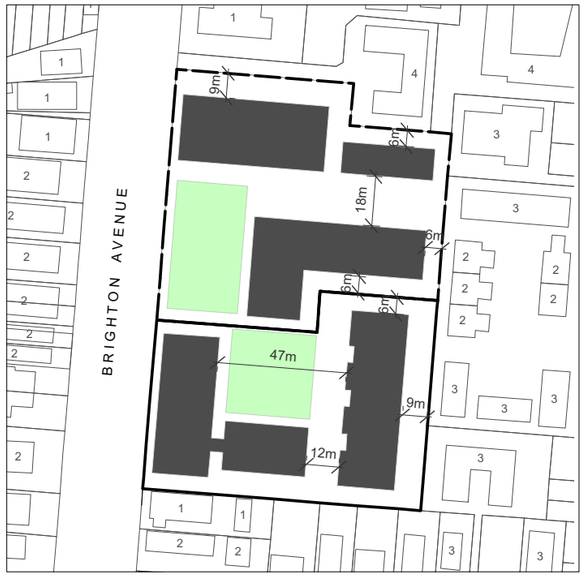
The following options were explored in terms of site layout.
The urban design strategies formed during previous stage are applied to these options.
Option 4 is further used for the purpose of building envelope testing since it has the best outcome in terms of building massing, building separation (internal and with the adjacent sites), solar access and open space location.



Option 1



Option 2



Option 3

Option 4 - Preferred

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PROPOSED BUILDING ENVELOPES

4.0 Proposed Building Envelopes

FSR	1.86 : 1
Height of Buildings	5 storeys

The 2D building envelope plan shows the proposed envelopes with the existing 3 storey residential flat buildings to east and south of the Site. Additionally, neighbouring lots located immediately north of the Site 15-25 Brighton Avenue Croydon Park are included in this scheme.

Our local context analysis (see 2.0 Analysis) shows the Cooks River and the adjacent parklands such as Croydon Park, Picken Oval and Mildura Reserve are located within a 500m walking radius from the Site. These parklands serve as recreational spaces for local residents. Croydon Park currently has a Good Provision of open space as per Canterbury Council's Open Space Needs Review (dated July 2015) endorsed by the Council. Therefore, a publicly accessible open space as recommended by the Department of Planning's Gateway Determination (September 2015) is not required to be provided on the Site.

Our building envelope testing suggests a height range of 5 storeys (shown in dark grey) reaches a floor space ratio of 1.86 : 1 for the subject Site and the northern site.

The 5 storey envelopes have an additional 3m upper setback to minimise visual impact when viewed from the neighbouring residential sites on east and west. The pink envelopes are 4 storey in height and are proposed with an additional 3m (6 + 3m) building separation to create a height transition to the existing 3 storey residential flat buildings to east and south.

A central courtyard (43 X 31m) is proposed to achieve an acceptable level of residential amenity including daylight, ventilation, visual and acoustic privacy. The courtyard will create a desirable outlook for the courtyard building which will have apartments with internal address.

The building envelope areas are reduced to 80% to calculate the residential GFA (gross floor area) for FSR calculations. 80% reduction allows for deducting building articulation, balconies, lift shafts, fire egress, stairwells, ducts and external walls (See 4.1 Area Calculations for details).

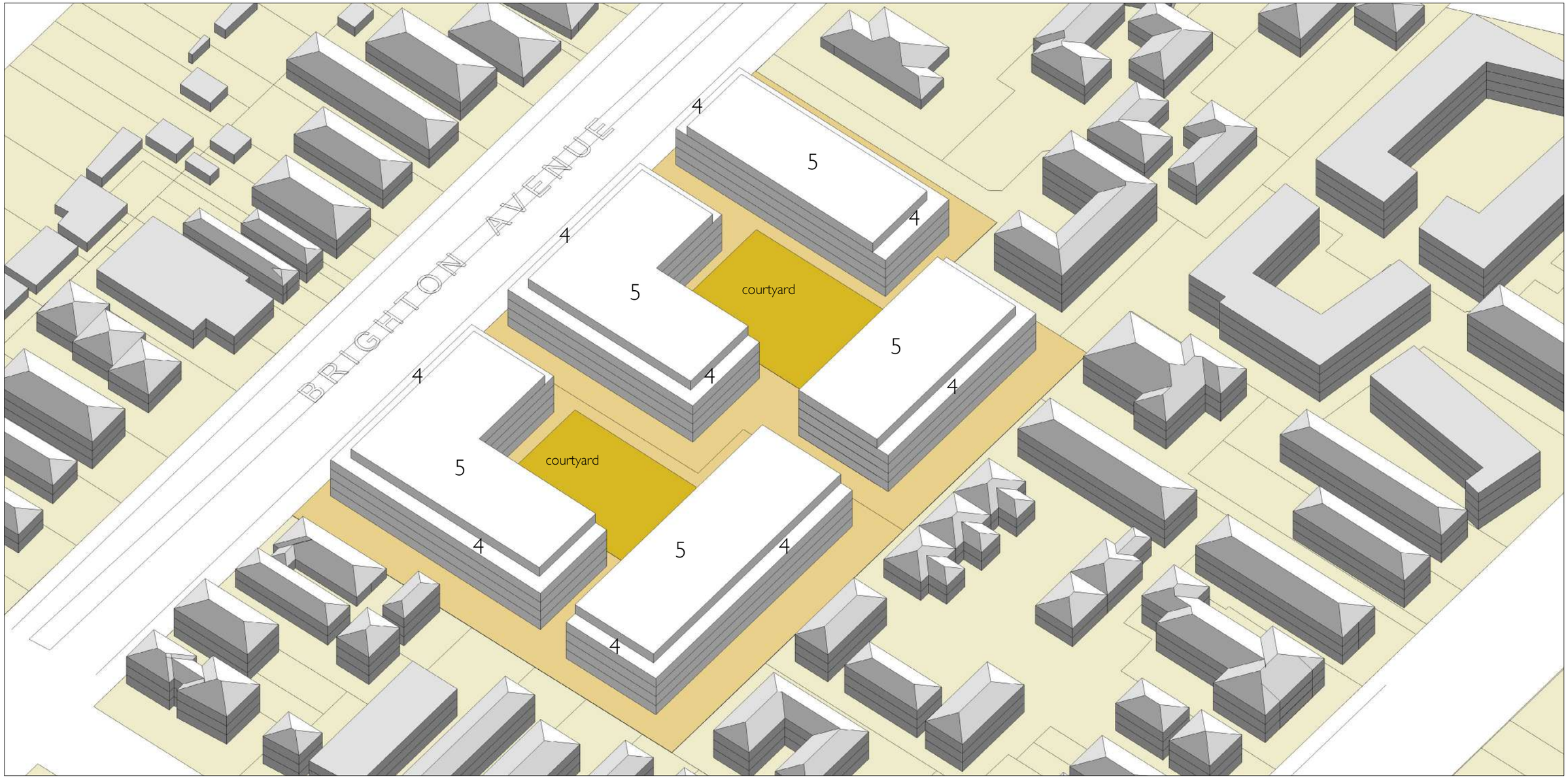
Key

- Site
- 5 Storey Envelope
- 4 Storey Envelope
- Existing Buildings
- Courtyard
- X Height of Buildings (number of storeys)

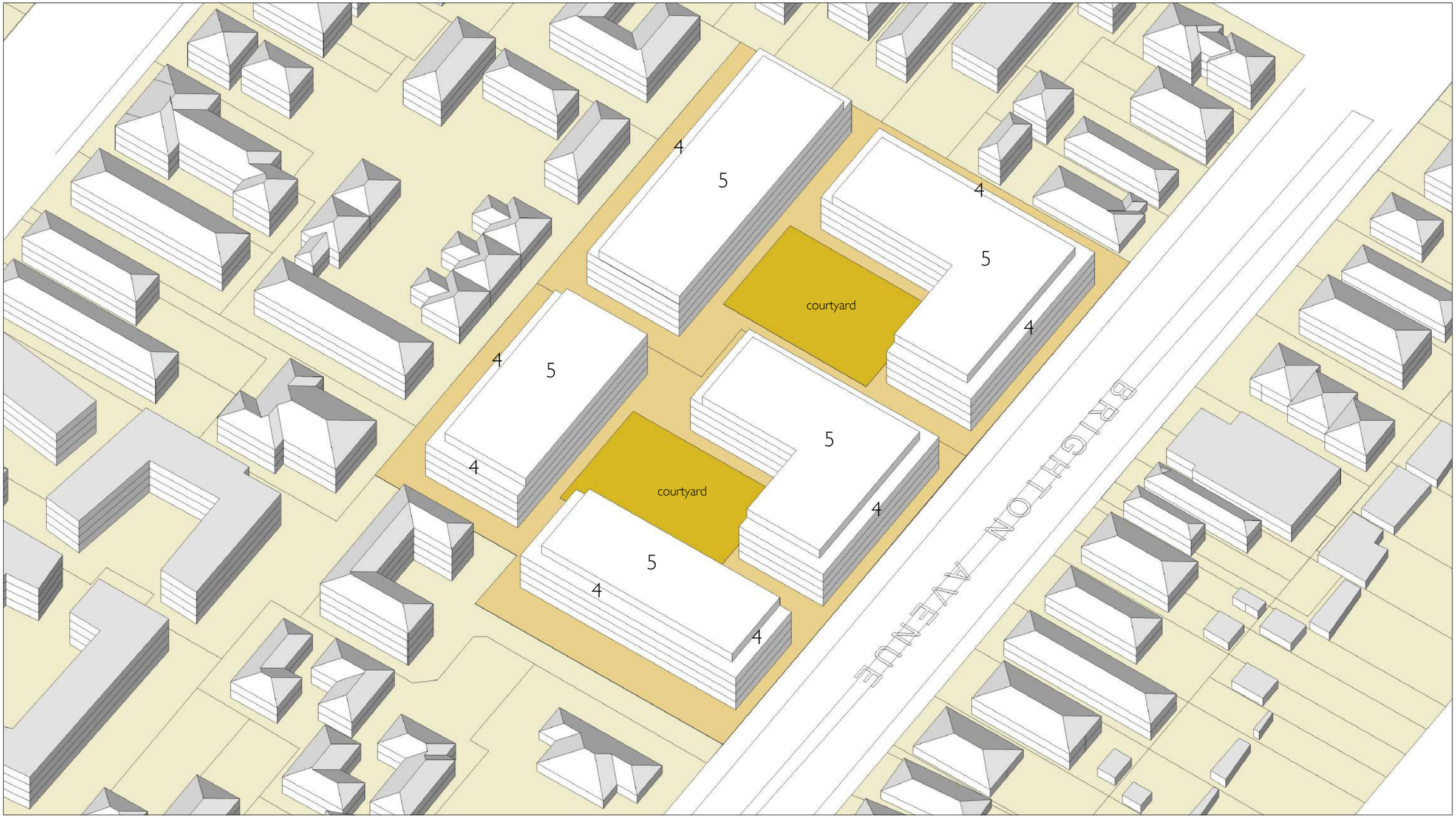
N 0 5 10 25 50m

1:1000@A3

2D Envelope Plan



Isometric View 1



Isometric View 2

4.1 Area Calculations

Subject Site

Site Area		6,770							
Total Gross Floor Area		12,628							
Floor Space Ratio		**1.87**							
total apartments		**178**	approx.						
BUILDING A									
Level	Retail Building Envelope Area (m2)	Residential Building Envelope Area (m2)	Retail Gross Floor Area (m2)	Residential Gross Floor Area (m2)	Total GFA	Residential NLA (m2)	Average No. of Dwellings		
1		1720	0	1376					
2		1720	0	1376					
3		1720	0	1376					
4		1720	0	1376					
5		1365	0	1092					
6				0					
7				0					
8				0					
				0					
Total			**0**	**6596**	**6596**	**5936**	**93**		
BUILDING B									
Level	Retail Building Envelope Area (m2)	Residential Building Envelope Area (m2)	Retail Gross Floor Area (m2)	Residential Gross Floor Area (m2)	Total GFA	Residential NLA (m2)	Average No. of Dwellings		
1		1560	0	1248					
2		1560	0	1248					
3		1560	0	1248					
4		1560	0	1248					
5		1300	0	1040					
6				0					
7				0					
8				0					
				0					
Total			**0**	**6032**	**6032**	**5429**	**85**		
								Apartment Type	**Area**
								1 bedroom = 30%	55m2
								2 bedroom = 70%	70m2
								Apartment Type	**Proposed No.**
								1 bedroom	53
								2 bedroom	125
								TOTAL	**178**

