APPENDIX G

DESKTOP CONTAMINATION ASSESSMENT

Desktop Contamination Assessment with Limited Sampling

Dunheved Road

800021086

Prepared for
Penrith City Council

20 July 2022

Cardno
now
Stantec

Contact Information

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

16 Burelli Street
Wollongong NSW 2500
PO Box 1285

Phone +612 4228 4133
Fax +612 4228 6811

Document Information

Prepared for	Penrith City Council
Project Name	Dunheved Road
File Reference	80021086_Dunheved Rd_Contamination_Rev0.docx
Job Reference	800021086
Date	20 July 2022
Version Number	Rev0

Author(s):

Clare Madigan
Environmental Scientist

Effective Date 20/07/2022

Approved By:

Mitch Blencowe
Senior Environmental Scientist – CEnvP

Date Approved 20/07/2022

Document History

Version	Effective Date	Description of Revision	Prepared by	Reviewed by
A	2 February 2022	Draft	CM	MB
0	20 July 2022	Finalised Report	CM	MB

Executive Summary

Cardno (NSW/ACT) Pty Ltd (Cardno) was engaged by Penrith City Council ("the client") to complete a Desktop Contamination Assessment with Limited Sampling along Dunheved Road, through the suburbs of Cambridge Gardens, Cambridge Park, Werrington Downs, Werrington County and Werrington NSW, for the proposed upgrade works.

The site is currently occupied by dual bitumen road corridor along Dunheved Road, with associated gravels, overgrown grass and footpaths adjacent the road corridors.

The site constraints were limited to the road corridor and did not include any adjacent allotments.

Objectives

The purpose of this assessment was to determine the potential for contamination to be encountered onsite during the proposed upgrade works.

The main objectives of this assessment were:

- Evaluate the potential for site contamination to be present based on a review of current and historical land use;
- Investigate the degree of any potential contamination through a preliminary and limited intrusive investigation and laboratory analysis of soil samples;
- Make recommendations for appropriate management should contamination be confirmed; and
- Provide an indicative preliminary waste classification assessment.

Scope

This assessment included a desktop review of historical site searches, along with the drilling of forty-two (42) boreholes distributed evenly along the road corridors, with multiple level soil sampling of both fill and natural soils. Laboratory analysis of selected samples for relevant analytical parameters was based on the site history and field observations during the investigation program. Based on review of the laboratory analytical results, this Desktop Contamination Assessment report was prepared.

Findings

Based on the findings of this assessment, the following conclusions are made:

- he site can be defined as the road corridors along Dunheved Road. At the time of the assessment the site surfaces were covered with asphaltic and concrete hardstand, gravels, grass and exposed soils;
- Historically the site has been vacant land from at least 1947 to sometime before 1961, assumedly used for agricultural purposes with minor crops evident. From at least 1961 to 1994 the site had been developed in multiple stages as a dirt to asphalt roads with associated infrastructure. From 1982 onwards, the surrounding land appeared to be cleared and developed as residential subdivisions. Finally, from 1996 to present day the site has remained unchanged from its land use as an asphalt road; The site was not subject to regulation by the NSW EPA and was found to be free of statutory notices and licencing agreements under both the CLM Act 1997 and PoEO Act 1997. The site was also not included on the List of NSW Contaminated Sites;
- Surrounding land use has historically ranged in use from vacant land, agricultural, residential and commercial purposes (i.e. service stations, retail shops etc.). Two active service stations are located immediately adjacent the site (<10 m);
  - Despite the high risk of contamination to be present associated with the adjacent service stations, the risk to the project is considered to be low, due to the proposed shallow earthworks. Should the project design be modified to include deeper excavations, the adjoining land users may need to be reconsidered more extensively as a construction constraint and contaminant risk.;
- Soils encountered along the assessed areas of the road corridors generally consisted of silty gravelly clay fill, overlying residual clays, alluvial sandy clay and siltstone bedrock;
- All concentrations of metals, TRH, BTEX, PAHs, OCP/OPPs and PCBs in the collected samples of both fill and natural soils were all either below the applicable laboratory LOR or below the adopted NEPM 2013 Tier 1 human health screening criteria. From a human health perspective, the soils assessed at these discrete locations were considered suitable to remain onsite under the proposed land use;