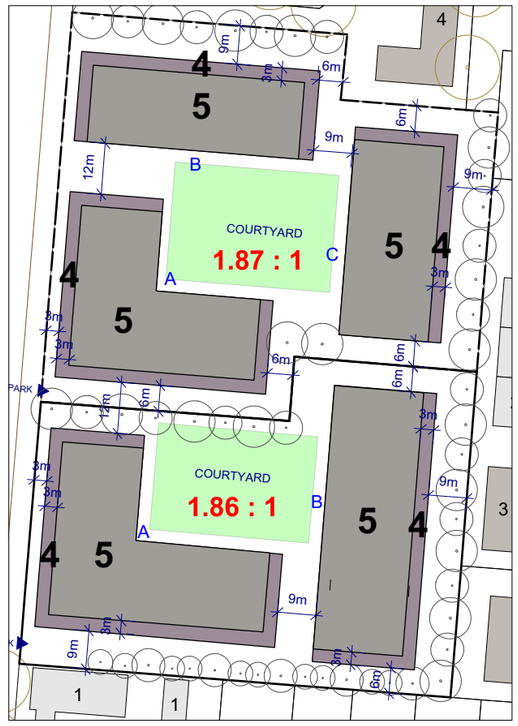
Building	**Retail GFA**	**Residential GFA**	**Total GFA**	**FSR**	**Resi. NLA**	**No. of Units**
A	**0**	**6596**	**6596**		**5936**	**93**
B	**0**	**6032**	**6032**		**5429**	**85**
C	**0**	**0**	**0**		**0**	**0**
TOTAL			**12,628**	**1.87**	**11,365**	**178**

Northern Site

Site Area		8,050					
Total Gross Floor Area		14,992					
Floor Space Ratio		**1.86**					
total apartments		208	approx.				
BUILDING A							
Level	Retail Building Envelope Area (m2)	Residential Building Envelope Area (m2)	Retail Gross Floor Area (m2)	Residential Gross Floor Area (m2)	Total GFA	Residential NLA (m2)	Average No. of Dwellings
1		1565	0	1252			
2		1565	0	1252			
3		1565	0	1252			
4		1565	0	1252			
5		1200	0	960			
6				0			
7				0			
8				0			
				0			
Total			**0**	**5968**	**5968**	**5371**	**83**
BUILDING B							
Level	Retail Building Envelope Area (m2)	Residential Building Envelope Area (m2)	Retail Gross Floor Area (m2)	Residential Gross Floor Area (m2)	Total GFA	Residential NLA (m2)	Average No. of Dwellings
1		1180	0	944			
2		1180	0	944			
3		1180	0	944			
4		1180	0	944			
5		895	0	716			
6				0			
7				0			
8				0			
				0			
Total			**0**	**4492**	**4492**	**4043**	**62**
BUILDING C							
Level	Retail Building Envelope Area (m2)	Residential Building Envelope Area (m2)	Retail Gross Floor Area (m2)	Residential Gross Floor Area (m2)	Total GFA	Residential NLA (m2)	Average No. of Dwellings
1		1175	0	940			
2		1175	0	940			
3		1175	0	940			
4		1175	0	940			
5		965	0	772			
6				0			
7				0			
8				0			
				0			
Total			**0**	**4532**	**4532**	**4079**	**63**

Building	**Retail GFA**	**Residential GFA**	**Total GFA**	**FSR**	**Resi. NLA**	**No. of Units**
A	**0**	**5968**	**5968**		**5371**	**83**
B	**0**	**4492**	**4492**		**4043**	**62**
C	**0**	**4532**	**4532**		**4079**	**63**
TOTAL			**14,992**	**1.86**	**13,493**	**208**

Northern Site



Subject Site

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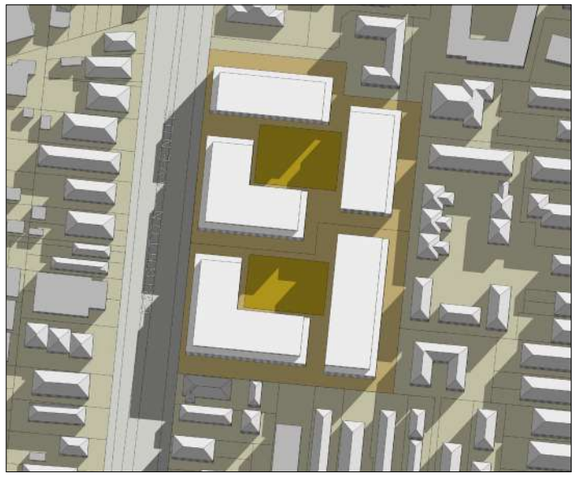
SOLAR STUDY

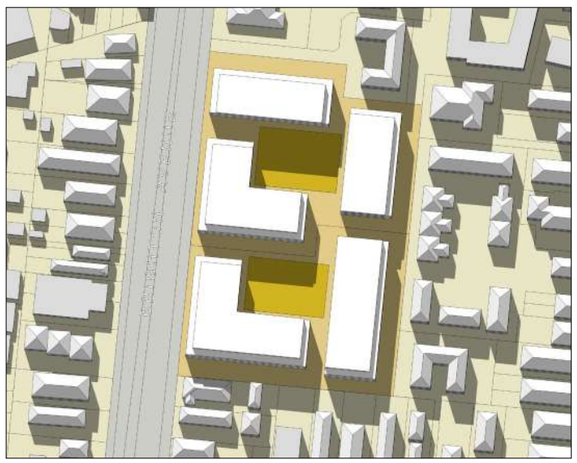
Shadow Diagrams - Midwinter

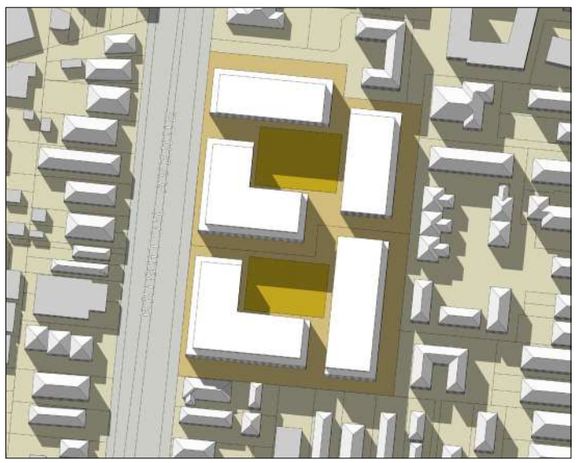

9am - 21st June

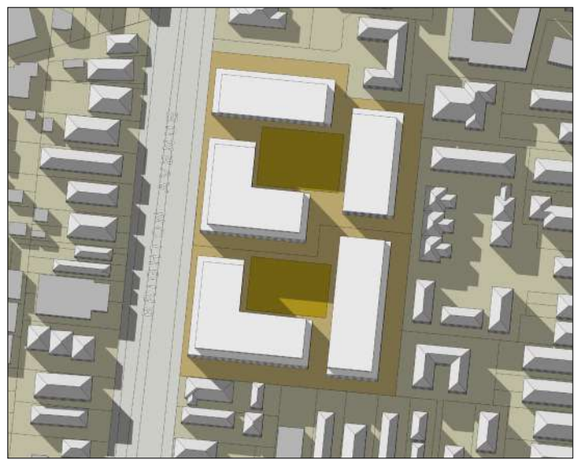

10am - 21st June


11am - 21st June

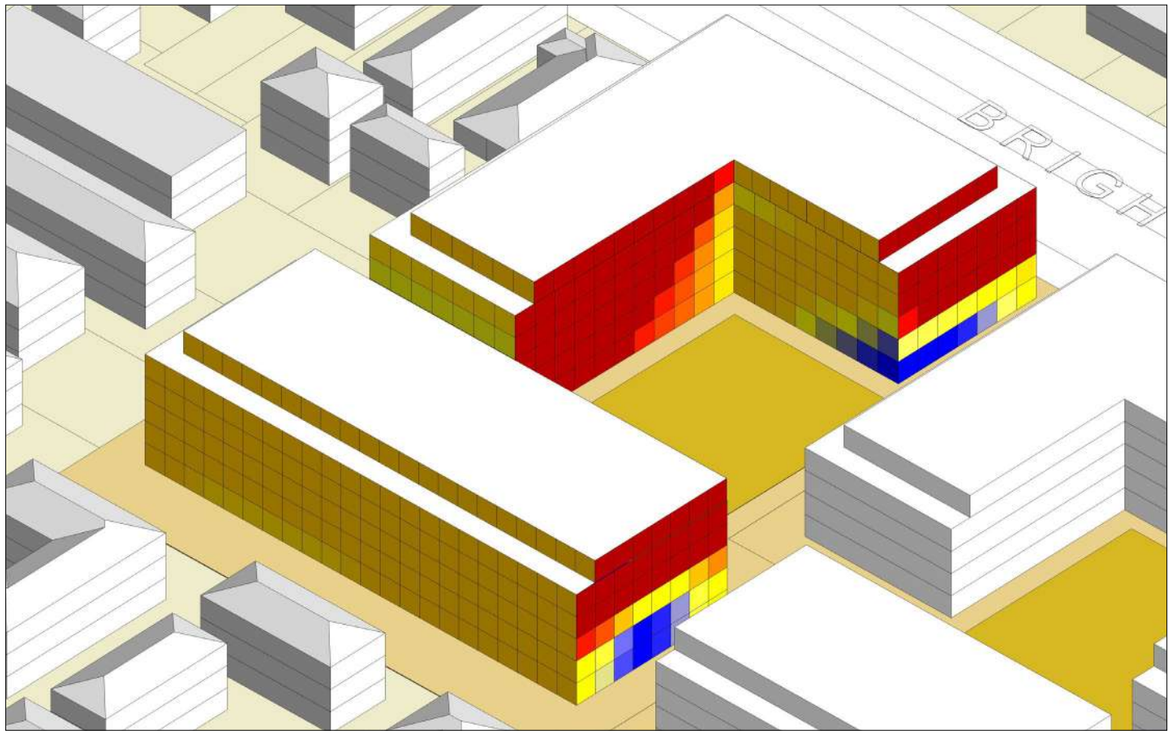

12pm - 21st June

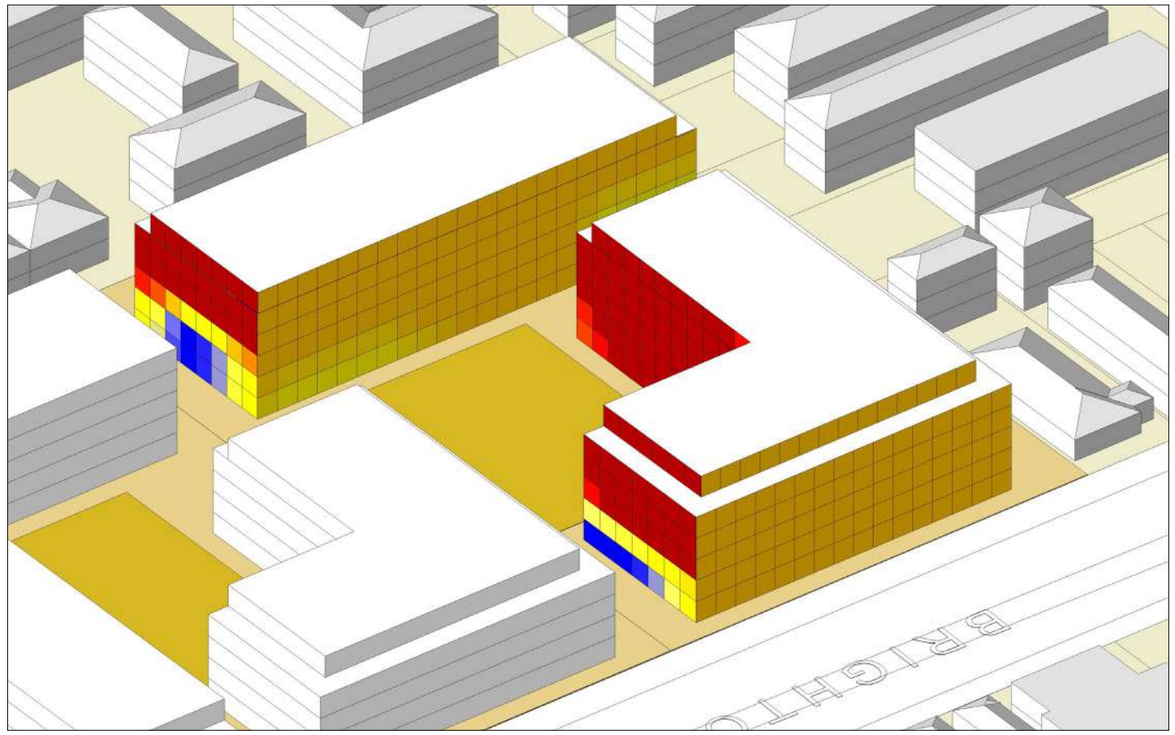

1pm - 21st June


2pm - 21st June

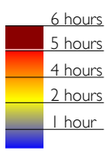

3pm - 21st June

Sun Hours Diagram - Midwinter





Solar access gradient
9am-3pm mid-winter



APPENDIX B
BOREHOLE LOGS (EI, 2018A/B)

BOREHOLE: BH1M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	-	▽	0					-	FILL: Silty CLAY; medium to high plasticity, dark brown, no odour.	-		BH1M: Gatic Cover
				0.40	BH1M_0.2-0.3 ES 0.20-0.30 m 0.20 m PID = 0.2 ppm	■		-	SANDSTONE; light orange-brown, weathered, no odour.			
			1		BH1M_0.8-0.9 ES 0.80-0.90 m 0.80 m PID = 0.2 ppm	■						Grout 50 mm uPVC Casing
			2									
			3							M	-	Bentonite
			4									
			5									Sand 50 mm uPVC Screen
			6	*6.10*						W		
									Hole Terminated at 6.10 m Target Depth Reached. Borehole Converted into Monitoring Well.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

EIA LIB 1.03.GLB Log IS AU BOREHOLE 3 E23775 SOIL LOGS.GPJ <<DrawingFile>> 10/04/2018 12:35 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: EIA 1.03 2014-07-05 Prj: EIA 1.03 2014-07-05

BOREHOLE: BH2

eiaustralia
Contamination | Remediation | Geotechnical

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	FILL: Clayey SAND; fine to coarse grained, dark brown, with angular to sub-angular gravels, no odour.	-		FILL
					BH2_0.2-0.3 ES 0.20-0.30 m 0.20 m PID = 0.2 ppm							
				0.30				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.	M	-	RESIDUAL SOIL
			0.5		BH2_0.4-0.5 ES 0.40-0.50 m 0.40 m PID = 0.3 ppm							
				0.60					Hole Terminated at 0.60 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.0									
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH3

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0							-		
			0.5		BH3_0.3-0.4 ES 0.30-0.40 m 0.30 m PID = 0.2 ppm					M	-	
			1.0		BH3_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.3 ppm							
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH4M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level BH4M
AD/T	-	GWNE	0	0.30	BH4M_0.2-0.3 ES 0.20-0.30 m 0.20 m PID = 0.3 ppm			-	FILL: Clayey SAND; fine to coarse grained, dark brown, with angular to sub-angular gravels, no odour.	-		Gatic Cover
			1		BH4M_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.4 ppm			CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			Grout 50 mm uPVC Casing
			2									Bentonite
			3							M	-	
			4									Sand 50 mm uPVC Screen
			5									
			6	6.00					Hole Terminated at 6.00 m Target Depth Reached. Borehole Converted into Monitoring Well.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH5

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	FILL: Clayey SAND; fine to coarse grained, dark brown, with angular to sub-angular gravels, no odour.	-		FILL
			0.5		BH5_0.3-0.4 ES 0.30-0.40 m 0.30 m PID = 0.3 ppm						-	
				0.60				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.	M		RESIDUAL SOIL
			1.0	1.00	BH5_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.6 ppm				Hole Terminated at 1.00 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH6

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20								
AD/T	-	GWNE			BH6_0.2-0.3 ES 0.20-0.30 m 0.20 m PID = 0.2 ppm			-	FILL: Clayey SAND; fine to coarse grained, dark brown, with angular to sub-angular gravels, no odour.		-	FILL
			0.5									
				0.60				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.	M		RESIDUAL SOIL
					BH6_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.2 ppm							
			1.0									
				1.10					Hole Terminated at 1.10 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH7M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	-	▽	0	0.20	BH7M_0.2-0.3 ES 0.20-0.30 m 0.20 m PID = 0.2 ppm			-	CONCRETE: 200mm thick.	-		BH7M
								-	FILL: Clayey SAND; fine to coarse grained, dark brown, with angular to sub-angular gravels, no odour.			Gatic Cover
			1	1.10	BH7M_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.2 ppm			CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			Grout
					BH7M_1.4-1.5 ES 1.40-1.50 m 1.40 m PID = 0.2 ppm							50 mm uPVC Casing
			2									
			3							M	-	Bentonite
			4	4.10				-	SHALE; weathered, no odour.			
			5									Sand
												50 mm uPVC Screen
			6	6.20						W		
									Hole Terminated at 6.20 m Target Depth Reached. Borehole Converted into Monitoring Well.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH8

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with angular to sub-angular gravels, no odour.			FILL
			0.5		BH8_0.3-0.4 ES QD1 QT1 0.30-0.40 m 0.30 m PID = 0.2 ppm							
				0.60				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			RESIDUAL SOIL
AD/T	-	GWNE	1.0		BH8_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.4 ppm					M	-	
				1.40					Hole Terminated at 1.40 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH9

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Gravelly SAND; fine to coarse grained, dark orange, angular to sub-angular gravel, no odour.			FILL
			0.5		BH9_0.3-0.4 ES 0.30-0.40 m 0.30 m PID = 0.6 ppm							
				0.60				-	FILL: Silty CLAY; medium to high plasticity, dark brown, with angular to sub-angular gravels and trace sandstone, no odour.			
			1.0		BH9_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.6 ppm					M	-	
				1.30				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			RESIDUAL SOIL
			1.5		BH9_1.5-1.6 ES 1.50-1.60 m 1.50 m PID = 0.5 ppm							
				1.70					Hole Terminated at 1.70 m Target Depth Reached. Backfilled with Drilling Spoil.			
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH10M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	-	▽	0	0.20				-	CONCRETE: 200mm thick.	-		BH10M: Gatic Cover
				0.50	BH10M_0.3-0.4 ES 0.30-0.40 m 0.30 m PID = 0.7 ppm			-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.			
			1		BH10M_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.7 ppm			CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.	M	-	Grout 50 mm uPVC Casing Bentonite
			2									
			3									
			4									Sand 50 mm uPVC Screen
			5									
			6	6.10						W		
									Hole Terminated at 6.10 m Target Depth Reached. Borehole Converted into Monitoring Well.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH11

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.	M	-	FILL
			0.5		BH11_0.3-0.4 ES 0.30-0.40 m 0.30 m PID = 0.6 ppm							
				0.60				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			RESIDUAL SOIL
			1.0		BH11_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 0.5 ppm							
			1.5	1.50					Hole Terminated at 1.50 m Target Depth Reached. Backfilled with Drilling Spoil.			
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH12

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	19/3/18
Position	Refer to Figure 2			Date Completed	19/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.			FILL
AD/T	-	GWNE	0.5		BH12_0.5-0.6 ES 0.50-0.60 m 0.50 m PID = 0.4 ppm					M	-	
				0.70				-	SANDSTONE; light orange-brown, weathered, no odour.			WEATHERED ROCK
			1.0		BH12_1.0-1.1 ES 1.00-1.10 m 1.00 m PID = 0.6 ppm							
				1.10					Hole Terminated at 1.10 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH13M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS
AD/T	-	▽	0	0.20				-	CONCRETE: 200mm thick.	-		ID: BH13M; Static Water Level: BH13M
					BH13M_0.3-0.4 ES 0.30-0.40 m			-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.			Gatic Cover
				0.60				-	SANDSTONE; light orange-brown, weathered, no odour.			
			1		BH13M_0.9-1.0 ES 0.90-1.00 m							Grout
				1.50				CL-CI	Silty CLAY; low to medium plasticity, orange mottled grey, no odour.			50 mm uPVC Casing
			2									50 mm uPVC Screen
										M		Bentonite
			3	3.20				-	SHALE; weathered, no odour.		-	
			4									
			5									
		▽		5.50	BH13M_5.5-5.6 ES 5.50-5.60 m 5.50 m PID = 64.1 ppm				From 5.5m, moderate hydrocarbon odour.	W		Sand
			6	6.40					Hole Terminated at 6.40 m Refusal. Borehole Converted into Monitoring Well.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH14

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			RESIDUAL SOIL
AD/T	-	GWNE			BH14_0.4-0.5 ES 0.40-0.50 m 0.40 m PID = 2.2 ppm						-	
			0.5									
				0.80				-	SANDSTONE; light orange-brown, weathered, no odour.	W		WEATHERED ROCK
			1.0		BH14_1.1-1.2 ES 1.10-1.20 m 1.10 m PID = 1.8 ppm							
				1.40					Hole Terminated at 1.40 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH15

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.			FILL
					BH15_0.3-0.4 ES 0.30-0.40 m 0.30 m PID = 1 ppm							
			0.5	0.50				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.	W	-	RESIDUAL SOIL
					BH15_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 1.3 ppm							
			1.0									
			1.5	1.50					Hole Terminated at 1.50 m Target Depth Reached. Backfilled with Drilling Spoil.			
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH16

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.			FILL
AD/T	-	GWNE	0.5		BH16_0.4-0.5 ES 0.40-0.50 m 0.40 m PID = 1.4 ppm					M	-	
					BH16_0.9-1.0 ES 0.90-1.00 m 0.90 m PID = 1.2 ppm							
			1.0	1.00				-	SANDSTONE; light orange-brown, weathered, no odour.			WEATHERED ROCK
					BH16_1.4-1.5 ES 1.40-1.50 m 1.40 m PID = 1.1 ppm							
			1.5	1.50					Hole Terminated at 1.50 m Target Depth Reached. Backfilled with Drilling Spoil.			
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH17