- All concentrations of metals, TRH, BTEX, PAHs, OCP/OPPs and PCBs in the collected samples were below the adopted ecological criteria, with the exceptions of samples PC16_0.1-0.2 and PC17_0.1-0.2 which exceeded the ESL criteria for B(α)P. Based on the limited data gathered during this assessment, the material within these discrete locations may not be suitable to remain onsite unless placed under a structure or roadway (hardstand) and isolated from potential interaction with ecological receptors. If the material cannot be placed under a structure or roadway further assessment may be necessary to determine the suitability for onsite re-use or to classify for off-site disposal purposes (should that be required);
- No asbestos was observed during sampling nor identified within the laboratory analytical reports;
- Coal tar was not identified to be present within the sampled asphalt;
- Laboratory analysis indicated that the deeper (>0.8 m) residual soils along the assessment area were found to be non-saline to slightly saline within the western and central parts of the site, and sodic to highly sodic in nature;
- Fill soils encountered were preliminarily classified as Restricted Solid Waste (RSW), however, could potentially be reclassified to General Solid Waste (GSW) subject to additional laboratory testing such as leachability (TCLP); and
- Residual and alluvial soils may be suitable for classification as either Excavated Natural Material (ENM) or Virgin Excavated Natural Material (VENM), however, this would need to be confirmed through further assessment that satisfies applicable NSW EPA guidelines.

These preliminary waste classifications do not constitute a waste classification certificate that enables removal of material from the site.

Recommendations

Based on the findings of this assessment and with reference to the purpose and objectives of this investigation, the following recommendations are made:

- The shallow fill material within the vicinity of PC16 and PC17 is suitable to remain onsite if situated beneath road infrastructure of structures during redevelopment. Should the material remain onsite within the vicinity of landscaping or an area of ecological significance / value, then additional testing will be required to confirm re-use suitability or if offsite disposal is required;
- Highly sodic soils were identified at depth (>0.8 m) and based on an assumption of shallow earthworks during construction it is unlikely that they will impact the proposed development, provided they remain undisturbed and at depth. Should sodic soils be exposed by the redevelopment then treatment may be required prior to the installation of any overlying infrastructure, and the project designed considerate of associated risks.
- Construction Environmental Management Plan:
  - A Construction Environmental Management Plan (CEMP) should be prepared prior to undertaking any future works. This CEMP will include details regarding waste classification, stockpile and waste and management procedures for any soils being excavated and requiring offsite disposal. The CEMP will be prepared in accordance with appropriate guidelines and regulatory authorities;
    - During construction all material proposed for removal from site will require sampling and analysis for Waste Classification purposes, which must be outlined in the CEMP. Waste classification sampling and certificates will be completed in accordance with the NSW EPA (2014) Waste Classification Guidelines;
- Unexpected Finds Protocol:
  - Preparation of an unexpected finds protocol (UFP) which outlines the procedures to be followed should contamination be identified during future works. The limited soil sampling and analysis completed as part of this assessment indicate a generally low contaminant risk at the location from which samples were collected. Despite this, large portions of the site remain unassessed and require implementation of a UFP.

Table of Contents

Abbreviations vii
1 Introduction 1
1.1 Background 1
1.2 Proposed Development 1
1.3 Purpose and Objectives 1
1.4 Scope of Works 1
1.5 Applicable Legislation and Guidelines 2
2 Site Identification 3
2.1 Site Details 3
2.2 Surrounding Land Uses 4
2.3 Regional and Site Settings 4
2.4 Site Description 6
3 Site History 8
3.1 Aerial Photograph Review 8
3.2 Lotsearch Review 11
3.3 EPA Record Search 13
3.4 Planning Information 14
3.5 Site History Summary 15
4 Conceptual Site Model 16
4.1 Controlled Chemicals 16
4.2 Per and Poly Fluoroalkyl Substances (PFAS) 16
4.3 Preliminary CSM 17
4.4 Data Gaps 18
5 Data Quality Objectives 19
5.1 Data Quality Objective 19
5.2 Data Quality Indicators 21
6 Methodology 23
6.1 Assessment Criteria 23
6.2 Site Investigation Program 24
7 Results 26
7.1 Soil Observations 26
7.2 Laboratory Analysis 27
7.3 Data Quality Assessment 29
8 Site Characterisation 30
8.1 Soil 30
8.2 Conceptual Site Model Review 31
8.3 Data Gaps and Uncertainties 31
9 Conclusions and Recommendations 32
9.1 Recommendations 33

10 Limitations 34
11 References 36

Appendices

Appendix A Figures
Appendix B Analytical Summary Tables
Appendix C Site Photographs
Appendix D Borehole Logs
Appendix E QA/QC Results
Appendix F Laboratory Reports
Appendix G Lotsearch Report