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, slight hydrocarbon odour.			FILL
AD/T	-	GWNE	0.5		BH17_0.5-0.6 ES 0.50-0.60 m 0.50 m PID = 8.5 ppm							
			1.0		BH17_1.0-1.1 ES 1.00-1.10 m 1.00 m PID = 6.2 ppm					M	-	
				1.30				-	SANDSTONE; light orange-brown, weathered, slight hydrocarbon odour.			WEATHERED ROCK
			1.5		BH17_1.5-1.6 ES 1.50-1.60 m 1.50 m PID = 3.3 ppm							
				1.90					Hole Terminated at 1.90 m Target Depth Reached. Backfilled with Drilling Spoil.			
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH18

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20								
AD/T	-	GWNE						-	SANDSTONE; light orange-brown, weathered, no odour.	M	-	WEATHERED ROCK
			0.5		BH18_0.5-0.6 ES 0.50-0.60 m 0.50 m PID = 1.8 ppm							
				0.70								
									Hole Terminated at 0.70 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.0									
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH19

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.		-	FILL
			0.5		BH19_0.5-0.6 ES 0.50-0.60 m 0.50 m PID = 2.2 ppm							
				0.80				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.	M		RESIDUAL SOIL
			1.0		BH19_1.0-1.1 ES 1.00-1.10 m 1.00 m PID = 1.2 ppm							
				1.40					Hole Terminated at 1.40 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH20

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0					-	CONCRETE: 200mm thick.	-		CONCRETE HARDSTAND
				0.20				-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.			FILL
AD/T	-	GWNE			BH20_0.4-0.5 ES 0.40-0.50 m 0.40 m PID = 1.2 ppm					M	-	
			0.5									
				0.80				CI-CH	Silty CLAY; medium to high plasticity, dark brown, mottled orange, no odour.			RESIDUAL SOIL
			1.0		BH20_1.0-1.1 ES 1.00-1.10 m 1.00 m PID = 1.9 ppm							
				1.30					Hole Terminated at 1.30 m Target Depth Reached. Backfilled with Drilling Spoil.			
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH21

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	25-33 Brighton Avenue, Croydon Park NSW			Date Started	20/3/18
Position	Refer to Figure 2			Date Completed	20/3/18
Job No.	E23775	Contractor	Geosense Drilling Pty Ltd	Logged MD	Date:
Client	R01 Croydon 88 Pty Ltd	Drill Rig	Hanjin D&B	Checked	Date:
		Inclination	-90°		

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0.0					-	FILL: Clayey SAND; fine to coarse grained, dark brown, with ash and angular to sub-angular gravels, no odour.	M	-	FILL
					BH21_0.4-0.5 ES 0.40-0.50 m 0.40 m PID = 2 ppm							
			0.5	*0.50*					Hole Terminated at 0.50 m Refusal. Backfilled with Drilling Spoil.			
			1.0									
			1.5									
			2.0									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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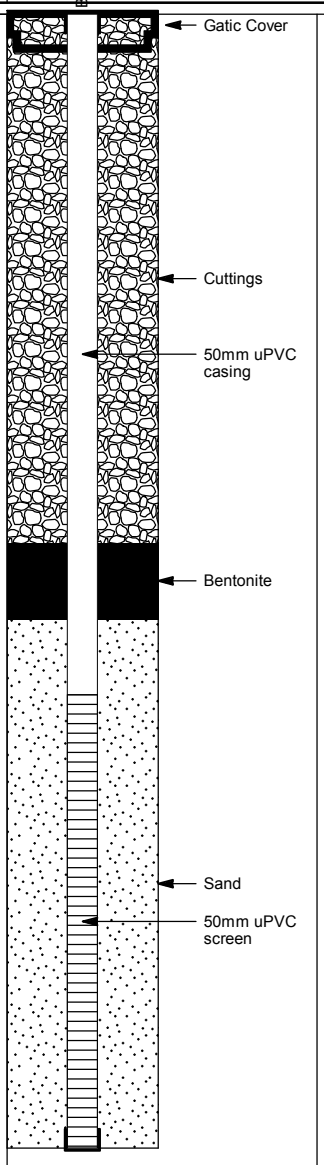
BOREHOLE: BH101M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	-	GWNE	0	0.15				-	Concrete Hardstand	-		BH101M
								-	FILL: Silty CLAY; low to medium plasticity, light brown to light grey with motted orange, no odour.	M		
				0.50	BH101M_0.4-0.5 PID = 1.1 ppm BH101M_0.6-0.7 PID = 1.3 ppm				SHALE; Highly weathered, light brown to orange, no odour.			
			1									
			2	2.00					Colour change to medium brown.	D	-	
			3									
			4									
			5									
			6									
			7									
			8	8.20					Hole Terminated at 8.20 mBGL; Target Depth Reached.			
			9									
			10									



This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH102

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Hand Auger	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	-	GWNE	0	0.15				-	Concrete Hardstand	-	-	CONCRETE HARDSTAND
				0.30	BH102_0.2-0.3			-	FILL: SAND; medium to coarse grained, brown, no odour.	M		FILL
					PID = 1.4 ppm				Hole Terminated at 0.30 mBGL; Resfusal on Concrete Slab.			
			1									
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH103

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Hand Auger	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	-	GWNE	0	0.15				-	Concrete Hardstand	-	-	CONCRETE HARDSTAND
				0.30	BH103_0.2-0.3			-	FILL: SAND; medium to coarse grained, brown, no odour.	M		FILL
					PID = 0.9 ppm				Hole Terminated at 0.30 mBGL; Resfusal on Road-base Gravel.			
			1									
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH104

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	0.13				-	Concrete Hardstand	-		CONCRETE HARDSTAND
AD/T	-	GWNE			BH104_0.2-0.3 PID = 1.4 ppm			-	FILL: Gravelly SAND; medium to coarse grained, reddish brown, with angular to subangular, medium to coarse gravels, no odour.	M		FILL
				0.50				CL	CLAY; low to medium plasticity, brown with light grey to orange, with with subangular to subrounded, medium to coarse gravels and charcoal, no odour.			RESIDUAL SOIL
			1		BH104_0.7-0.8 PID = 1.2 ppm					M	-	
				1.50					Hole Terminated at 1.50 mBGL; Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH105

Project	Detailed Site Investigation		
Location	15-21 Brighton Avenue, Croydon Park NSW		
Position	Refer to Figure 2		
Job No.	E23959.E02	Contractor	Hart Geo
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig
		Inclination	-90°

Sheet 1 OF 1
Date Started 22/8/18
Date Completed 22/8/18
Logged CM/CZ
Checked NF

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0	0.10				-	Concrete Hardstand	-		CONCRETE HARDSTAND
					BH105_0.3-0.4			-	FILL: Sandy CLAY; low to medium plasticity, dark brown, medium to coarse sand, with angular to subangular, medium to coarse gravels with charcoal, with glass fragment, no odour.	M		FILL
				0.50	PID = 1.2 ppm			-		M		
				0.70	BH105_0.3-0.4			CL	FILL: CLAY; low to medium plasticity, brown with light grey to orange, with with subangular to subround, medium to coarse gravels, no odour.	M	-	RESIDUAL SOIL
			1	1.10	PID = 1.5 ppm				CLAY; low to medium plasticity, light grey to orange brown, with small subangular to subrounded gravels, no odour.	D		BEDROCK
				1.50	BH105_1.3-1.4				SHALE; Highly weathered, light brown to orange, no odour.			
					PID = 2.3 ppm				Hole Terminated at 1.50 mBGL; Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH106

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0	0.30				-	Concrete Hardstand	-		CONCRETE HARDSTAND
				0.40	BH106_0.3-0.4 PID = 2.3 ppm			-	FILL: SAND; medium to coarse grained, dark brown to grey, with dark grey staining, no odour .	M	-	FILL
				0.70	BH106_0.4-0.5 PID = 2.4 ppm			-		M		
				1.00	BH106_0.4-0.5 PID = 1.5 ppm			CI	Sandy CLAY: low to medium plasticity, dark brown, medium to coarse sand, with angular to subangular, medium to coarse gravels, no odour.	M		RESIDUAL SOIL
			1						CLAY: medium to high plasticity, brown with light grey to orange, no odour.			
									Hole Terminated at 1.00 mBGL; Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH107

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0	0.10				-	Concrete Hardstand	-		CONCRETE HARDSTAND
				0.30	BH107_0.2-0.3			-	FILL: Gravelly SAND; medium to coarse grained, light grey to dark brown, sub-angular to angular, medium to coarse gravels, no odour.	M		FILL
					PID = 1.2 ppm			CL				RESIDUAL SOIL
					BH107_0.7-0.8				CLAY: low to medium plasticity, dark brown with mottled reddish orange, with with subangular to subround, no odour.	M	-	
				1.00	PID = 1.2 ppm							
			1						Hole Terminated at 1.00 mBGL; Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH108M

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level BH108M
AD/T	-	GWNE	0					-	Concrete Hardstand			BH108M
								-	FILL: Sandy CLAY; low to medium plasticity, dark brown, medium to coarse grained sand, with angular to subangular, medium to coarse gravels, no odour.	M		
				0.50	BH108M_0.3-0.4 PID = 1.6 ppm			CI	CLAY: low to medium plasticity, greenish brown, no odour.			
			1		BH108M_.0.9-0.8 PID = 1.9 ppm					M		
				1.40					SHALE; weathered, light brown, no odour.			
			2		BH108M_.1.7-1.8 PID = 1.1 ppm							
			3								-	
			4							D		
			5									
			6	6.30								
									Hole Terminated at 6.30 mBGL; Resfusal on Shale.			
			7									
			8									
			9									
			10									

Gatic Cover
Cuttings
50mm uPVC casing
Bentonite
Sand
50mm uPVC screen

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH109

Project	Detailed Site Investigation		
Location	15-21 Brighton Avenue, Croydon Park NSW		
Position	Refer to Figure 2		
Job No.	E23959.E02	Contractor	Hart Geo
Client	CROYDON 88 UNIT TRUST	Drill Rig	Hand Auger
		Inclination	-90°

Sheet	1 OF 1
Date Started	22/8/18
Date Completed	22/8/18
Logged	CM/CZ
Checked	NF

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	-	GWNE	0	0.10					Concrete Hardstand	-		CONCRETE HARDSTAND
				0.30	BH109_0.1-0.2 PID = 1.1 ppm			-	FILL: SAND; medium to coarse grained, yellow, no odour.	M	-	FILL
									Hole Terminated at 0.30 mBGL; Resfusal on 0.3m Road Base Gravels.			
			1									
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

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BOREHOLE: BH110

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Hand Auger	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	-	DWNE	0	0.10				-	Concrete Hardstand	-		CONCRETE HARDSTAND
				0.30	BH110_0.1-0.2 PID =0.8 ppm			-	FILL: SAND; medium to coarse grained, yellow, no odour.	M	-	FILL
									Hole Terminated at 0.30 mBGL; Resfusal on 0.3m Road Base Gravels.			
			1									
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH111

Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0					-	Topsoil: Silty SAND; fine to medium grained, brown, with rootlets, no odour.	-		TOPSOIL
								-	Concrete Hardstand	M		CONCRETE HARDSTAND
				0.50				-				FILL
					BH111_0.4-0.5 PID = 0.6 ppm			CL	FILL: Clayey SAND; medium to coarse grained, reddish brown, low to medium plasticity, with subangular to angular gravel, no odour.	D	-	RESIDUAL SOIL
				1.00	BH111_0.8-0.9 PID = 0.8 ppm				CLAY: low to medium plasicity, light brown to orange, no odour.			
			1						Hole Terminated at 1.00 mBGL; Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH112M