Tables

Table 2-1 Site Identification Details 3
Table 2-2 Surrounding Land Summary and Sensitive Receptors 4
Table 2-3 Site Setting Information 5
Table 2-4 Site Inspection Details 6
Table 3-1 Summary of Historical Aerial Photographs 8
Table 3-2 Summary of Lotsearch Findings 11
Table 3-3 Summary of NSW Contaminated Sites List 14
Table 4-1 Preliminary Controlled Chemicals Screening 16
Table 4-2 PFAS Desktop Survey 16
Table 4-3 Preliminary Conceptual Site Model 18
Table 5-1 Data Quality Objectives 19
Table 5-2 Data Quality Indicators 21
Table 6-1 Adopted Human Health Criteria 23
Table 6-2 EIL Criteria 23
Table 6-3 Adopted Waste Classification Criteria 24
Table 6-4 Investigation Activity Summary 24
Table 7-1 Typical Soil Profile 26
Table 7-2 Summary of Soil Analytical Results 27
Table 11-1 Assessment of Field Data Quality 60
Table 11-2 Field QA/QC Collection Summary 61
Table 11-3 Assessment of Laboratory Data Quality 61

Figures

Figure 2-1 Approximate Site Area – Dunheved Road Extent (Source: NearMap) 4

Abbreviations

ACM	Asbestos Containing Material
ASS	Acid Sulfate Soils
BoM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CBD	Central Business District
CCO	Chemical Control Order
CEC	Cation Exchange Capacity
CLM	Contaminated Land Management
CSM	Conceptual Site Model
DBYD	Dial Before You Dig
DCP	Development Control Plan
DIPNR	Department of Infrastructure, Planning and Natural Resources
DLWC	Department of Land and Water Conservation
DNR	Department of Natural Resources
DoD	Department of Defence
DQI	Data Quality Indicator
DQO	Data Quality Objectives
EC	Electrical Conductivity
ECe	Extract Electrical Conductivity
ENM	Excavated Natural Material
EPA	Environmental Protection Authority
EPI	Environmental Planning Instrument
EPL	Environmental Protection Licence
ESP	Exchangeable Sodium Percentage
HIL	Health Investigation Level
HSL	Health Screening Level
km	kilometres
LEP	Locale Environmental Plan
LGA	Local Government Area
LOR	Limit of Reporting
m	metres
mAHD	metres Australian Height Datum
mBGL	metres Below Ground Level
NATA	National Associated Testing Authority
NEMP	National Environmental Management Plan
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measures
NSW	New South Wales

OCP	Organochlorine Pesticides
OEH	Office of Environment and Heritage
OPP	Organophosphorus Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PFAS	Per- and poly-fluoroalkyl substances
PID	Photo-Ionisation Detector
PoEO	Protection of Environment Operations
ppm	parts per million
QA/QC	Quality Assurance / Quality Control
RL	Reduced level
RPD	Relative Percentage Difference
RRO	Resource Recovery Order
RTA	Roads and Traffic Authority
SEPP	State Environmental Planning Policy
SPR	Source – Pathway – Receptor
SWL	Standing Water Level
SWMS	SafeWork Method Statement
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
UST	Underground Storage Tank
VENM	Virgin Excavated Natural Material
VOC	Volatile Organic Compounds

1 Introduction

1.1 Background

Cardno (NSW/ACT) Pty Ltd, now Stantec ("Cardno") was engaged by Penrith City Council ("the client") to complete a Desktop Contamination Assessment with Limited Sampling for the proposed upgrade works ("the project").

The site encompasses Dunheved Road within several suburbs in the Penrith Local Government Area (LGA), including Cambridge Gardens, Cambridge Park, Werrington Downs, Werrington County and Werrington. The site boundary is shown on **Figure 2** in **Appendix A** and was limited to the road corridor and did not include adjacent allotments.

This assessment was completed in conjunction with a Geotechnical Investigation undertaken at the site by Cardno, proposal reference 48980021-0179 dated 15 March 2021.

1.2 Proposed Development

The upgrade is proposed to span 4.2 km in total, commencing from the intersection of Richmond Road and Dunheved Road to Christie Street and Werrington Road roundabout. Based on the preliminary design plans prepared by Cardno, it is understood the upgrade will involve dual carriageways, with planting, cycle and pedestrian zones along the extent of Dunheved Road.

The upgrade will also include the drainage network at Orleton Place / Rugby Street, new bridge at Werrington Creek crossing and new roundabouts at the following intersections:

- Tasman Street and Elton Road;
- Henry Lawson Avenue and Madigan Drive; and
- John Batman Avenue and Ovens Drive.

1.3 Purpose and Objectives

The purpose of this assessment was to preliminarily determine the potential for contamination to be encountered onsite during the proposed upgrade works.

Cardno's objectives during this assessment were to:

- Evaluate the potential for site contamination to be present based on a review of current and historical land use;
- Investigate the degree of any potential contamination through a preliminary and limited intrusive investigation and laboratory analysis of soil samples;
- Make recommendations for appropriate management should contamination be confirmed; and
- Provide an indicative preliminary waste classification assessment.

1.4 Scope of Works

Cardno carried out the following scope of works to meet the objectives (outlined above in **Section 1.3**) of this assessment:

- Preliminaries:
  - A review of dial-before-you-dig (DBYD) plans of existing underground services on site;
- Desktop Study:
  - A review of local and regional geology, hydrogeology, topography, salinity, soil landscape and groundwater data and maps;
  - A review of NSW Environment Protection Authority (EPA) public registers;
  - A review of historical aerial photographs available online to identify previous site and surrounding land uses;

- A review of historical records including UBD directories to identify possible historical and current site uses and listings;

> Fieldwork:

- A kick-off toolbox meeting with sub-contractors and Cardno's geotechnical team, discussing works to be completed, risks and safety measures (as outlined in the SWMS);
- A detailed site-walkover inspection completed by an experienced environmental professional from Cardno;
- Drilling of forty-two (42) boreholes spaced along the road corridors within the site to maximum depths of 1.5 metres below ground level (mBGL);
- Drilling of four (4) deep boreholes surrounding Werrington Creek bridge (one per abutment) to maximum depths of 15 mBGL;
- Collection of soil samples from both the fill and natural soil profiles from each borehole;
- Preliminary screening of the collected soil samples for volatile organic compounds (VOCs) using a calibrated Photo-Ionisation Detector (PID);
- Logging of the soil profile by the geotechnical engineer supervising the drilling. The logging included a visual and olfactory assessment for indications of contamination such as sheen, staining, discolouration and odour;
- Collection of eleven (11) asphalt samples to confirm the presence / absence of coal tar;
- Laboratory analysis by a National Associated Testing Authority (NATA) accredited laboratory of selected soil samples for relevant analytical parameters determined by the investigation findings;

> Reporting:

- Review of laboratory analytical results in consideration of the applicable criteria and guidelines; and
- Preparation of the Desktop Contamination Assessment Report, detailing the findings, conclusions and recommendations (if any) from the assessment, as well as a preliminary and indicative waste classification.

1.4.1 Deviation from the Original Scope

Based on review of site locality, soils and salinity mapping (as shown in **Table 2-3**), it was considered a moderate to high likelihood that the proposed upgrade works may encounter saline soils. Based on this Cardno have undertaken a preliminary salinity assessment for the site in accordance with Penrith City Council Development Control Plan (DCP) 2014 requirements, where salinity assessments are required for lands identified on the *Salinity Potential in Western Sydney 2002* map .

1.5 Applicable Legislation and Guidelines

The scope of the assessment was developed in accordance with the following guidelines and legislation:

> DLWC (2002) Site Investigations for Urban Salinity. Department of Land and Water Conservation 2002.

> NEPC (2013) National Environment protection (Assessment of Site Contamination) Measure 1999. National Environmental Protection Council;

> NSW Department of Urban Affairs and Planning (1998) Managing Land Contamination: Planning Guidelines: SEPP 55 Remediation of Land, 1998;

> NSW EPA (2020) Consultants Reporting on Contaminated Land: Contaminated Land Guidelines. New South Wales Environment Protection Authority, April 2020, Updated May 2020;

> NSW EPA (2014) Waste Classification Guidelines, Part 1: Classifying Waste;

> NSW EPA (2014) The Excavated Natural Material Order 2014, Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014; and

> NSW EPA (1995) Contaminated Sites Sampling Design Guidelines. New South Wales Environment Protection Authority (EPA), September 1995.

2 Site Identification

2.1 Site Details

The site is located along Dunheved Road spanning from Richmond Road (west) to Christie Street (east) across multiple suburbs including:

- Cambridge Gardens;
- Cambridge Park;
- Werrington Downs;
- Werrington County; and
- Werrington.