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Ute-Mounted Rig	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	-	▽	0	0.13				-	Concrete Hardstand	-		BH112M
					BH112M_0.3-0.4 PID = 0.9 ppm			-	FILL: Sandy CLAY; low to medium plasticity, dark brown, medium to coarse sand, with angular to subangular, medium to coarse gravels, no odour.	M		Gatic Cover
			1		BH112M_0.8-0.9 PID = 0.8 ppm							
				1.40					SHALE; Highly weathered, light brown to orange, no odour.			Cuttings
			2		BH112M_1.7-1.8 PID = 0.7 ppm							50mm uPVC casing
			3								-	
			4							D		Bentonite
			5									
			6									Sand
												50mm uPVC screen
		▽	7	7.50						W		
			8						Hole Terminated at 7.50 mBGL; Target Depth Reached.			
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH113

Project	Detailed Site Investigation		
Location	15-21 Brighton Avenue, Croydon Park NSW		
Position	Refer to Figure 2		
Job No.	E23959.E02	Contractor	Hart Geo
Client	CROYDON 88 UNIT TRUST	Drill Rig	Hand Auger
		Inclination	-90°

Sheet	1 OF 1
Date Started	22/8/18
Date Completed	22/8/18
Logged	CM/CZ
Checked	NF

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	-	GWNE	0	0.10				-	Concrete Hardstand	-		CONCRETE HARDSTAND
				0.35	BH113_0.2-0.3 PID = 1.0 ppm			-	FILL: Clayey SAND; medium to coarse grained, reddish brown, no odour.	M	-	FILL
									Hole Terminated at 0.35 mBGL; Resfusal on Road-base Gravel.			
			1									
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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BOREHOLE: BH114

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Project	Detailed Site Investigation			Sheet	1 OF 1
Location	15-21 Brighton Avenue, Croydon Park NSW			Date Started	22/8/18
Position	Refer to Figure 2			Date Completed	22/8/18
Job No.	E23959.E02	Contractor	Hart Geo	Logged	CM/CZ
Client	CROYDON 88 UNIT TRUST	Drill Rig	Hand Auger	Checked	NF
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	-	GWNE	0	0.10				-	Concrete Hardstand	-		CONCRETE HARDSTAND
				0.20	BH114_0.2-0.3			-	FILL: SAND: medium to coarse grained, yellow, no odour.	M		FILL
				0.40	PID = 1.4 ppm			-	FILL: SAND; medium to coarse grained, reddish brown, no odour.	M	-	
				0.60				CL		M		RESIDUAL SOIL
					BH114_0.7-0.8				CLAY: low to medium plasticity, light grey to brown with orange, no odour.			
					PID = 1.2 ppm				Hole Terminated at 0.60 mBGL; Resfusal on Clay.			
			1									
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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APPENDIX C
ANALYTICAL RESULTS (EI, 2018A/B)

Table B.1 - Summary of Soil Analytical results

E23775_Dyldam_Croydon Park

Sample ID	Material	Date	Heavy Metals								PAHs				BTEX				TRH						Pesticides		PCBs	Asbestos
			As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Carcinogenic PAHs (as B(a)P TEQ)	Benzo(a)pyrene	Total PAHs	Naphthalene	Benzene	Toluene	Ethylbenzene	Total Xylenes	F1	F2	F3	F4	C^{6}-C^{9}	C^{10}-C^{36}	OCPs (total)	OPPs	Total	Presence / absence
BH1M_0.2-0.3	Fill		10	<0.3	14	13	17	<0.05	1.5	15	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH1M_0.8-0.9	Natural		4	<0.3	5.6	22	10	<0.05	1.3	13	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	NA	NA	<1	NA
BH2_0.2-0.3	Fill		9	<0.3	17	56	140	0.07	18	2200	3.2	2.3	23	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	120	<120	<20	120	<1	<1.7	<1	No
BH3_0.3-0.4	Fill		4	<0.3	62	25	21	<0.05	57	340	0.9	0.6	6.9	0.1	<0.1	<0.1	0.2	1.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	Yes
BH4M_0.2-0.3	Fill		8	0.3	11	18	260	<0.05	5.9	140	0.3	0.2	2.2	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH5_0.3-0.4	Fill		9	<0.3	22	23	67	0.05	16	87	1	0.6	5.6	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	94	<120	<20	<110	<1	<1.7	<1	No
BH6_0.2-0.3	Fill		10	<0.3	13	28	87	<0.05	5.1	69	0.3	0.2	1.3	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH7M_0.2-0.3	Fill	19/03/2018	7	<0.3	10	13	34	<0.05	3.1	31	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH7M_1.4-1.5	Natural		8	<0.3	4.4	17	11	<0.05	0.7	15	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	NA	NA	NA	NA
BH8_0.3-0.4	Fill		8	<0.3	9.1	21	430	<0.05	2.7	280	0.4	0.2	2.2	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH9_0.3-0.4	Fill		7	<0.3	18	17	25	<0.05	16	120	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH10M_0.3-0.4	Fill		25	2.2	6.4	280	480	0.11	8.4	850	0.5	0.3	3.4	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	760	<120	<20	830	<1	<1.7	<1	Yes
BH10M_0.9-1.0	Natural		8	<0.3	6.3	26	11	<0.05	<0.5	5	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	NA	NA	NA	NA
BH11_0.3-0.4	Fill		5	<0.3	12	79	6	<0.05	73	62	<0.3	0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH12_0.5-0.6	Fill		13	<0.3	4.9	20	16	<0.05	0.7	9.1	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH13M_0.3-0.4	Fill		4	<0.3	11	18	24	<0.05	14	80	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH13M_0.9-1.0	Fill		8	<0.3	4.3	24	23	<0.05	<0.5	12	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	NA	NA	NA	NA
BH13M_5.5-5.6	Natural		6	<0.3	10	53	24	<0.05	26	120	<0.3	<0.1	3.8	0.5	<0.1	0.2	0.1	1.2	36	59	<90	<120	24	110	NA	NA	NA	NA
BH14_0.4-0.5	Natural		6	<0.3	17	25	18	<0.05	7.1	23	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH15_0.3-0.4	Fill		8	<0.3	27	29	43	<0.05	23	130	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH16_0.4-0.5	Fill		5	<0.3	15	54	32	<0.05	14	64	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH17_0.5-0.6	Fill	20/03/2018	6	<0.3	23	22	27	<0.05	20	51	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH17_1.0-1.1	Fill		5	<0.3	22	21	10	<0.05	19	33	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	NA	NA	NA	NA
BH17_1.-1.6	Natural		5	<0.3	5.8	25	7	<0.05	0.6	8.1	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	NA	NA	NA	NA
BH18_0.5-0.6	Natural		5	<0.3	5.8	23	12	<0.05	1.3	22	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH19_0.5-0.6	Fill		<3	<0.3	6.9	2.8	13	<0.05	<0.5	13	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH20_0.4-0.5	Fill		3	<0.3	6.5	1.9	16	<0.05	1.9	31	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
BH21_0.4-0.5	Fill		4	<0.3	7.5	4.5	18	<0.05	1.4	19	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<20	<110	<1	<1.7	<1	No
Statistical Analysis																												
Maximum Concentration			25	2.2	62	280	480	0.11	73	2200	3.2	2.3	23	0.5	<0.1	<0.1	<0.1	<0.3	<25	<25	760	<120	<20	830	0	<1.7	<1	No
SILs																												
HIL B - *Residential with minimal opportunities for garden soil access.*			500	150	500 Cr(VI)	30000	1200	120	1200	60000	4		400												600		1	
HSL D - *Commercial / Industrial* Soil texture classification –Sand [1]			Source depths (0 m to <1 m. BGL)											NL	3	NL	NL	230	260	NL								
			Source depths (1 m to <2 m. BGL)											NL	3	NL	NL	NL	370	NL								
			Source depths (2m to <4 m. BGL)											NL	3	NL	NL	NL	630	NL								
			Source depths (4 m+)											NL	3	NL	NL	NL	NL	NL								
Management Limits – *Residential, parkland and public open space* Coarse grained soil texture[1]																			700	1000	3500	10000						
Asbestos contamination HSL – A&B *Residential* Bonded ACM (%w/w)																												0.01
Asbestos contamination HSL for Non Bonded / Friable Asbestos (%w/w)																												0.001

Notes: All results are recorded in mg/kg (unless otherwise stated)

Highlighted values indicates concentration exceeds Human Health Based Soil Criteria□

Highlighted indicates soil criteria exceeded

HIL B	NEPC 1999 Amendment 2013 'HIL B' Health Based Investigation Levels applicable for residential exposure settings with minimal opportunities for garden soil access.
HSL C	NEPC 1999 Amendment 2013 'HSL C' Health Based Screening Levels based on vapour intrusion values applicable for recreational open space settings.
HSL D	NEPC 1999 Amendment 2013 'HSL D' Health Based Screening Levels based on vapour intrusion values applicable for commercial / industrial settings.
*	Site specific EIL criteria / Conservative ESL criteria (See **Section 7.3**)
NA	'Not Analysed' i.e. the sample was not analysed.
NC	Not Calculated'
ND	'Not detected' i.e. all concentrations of the compounds within the analyte group were found to be below the laboratory limits of detection.
NL	'Not Limiting' - The soil vapour limit exceeds the soil concentration at which the pore water phase cannot dissolve any more of the individual chemical.
NR	No current published criterion.
1	Coarse Grained soil values were applied, being the most conservative of the material types.
2	Combined total of which all Chlordane speciations are assessed against.
3	NSW EPA (2014) CT1 General Solid Waste Thresholds (without leachate test), in Waste Classification Guidelines, Table 1.
4	NSW EPA (2014) CT2 Restricted Solid Waste Thresholds (without leachate test), in Waste Classification Guidelines, Table 1.
5	NSW EPA 2014 TCLP1/SCC1 Maximum values for Leachable concentration and specific contaminant concentration for General Solid Waste Thresholds, Waste Classification Guidelines Table 2.
6	NSW EPA (2014) TCLP2/SCC2 Maximum values for Leachable concentration and specific contaminant concentration for Restricted Solid Waste Thresholds, Waste Classification Guidelines Table 2.
F1	To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction.
F2	To obtain F2 subtract Naphthalene from the >C10-C16 fraction.
F3	(>C16-C34)
F4	(>C34-C40)

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Table B.2 – Summary of Groundwater Investigation Results

Sample ID	Heavy Metals								BTEX				TRHs				PAH		Totatl Phenols	VOCs	
	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Benzene	Toluene	Ethylbenzene	Total Xylene	F1*	F2**	F3 (>C_{16}-C_{34})	F4 (>C_{34}-C_{40})	Naphthalene	Other PAHs		Total VOCs	Acetone (2-propanone)
BH1M-1	<1	1	2	32	2	<0.1	120	600	<0.5	<0.5	<0.5	<1.5	<50	<60	<500	<500	<0.1	<1	<0.01	<10	<10
BH4M-1	<1	<0.1	1	60	4	<0.1	73	280	<0.5	<0.5	<0.5	<1.6	<50	<60	<500	<500	<0.2	<2	<0.02	<10	<10
BH7M-1	<1	0.6	3	53	4	<0.1	170	900	<0.5	<0.5	<0.5	<1.7	<50	<60	<500	<500	<0.3	<3	<0.03	<10	<10
BH10M-1	<1	0.9	2	54	4	<0.1	67	290	<0.5	<0.5	<0.5	<1.8	<50	<60	<500	<500	<0.4	<4	<0.04	<10	<10
BH13M-1	1	<0.1	1	25	2	<0.1	47	84	<0.5	<0.5	<0.5	<1.5	<50	<60	<500	<500	<0.1	<1	<0.01	28	24
GIL																					
GIL (MarineWaters)	NR	0.7[3]	27 (Cr (III)) 4.4 (Cr (VI))	1.3	4.4	0.1[3]	7	15[1]	500[1]	NR	NR	NR	NR	NR	NR	NR	50	NR	400	NR	
Drinking Waters	10	2	50	2000	10	1	20	NR	1	800	300	600	NR	NR	NR	NR	0.01	NR	NR		
HSL D [2]	NR	NR	NR	NR	NR	NR	NR	NR	5000	NL	NL	NL	6000	NL			NL				

Notes: All results are in units of µg/L.

Highlighted concentration value indicates exceedance of adopted GILs.

GIL Groundwater Investigation Level. All GIL values sourced from *National Environment Protection (Assessment of Site Contamination) Measure 1999 – Amendment 2013*, *Schedule (B1)* - Guideline on Investigation Levels for Soil and Groundwater, (NEPC) Investigation levels apply to Fresh Waters for typical slightly-moderately disturbed systems.

HSL Health-based Screening Level.

NL 'Not Limiting' If the derived soil vapour limit exceeds the soil concentration at which the pore water phase cannot dissolve any more of the individual chemical, i.e. where the soil vapour is at equilibrium with the pore water, then the soil vapour source cannot exceed a level that would result in the

NR No recommended soil assessment criteria are currently available for the indicated parameter(s).

N.D. Concentrations of all tested analytes in this group was under laboratory's practical quantifation limit.

* To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction.

** To obtain F2 subtract Naphthalene from the >C10-C16 fraction.

1 Indicated threshold value may not protect key species from chronic toxicity, refer to ANZECC & ARMCANZ (2000) for further guidance.

2 NEPC (2013) Table 1A(4) Groundwater HSL D for vapour intrusion at the contaminant source depth ranges in sands 2m to <4m, which is consistent with the groundwater sampling depth.

3 Chemical for which possible bioaccumulation and secondary poisoning effects should be considered, refer to ANZECC & ARMCANZ (2000) for further guidance.

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Table T1 - Summary of Soil Analytical Results

E23959 - Croydon Park

Sample ID	Material	Date	Heavy Metals								PAHs				BTEX				TRH				Pesticides		PCBs	Asbestos
			As	Cd	Cr VI	Cu	Pb	Hg	Ni	Zn	Carcinogenic PAHs (as B(a)P TEQ)	Benzo(a)pyrene	Total PAHs	Naphthalene	Benzene	Toluene	Ethylbenzene	Total Xylenes	F1	F2	F3	F4	OCPs	OPPs	Total	Presence / absence
EI Australia, 2018																										
BH101M_0.4-0.5	Fill	22/8/2018	7	<0.3	4.6	19	11	<0.05	1.3	14	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH102_0.2-0.3			<1	<0.3	1.2	<0.5	2	<0.05	<0.5	2.8	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH103_0.2-0.3			3	<0.3	2.5	15	6	<0.05	1.9	14	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH104_0.2-0.3			2	<0.3	2.6	3.3	12	<0.05	1.6	6.0	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH104_0.7-0.8			7	<0.3	14	15	19	<0.05	4.0	23	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH105_0.3-0.4			22	0.8	8.3	150	350	0.13	4.6	270	<0.3	<0.1	0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH106_0.3-0.4			7	<0.3	7.5	15	36	<0.05	2.7	47	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH107_0.2-0.3			2	<0.3	14	63	150	<0.05	25	150	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH108M_0.4-0.5			8	0.4	17	59	250	0.06	13	210	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	130	160	<120	<1	<1.7	<1	No
BH109_0.1-0.2			10	<0.3	5.3	6.0	2	<0.05	1.1	4.3	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH110_0.1-0.2			9	<0.3	4.9	0.9	1	<0.05	0.6	2.9	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH111_0.4-0.5			5	<0.3	14	16	19	<0.05	3.7	24	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH112M_0.3-0.4			7	<0.3	11	30	44	<0.05	1.8	51	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH113_0.2-0.3			6	<0.3	4.7	13	37	<0.05	1.6	31	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	No
BH101M_0.6-0.7	Natural		6	<0.3	4.8	26	12	<0.05	5.1	36	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N/A	N/A	N/A	N/A
BH105_0.8-0.9			7	<0.3	6.3	17	11	<0.05	1.1	15	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N/A	N/A	N/A	N/A
BH106_0.8-0.9			5	<0.3	8.3	26	13	<0.05	2.5	22	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N/A	N/A	N/A	N/A
BH108M_0.9-1.0			6	<0.3	10	31	23	<0.05	1.6	20	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N/A	N/A	N/A	N/A
BH111_0.8-0.9			7	<0.3	5.1	16	11	<0.05	0.5	7.4	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N/A	N/A	N/A	N/A
BH114_0.4-0.5			4	<0.3	7.0	24	12	<0.05	0.6	12	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N/A	N/A	N/A	N/A
Statistical Analysis																										
Maximum Concentration			22	0.8	17	150	350	0.13	25	270	<0.3	<0.1	0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	130	160	<120	<1	<1.7	<1	No
Mean			6.8421053	0.6	7.655	28.694737	51.05	0.095	3.9105263	48.12	NC	NC	0.8	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Standard Deviation			4.2460852	0.2828427	4.3985015	33.456713	92.406126	0.0494975	5.837893	73.674895	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
95% UCL			NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
SILs																										
HIL B - *Residential*			500	150	500 Cr (VI)	30,000	1,200	120	1,200	60,000	4		400										600		1	
HSL A & B - Residential			Source depths (0 m to <1 m BGL)											5	0.7	480	NL	110	50	280	NR					
			Source depths (1 m to <2 m BGL)											NL	1	NL	NL	310	90	NL						
			Source depths (2 m to <4 m BGL)											NL	2	NL	NL	NL	150	NL						
			Source depths (4m +)											NL	3	NL	NL	NL	290	NL						
EILs / ESLs			100		205	90	1,260		35	190		0.7		170	50	85	70	105	180	120	300	2,800	180			
Management Limits – *Residential, parkland and public open space* Coarse grained soil texture[1]																			700	1,000	3,500	10,000				
Asbestos contamination HSL – A&B *Residential* Bonded ACM (%w/w)																										0.01
Asbestos contamination HSL for Non Bonded / Friable Asbestos (%w/w)																										0.001

Notes:

All results are recorded in mg/kg (unless otherwise stated)

Highlighted valuses indicate concentration exceeds Human Helath Based Soil Criteria
Highlighted values indicates concentration exceeds Ecological Based Soil Criteria
Highlighted indicates NEPM 2013 criteria exceeded

HIL B	NEPM 1999 Amendment 2013 'HIL B' Health Based Investigation Levels applicable for residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.
HSL A & B	NEPM 1999 Amendement 2013 'HSL A & B' Health Based Investigation Levels applicable for low to high density residential use.
NA	'Not Analysed' i.e. the sample was not analysed.
NC	Not Calculated'
ND	'Not detected' i.e. all concentrations of the compounds within the analyte group were found to be below the laboratory limits of detection.
NL	'Not Limiting' - The soil vapour limit exceeds the soil concentration at which the pore water phase cannot dissolve any more of the individual chemical.
NR	No current published criterion.
1	Coarse Grained soil values were applied, being the most conservative of the material types.
F1	To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction.
F2	To obtain F2 subtract Naphthalene from the >C10-C16 fraction.
F3	(>C16-C34)
F4	(>C34-C40)
*	Benzo(a)pyrene criteria based on CRC Care Technical Report No. 39, 'Risk-based management guidance for benzo(a)pyrene' (2017).

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Table T2 – Summary of Groundwater Investigation Results **E23959 - Croydon Park**

Sample Identification		Date	Heavy Metals								PAHs			BTEX					TRHs				Other	VOCs	
			As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Total PAHs	Benzo(a)pyrene	Naphthalene	Benzene	Toluene	Ethylbenzene	o-xylene	m/p-xylene	F1	F2	F3	F4	Phenols (Total)	Total VOC	Acetone (2-propanone)
BH101M-1		29/8/2018	14	0.4	2	64	4	<0.1	35	200	<1	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<10	17	13
BH108M-1			20	0.9	2	63	4	<0.1	89	300	<1	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<10	19	12
BH112M-1			3	0.7	1	59	3	<0.1	47	210	<1	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<10	<10	<10
Statistical Analysis																									
Maximum Concentration			20	0.9	2	64	4	<0.1	89	300	<1	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500	<10	19	13
Mean			12.333333	0.6666667	2	62	3.6666667	NC	57.0	236.7	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	18	12.5
GILs																									
HSL A & B - Low to High Density Residential			2 m to < 4m										NL	5	NL	NL			NL	NL					
			4 m to <8 m										NL	5	NL	NL			NL	NL					
			8 m +										NL	5	NL	NL			NL	NL					
ANZAST (2018)	**Fresh Water** [4]		24 (AsIII) [4] 13 (AsV)	0.2 [4]	3.3 (CrIII) [4] 0.4 (Cr VI)	1.4 [4]	3.4 [4]	0.6 [4]	11 [4]	8 [4]			16 [4]	950 [4]	180 [8,4]	80 [9]	350 [8,4]	275 [8,4]	50 [7]	60 [7]	500 [7]	500 [7]	320 [4]		
	Marine Water [4]			5.5	27.4 (CrIII) [4] 4.4 (Cr VI)	1.3 [4]	4.4 [4]	0.4 [4]	70 [4]	15 [2,4]			70 [4]	700 [4]	180 [9]	5 [4]	350 [9]	275 [9]					400 [4]		
NHMRC (2017)	**Recreational Water** [5,6]		100	20	50	1000 *	100	10	200	3000		0.01		10	25 *	3 *	20 *	20 *					2		

Notes:

All values are µg/L unless stated otherwise

NL = Not Limiting

NA = 'Not Analysed' i.e. the sample was not analysed.

NR = No currently recommended criteria

ND = Not Detected - i.e. concentration below the laboratory PQL

F1 To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction.

F2 To obtain F2 subtract naphthalene from the >C10-C16 fraction.

F3 (>C16-C34)

F4 (>C34-C40)

2 = Figure may not protect key species from chronic toxicity, refer to ANZAST (2018) for further guidance.

3 = Chemical for which possible bioaccumulation and secondary poisoning effects should be considered, refer to ANZAST (2018) for further guidance.

4 = NEPM (2013) Groundwater Investigation Levels for fresh and marine water quality, based on ANZAST (2018).

5 = Based on NHMRC (2017) Drinking Water Guidelines. The lowest of the Health Guideline x10 or the Aesthetic Guideline has been chosen as the assessment criteria. Aesthetic based criteria have been indicated by *.

6 = Where no NHMRC (2017) Recreational Water Criteria provided, ANZAST (2018) Recreational Criteria have been utilised.

7 = In lack of a criteria the laboratory PQL has been used (DEC, 2007).

8 = Low and moderate reliability toxicity data, refer to ANZAST (2018).

9 = Unknown reliability of species protection, refer to ANZAST (2018).

Highlighted indicates ecological criteria exceeded

Highlighted indicates criteria exceeded

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APPENDIX D
REMEDIATION ACCEPTANCE CRITERIA

Table D-1 Soil Remediation Criteria

Chemical	Unit	HIL A [1a]	HIL B [1b]	HSL D [11]	EIL [2a]	ESL [2b]
Metals						
Arsenic – As	mg / kg	100 [3]	500 [3]	-	100	-
Cadmium - Cd	mg / kg	20	150	-	100	-
Chromium(VI) – Cr(VI)	mg / kg	100	500	-	415	-
Copper – Cu	mg / kg	6000	30,000	-	125	-
Lead – Pb	mg / kg	300	1,200	-	1260	-
Mercury – Hg (inorganic)	mg / kg	40	120	-	NA	-
Nickel – Ni	mg / kg	400	1,200	-	135	-
Zinc – Zn	mg / kg	7,400	60,000	-	350	-
Petroleum Hydrocarbons						
F1 [4]	mg / kg	-	-	260	-	180
F2 [5]	mg / kg	-	-	NL	-	120
F3 [6]	mg / kg	-	-	-	-	300
F4 [7]	mg / kg	-	-	-	-	2800
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	mg / kg	-	-	NL	170	-
Benzo(α)pyrene	mg / kg	-	-	-	-	0.7
Carcinogenic PAHs (as B(α)P TEQ) [8]	TEQ	3	4	-	-	-
Total PAHs [9]	mg / kg	300	400	-	-	-
Monocyclic Aromatic Hydrocarbons (BTEX)						
Benzene	mg / kg	-	-	3	-	50
Toluene	mg / kg	-	-	NL	-	85
Ethylbenzene	mg / kg	-	-	NL	-	70
Xylenes (total)	mg / kg	-	-	230	-	105
Chlorinated Volatile Organic Compounds (CVOCs)						
Tetrachloroethylene (PCE)	mg/kg	24 [10]				
Trichloroethylene (TCE)	mg/kg	0.94 [10]				
cis-1,2-dichloroethylene (cis 1,2 DCE)	mg/kg	1600 [10]				
Vinyl chloride (VC)	mg/kg	0.059 [10]				
Asbestos		**HSL A**	**HSL B**			
Asbestos (friable or fines)	w / w	0.001%	0.001%			
Asbestos (bonded)	w / w	0.01%	0.04%			

Notes:

1. Health-based investigation levels:
   a. HIL A - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools, Ref. NEPC 2013, Schedule B1, Table 1A(1).
   b. HIL B - Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments, Ref. NEPC 2013, Schedule B1, Table 1A(1).
2. Ecological investigation levels:
   a. EIL – Generic EIL for aged Arsenic and Naphthalene, Calculated EILs for other metals in urban residential and public open space settings with due regard for background concentrations, soil cation exchange capacity, texture and pH, Ref. NEPC 2013, Schedule B1, Tables 1B(1) to 1B(5).

b. ESL – Ecological Screening Level for F1, F2, F3, F4, BTEX and Benzo(a)pyrene in coarse texture soils in urban residential and public open space settings, Ref. NEPC 2013, Schedule B1, Table 1B(6).

3. Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).
4. F1: concentration of TRH C_6-C_{10} fraction minus the sum of BTEX concentrations.
5. F2: concentration of TRH >C_{10}-C_{16} fraction minus the concentration of Naphthalene.
6. F3: concentration of TRH >C_{16}-C_{34}.
7. F4: concentration of TRH >C_{34}-C_{40}.
8. Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.
9. Total PAHs: HIL is based on the sum of the 16 PAHs most commonly reported for contaminated sites (WHO 1998). The application of the total PAH HIL should consider the presence of carcinogenic PAHs and naphthalene (the most volatile PAH). Carcinogenic PAHs reported in the total PAHs should meet the B(a)P TEQ HIL. Naphthalene reported in the total PAHs should meet the relevant HSL.
10. USEPA 2015 Region 9 Screening Levels (RSLs) for Resident Soils.
11. Soil HSLs for vapour intrusion assuming coarse texture (sand) soils and a contamination source at 0m to <1m depth.

Table D-2 Groundwater Investigation Levels

Chemical	Unit	GIL (Marine Water) [4]	Recreational Water [5,6]
Metals			
Arsenic – As	µg/L	-	100
Cadmium - Cd	µg/L	0.7 [1]	20
Chromium - Cr	µg/L	27 (Cr III)	-
Copper – Cu	µg/L	1.3	20,000
Lead – Pb	µg/L	4.4	100
Mercury – Hg (inorganic)	µg/L	0.1 [3]	10
Nickel – Ni	µg/L	7	200
Zinc – Zn	µg/L	15 [2]	-
Polycyclic Aromatic Hydrocarbons (PAH)			
Naphthalene	µg/L	50	-
Benzo(α)pyrene	µg/L	-	0.1
Total PAHs [7]	µg/L	-	-
Petroleum Hydrocarbons			
F1 [8]	µg/L	50 [7]	-
F2 [9]	µg/L	60 [7]	-
F3 [10]	µg/L	500 [7]	-
F4 [11]	µg/L	500 [7]	-
Monocyclic Aromatic Hydrocarbons (BTEX)			
Benzene	µg/L	500	10
Toluene	µg/L	-	8,000
Ethylbenzene	µg/L	-	3,000
Xylenes (total)	µg/L	-	6,000
Phenols			
Total Phenols	µg/L	400	-

VOCs			
Naphthalene	µg/L	50	-
Vinyl Chloride (Chloroethene)	µg/L	-	3
1,1-dichloroethene	µg/L	700 [14]	300
Trans-1,2-dichloroethene	µg/L	20 [16]	-
Cis-1,2-dichloroethene	µg/L	20 [16]	600
1,1-dichloroethane	µg/L	250 [13]	-
Chloroform (THM)	µg/L	370 [12]	30
1,2-dichloroethane	µg/L	1,900 [13]	30
1,1,1-trichloroethane	µg/L	270 [13]	-
Trichloroethene (TCE)	µg/L	330 [14]	-
1,1,2-trichloroethane	µg/L	1,900 [15]	-
Tetrachloroethane (Perchloroethylene, PCE)	µg/L	70 [14]	500
1,1,2,2-tetrachloroethane	µg/L	400 [13]	-
Isopropylbenzene (Cumene)	µg/L	-	-
1,3,5-trimethylbenzene	µg/L	-	-
Tert-butylbenzene	µg/L	-	-
1,2,4-trimethylbenzene	µg/L	-	-

Notes:

1. Values have been calculated using a hardness of 30mg/L CaCO3 refer to ANZECC & ARMCANZ (2000) for further guidance on recalculating for site-specific hardness.
2. Figure may not protect key species from chronic toxicity, refer to ANZECC & ARMCANZ (2000) for further guidance
3. Chemical for which possible bioaccumulation and secondary poisoning effects should be considered, refer to ANZECC & ARMCANZ (2000) for further guidance
4. NEPC (2013) Groundwater Investigation Levels for marine water quality, based on ANZECC & ARMCANZ (2000).
5. NEPC (2013) Groundwater Investigation Levels for drinking water quality, based on Australian Drinking Water Guidelines (NHMRC 2011).
6. Drinking Water value has been used multiplied by a factor of 10 to address the secondary contact recreation.
7. In lack of a criteria the laboratory PQL has been used.
8. F1: concentration of TRH C_6-C_{10} fraction minus the sum of BTEX concentrations.
9. F2: concentration of TRH >C_{10}-C_{16} fraction minus the concentration of Naphthalene.
10. F3: concentration of TRH >C_{16}-C_{34}.
11. F4: concentration of TRH >C_{34}-C_{40}.
12. Low reliability toxicity data Table 8.3.11, refer to ANZECC & ARMCANZ (2000)
13. Low reliability toxicity data Table 8.3.12, refer to ANZECC & ARMCANZ (2000)
14. Low reliability toxicity data Table 8.3.13, refer to ANZECC & ARMCANZ (2000)
15. Moderate reliability toxicity data Table 8.3.12, refer to ANZECC & ARMCANZ (2000)
16. Dutch Intervention (2000) values

Table D-3 Waste Classification without Leachate Testing

Contaminant	Maximum Values of *Specific Contaminant Concentration* for Classification without TCLP	
	General Solid Waste CT1 (mg/kg)	**Restricted Solid Waste CT2 (mg/kg)**
Arsenic	100	400
Asbestos	**"Special Waste - Asbestos Waste"** if ANY Asbestos is present	
Benzene	10	40
Benzo(a)pyrene	0.8	3.2
Cadmium	20	80
Chromium (VI)	100	400
Cyanide (amenable)	70	280
Ethylbenzene	600	2,400
Lead	100	400
Mercury	4	16
Nickel	40	160
Petroleum hydrocarbons C_6-C_9	650	2,600
Petroleum hydrocarbons C_{10}-C_{36}	10,000	40,000
Polychlorinated biphenyls (PCB)	<50	<50
Polycyclic aromatic hydrocarbons (total PAH)	200	800
Tetrachloroethylene (PCE)	14	56
Toluene	288	1,152
Trichloroethylene (TCE)	10	40
Vinyl Chloride (VC)	4	16
Xylenes (total)	1,000	4,000

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only) see **Table D-4**

Table D-4 Waste Classification using TCLP and SCC Values

Contaminant	Maximum Values for *Leachable Concentration* and Specific Contaminant Concentration when used together			
	General Solid Waste		***Restricted Solid Waste***	
	Leachable Concentration	**Specific Contaminant Concentration**	**Leachable Concentration**	**Specific Contaminant Concentration**
	TCLP1 (mg/L)	**SCC1 (mg/kg)**	**TCLP2 (mg/L)**	**SCC2 (mg/kg)**
Arsenic	5.0	500	20	2,000
Asbestos	**"Special Waste - Asbestos Waste"** if ANY Asbestos is present			
Benzene	0.5	18	2	72
Benzo(a)pyrene	0.04	10	0.16	23
Cadmium	1.0	100	4	400
Chromium (VI)	5	1,900	20	7,600
Cyanide (amenable)	3.5	300	14	1,200
Ethylbenzene	30	1,080	120	4,320
Lead	5	1,500	20	6,000
Mercury	0.2	50	0.8	200
Nickel	2	1,050	8	4,200
Petroleum hydrocarbons C_6-C_9	N/A	650	N/A	2,600
Petroleum hydrocarbons C_{10}-C_{36}	N/A	10,000	N/A	40,000
Polychlorinated biphenyls (PCB)	N/A	<50	N/A	<50
Polycyclic aromatic hydrocarbons (total PAH)	N/A	200	N/A	800
Tetrachloroethylene (PCE)	0.7	25.2	2.8	100.8
Toluene	14.4	518	57.6	2,073
Trichloroethylene (TCE)	0.5	18	2	72
Vinyl Chloride (VC)	0.2	7.2	0.8	28.8
Xylenes	50	1,800	200	7,200

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only)

APPENDIX E
REVIEW OF REMEDIAL OPTIONS AND TECHNOLOGIES

REVIEW OF REMEDIATION OPTIONS AND TECHNOLOGIES

A number of soil remediation options were reviewed to examine the suitability of each method, in considering the remedial options available for the site, the surrounding lands and the geological and hydrogeological limitations, the following issues have been considered:

- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to natural and infrastructure limitations;
- Remedial timetable;
- Cost effectiveness;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

The following sections provide details on various remediation options for the material found on site.

E1 FILL, SOILS & RESIDUAL CLAYS

E1.1. BIOVENTING

Bioventing stimulates the natural in situ biodegradation of aerobically degradable compounds in soil by increasing oxygen flow to existing soil microorganisms. In contrast to soil vapour vacuum extraction, bioventing uses low air flow rates to provide only enough oxygen to sustain microbial activity. Oxygen is most commonly supplied through direct air injection into residual contamination in soil. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapours move slowly through biologically active soil. Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, non-chlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.

Factors that may limit the applicability and effectiveness of the process include:

- A high water table within 1-2 m of the surface, saturated soil lenses, or low permeability soils all may reduce bioventing performance.
- Vapours can build up in basements or underneath buildings within the radius of influence of air injection wells. This problem can be alleviated by extracting air near the structure of concern.
- Extremely low soil moisture content may limit biodegradation and the effectiveness of bioventing.
- Monitoring of off-gases at the soil surface may be required.
- Aerobic biodegradation of many chlorinated compounds may not be effective unless there is a co-metabolite present, or an anaerobic cycle.

E1.2 ENHANCED BIOREMEDIATION

Enhanced bioremediation is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water, converting them to harmless end products. Nutrients, oxygen, or other additives are used to enhance bioremediation and contaminant desorption from subsurface materials. In the presence of sufficient oxygen (aerobic conditions), and other nutrient elements, microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen (anaerobic conditions), the organic contaminants will be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate is converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, nitrogen gas is ultimately produced.

Factors that may limit the applicability and effectiveness bio remediation of the process include:

- Interaction between the soil matrix and microorganisms influence the results.
- Contaminants may be subject to leaching requiring treatment of the underlying ground water.
- Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones. The system should not be used for clay, highly layered, or heterogeneous subsurface environments because of oxygen (or other electron acceptor) transfer limitations.
- High concentrations of heavy metals, highly chlorinated organics, long chain hydrocarbons, or inorganic salts may be toxic to microorganisms.
- A surface treatment system, such as air stripping or carbon adsorption, may be required to treat extracted groundwater prior to re-injection or disposal.
- The length of time required for treatment can range from 6 months to 5 years and is dependent on many site-specific factors.

E1.3 CAPPING AND CONTAINMENT

The “cap and contain” method employs a risk minimisation approach similar to “ongoing management”, where impacted soils are managed on site so as not to pose an ongoing risk to the environment or human health. Impacted soils are contained by the placement of an impervious barrier or clean fill materials on top of the impacted material to prevent exposure to site occupiers, workers or the environment. The base of this “clean zone” would be clearly marked by a demarcation barrier to indicate that below this depth workers could potentially be exposed to contamination, which would then trigger additional health, safety and environmental controls.

Capping and containment may be an appropriate remedial option for soil containing both organic and inorganic contaminants that contain residual contamination, particularly if the mix of contaminants is not easily treated. The conditions for this remedial action alternative are:

- The contaminant is relatively non-mobile, including low volatility, insoluble and has low migration potential in a soil matrix;
- The primary exposure route to the contaminant and risk to human health is through direct dermal contact, dust inhalation or soil ingestion;
- The primary exposure route for the environment is mitigated through low leaching potential or migration to groundwater; and
- The contained area can be monitored and incorporated into any final land-use plans.

In the use of capping and containment, the focus of the response is to prevent contact with, or exposure to the contaminated soils by human receptors and/or eliminate transport by water to off-site receptors.

E1.4 CHEMICAL OXIDATION/INJECTION

Chemical oxidation remedial strategies involve the addition of an oxidising agent to the soil or groundwater. The rate and extent of degradation of a target chemical of concern is dependent on its susceptibility to oxidative degradation as well as the site conditions, such as pH, temperature, the concentration of oxidant, and the concentration of secondary oxidant-consuming substances such as natural organic matter.

Factors which may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation;
- Some chemicals of concern are resistant to oxidation; and
- There is a potential for process-induced detrimental effects.

E1.5 EXCAVATION AND OFF-SITE DISPOSAL

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off-site receptors. Wastes must be classified in accordance with the NSW EPA Guidelines.

Based on the required disposal of the landfill material, this option would adequately address the remediation goals through the removal of the contaminants from the site. Furthermore, with the removal of any identified contaminated fill soils, the long-term liability associated with soil contamination shall be minimised, along with substantial improvement of subsurface site conditions with regard to contamination of soil and groundwater.

E1.6 LAND FARMING

Ex situ land-farming is a proven treatment for petroleum hydrocarbon impacted soils. In general the higher the molecular weight or number of rings in a compound, the slower the degradation rate.

Factors that may limit the applicability and effectiveness of the land farming include:

- The large amount of space required.
- Conditions affecting biological degradation of contaminants (e.g., temperature, rain fall) are largely uncontrolled, which increases the length of time to complete remediation.
- Only suitable for organic contaminants.
- Volatile contaminants, such as solvents, must be pre-treated because they would volatilise into the atmosphere, causing air pollution.
- Dust control is an important consideration, especially during tilling and other material handling operations.
- Runoff collection facilities must be constructed and monitored.

E2 GROUNDWATER

E2.1 ENHANCED BIOREMEDIATION

Bioremediation is a process in which indigenous micro-organisms (i.e., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water.

Enhanced bioremediation attempts to accelerate the natural biodegradation process by providing nutrients, electron acceptors, and competent degrading microorganisms that may otherwise be limiting the rapid conversion of contamination organics to innocuous end products.

Oxygen enhancement can be achieved by either sparging air below the water table or circulating hydrogen peroxide (H_2O_2) throughout the contaminated ground water zone. Under anaerobic conditions, nitrate is circulated throughout the ground water contamination zone to enhance bioremediation. Additionally, solid-phase peroxide products (e.g., oxygen releasing compound (ORC)) can also be used for oxygen enhancement and to increase the rate of biodegradation.

Air sparging below the water table increases ground water oxygen concentration and enhances the rate of biological degradation of organic contaminants by naturally occurring microbes. Air sparging also increases mixing in the saturated zone, which increases the contact between ground water and soil. Oxygen enhancement with air sparging is typically used in conjunction with SVE or bioventing to enhance removal of the volatile component under consideration.

During hydrogen peroxide enhancement, a dilute solution of hydrogen peroxide is circulated through the contaminated ground water zone to increase the oxygen content of ground water and enhance the rate of aerobic biodegradation of organic contaminants by naturally occurring microbes.

Solubilized nitrate is circulated throughout ground water contamination zones to provide an alternative electron acceptor for biological activity and enhance the rate of degradation of organic contaminants. Development of nitrate enhancement is still at the pilot scale. This technology enhances the anaerobic biodegradation through the addition of nitrate.

Bio-enhanced remediation strategies are slow and may take several years for plume clean-up.

E2.2 AIR SPARGING

In air sparging, air is injected into a contaminated aquifer where it traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps to flush (bubble) the contaminants up into the unsaturated zone where a vapour extraction system is used to remove the vapour phase contamination.

In principal the more volatile a contaminant the more appropriate air sparging as a remediation strategy is. Methane can be added to the system to enhance co-metabolism of chlorinated organics.

Factors that may limit the applicability and effectiveness of the process include:

- Preferential air flow pathways reducing the contact between sparged air and the contaminants;
- Air injection wells must be designed for site-specific conditions; and
- Soil heterogeneity may cause some zones to be relatively unaffected.

E2.3 CHEMICAL OXIDATION

In a chemical oxidation system oxidants are added to the system in order to oxidise the chemical of concern to less toxic species. The Chemical oxidants most commonly employed include peroxide, ozone, and permanganate. These oxidants cause the rapid and complete chemical destruction of many toxic organic chemicals while some chemicals are subject to partially degradation and subsequently reduced by bioremediation.

In general, oxidants are capable of achieving high treatment efficiencies (e.g. >90%) for unsaturated aliphatic (e.g., trichloroethylene [TCE]) and aromatic compounds (e.g. benzene), with very fast reaction rates (90% destruction in minutes). Field applications have clearly affirmed that matching the oxidant and *in situ* delivery system to the contaminants of concern (COCs) and the site conditions is the key to successful implementation and achieving performance goals.

Oxidation using liquid hydrogen peroxide (H_2O_2) in the presence of native or supplemental ferrous iron (Fe^{+2}) produces Fenton's Reagent which yields free hydroxyl radicals (OH-). These strong, nonspecific oxidants can rapidly degrade a variety of organic compounds. Fenton's Reagent oxidation is most effective under very acidic pH (e.g. pH 2-4) and becomes ineffective under moderate to strongly alkaline conditions. The reactions are extremely rapid and follow second-order kinetics.

Ozone gas can oxidize contaminants directly or through the formation of hydroxyl radicals. Like peroxide, ozone reactions are most effective in systems with acidic pH. Due to ozone's high reactivity and instability, O_3 is usually produced onsite and requires closely spaced delivery points (e.g. air sparging wells). *In situ* decomposition of the ozone can lead to beneficial oxygenation and bio-stimulation.

The following factors may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation.
- Some COCs are resistant to oxidation.
- There is a potential for process-induced detrimental effects. Further research and development is ongoing to advance the science and engineering of *in situ* chemical oxidation and to increase its overall cost effectiveness.

E2.4 REACTIVE BARRIER WALL

Construction of a permeable reactive barrier (PRB) involves the subsurface emplacement of reactive materials through which a dissolved contaminant plume enters on one side of the PRB and treated water exits the other side. This *in situ* method for remediating dissolved-phase contaminants in groundwater combines a passive chemical or biological treatment zone with subsurface fluid flow management.

PRBs can be installed as permanent or semi-permanent units. The most commonly used PRB configuration is that of a continuous trench in which the treatment material is backfilled. The trench is perpendicular to and intersects the groundwater plume.

Alternately low-permeability walls can be used to direct a groundwater plume toward a permeable treatment zone.

E2.5 PUMP AND TREAT

As its name implies, a pump and treat remedial involves the pumping of contaminated of ground water pumping include removal of dissolved contaminants from the subsurface, and containment and treatment the water. The treated groundwater is then either re-introduced into the aquifer or disposed off-site.

The criteria for well design, pumping system and treatment are dependent on the physical site characteristics and contaminant type. While treatment options may include a train of processes such as gravity segregation, air strippers, and activated carbon filters designed to remove specific contaminants.

The first step in determining whether ground water pumping is an appropriate remedial technology is to conduct a site characterization investigation. Site characteristics, such as hydraulic conductivity,

will determine the range of remedial options possible. Chemical properties of the site and plume need to be determined to characterize transport of the contaminant and evaluate the feasibility of ground water pumping. To determine if ground water pumping is appropriate for a site, one needs to know the history of the contamination event, the properties of the subsurface and the biological and chemical contaminant characteristics. Identifying the chemical and physical site characteristics, locating the ground water contaminant plume in three dimensions and determining aquifer and soil properties are necessary in designing an effective ground water pumping strategy.

The following factors may limit the applicability and effectiveness of ground water pump and treat options as a remedial option:

- The time frame required to achieve the remediation goal;
- The pumping system fail to contain the contaminant plume as predicted;
- Residual saturation of the contaminant in the soil pores cannot be removed by ground water pumping;
- A pump and treat option is not suitable for contaminants with:
    - high residual saturation;
    - high sorption capabilities; and
    - homogeneous aquifers with hydraulic conductivity less than 10^{-5} cm/sec;
- Potential high operating costs;
- Biofouling of the extraction wells and associated treatment stream may severely affect system performance;
- Subsurface heterogeneities, may severely affect system performance;
- Potential toxic effects of residual surfactants in the subsurface;
    - Drawdown pumping generally produces large volumes of water requiring storage and or treatment.

E2.6 EXCAVATION

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off-site receptors. Excavation can also be used to remove primary sources of any groundwater contamination (such as buried tanks or drums and waste disposal areas) and remove the secondary sources of impact (contaminated fill, residual soils and impacted bedrock and bedrock fractures such as joints and bedding planes).

E3 REMEDIATION OPTIONS

The various remediation options were reviewed in a technology matrix to assess their suitability against the various subsurface materials at the site and whether the option meets the primary objectives of the remediation works program, as discussed in **Section 7.3**.