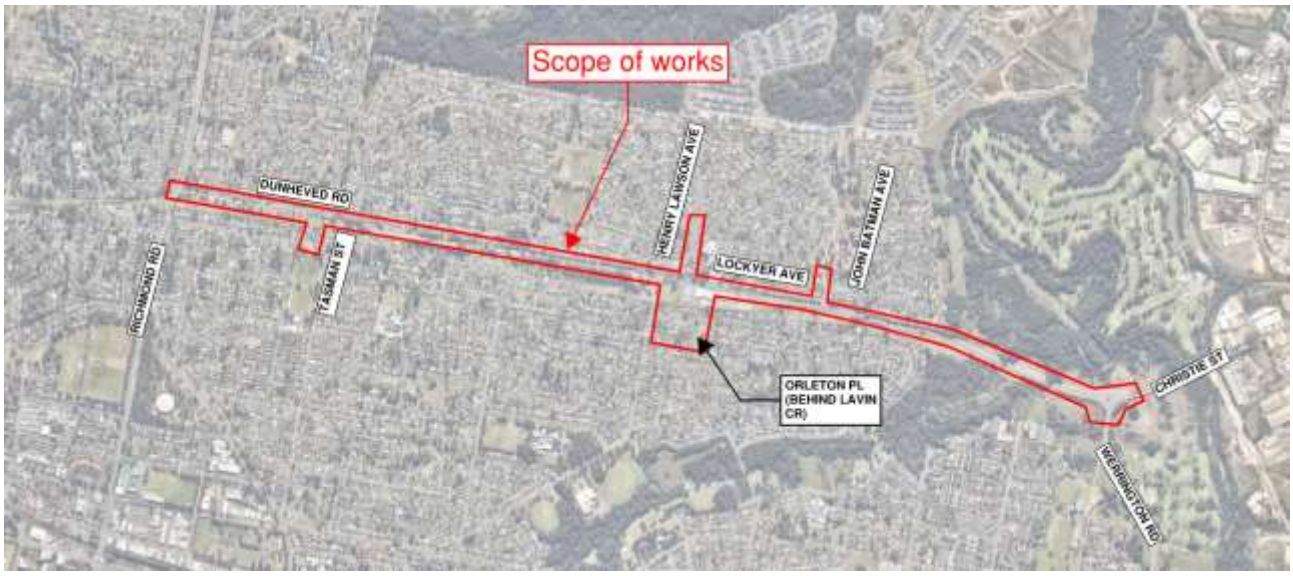
The site is situated approximately 44 km north-west of Sydney central business district (CBD). Further site details are presented below in **Table 2-1.**

A site plan is provided below as **Figure 2-1** defining the extent of the investigation area in red.

Table 2-1 Site Identification Details

Item	Details		
Site Address	Dunheved Road		
Approximate Area	430,036 m² (43 ha) (Source: Lotsearch Reports in **Appendix G)**		
Approximate Length	4.2 km (Source: SixMaps Imagery, 2013)		
Title Details	N/A		
Local Government Area (LGA)	Penrith City Council		
Parish and County	▪ **Parish:** Londonderry & Claremont ▪ **County:** Cumberland		
Site Coordinates (GDA2020 MGA56) (Source: SixMaps)	**Location**	**Easting**	**Northing**
	Cnr Richmond & Dunheved Rd	288420.242	6264074.465
	Cnr Richmond & Dunheved Rd	288416.96	6264065.482
	Cnr Dunheved Rd & Greenbank Dr	289368.749	6263907.846
	Cnr Dunheved Rd & Greenbank Dr	290407.388	6263755.981
	Cnr Dunheved Rd & Lawn Cres	290601.736	6263714.215
	Cnr Dunheved Rd & Henry Lawson Ave	290773.78	6263691.755
	Cnr Dunheved Rd & John Oxley Ave	291111.824	6263627.39
	Cnr Dunheved Rd & Christie St	292445.795	6263266.979
	Cnr Dunheved Rd & Christie St	292444.399	6263239.728
Current Land Use	Bitumen road corridor along the extent of Dunheved Road (spanning from Richmond Road to Christie Street), with associated gravels, overgrown grass, adjacent footpaths and bridge.		

Figure 2-1 Approximate Site Area – Dunheved Road Extent (Source: NearMap)



2.2 Surrounding Land Uses

The land uses immediately surrounding the site and sensitive receptors within 500 m of the site are summarised below in **Table 2-2**. The site and surrounding land uses are illustrated in **Figure 2-1** above.

Table 2-2 Surrounding Land Summary and Sensitive Receptors

Direction	Land Use or Activity	Sensitive Receptors
North	Individual residential dwellings and suburban streets, parklands, commercial buildings (including service stations, supermarkets and fast food restaurants), educational facilities, dense vegetation and grassed land, Werrington Creek and South Creek.	▪ Werrington Creek (onsite) ▪ Werianda Children's Centre (<140 m north) ▪ Jim Anderson Park (<180 m north) ▪ Werrington County Public School (<200 m north) ▪ South Creek (<200 m north-east) ▪ Werrington County Children's Centre (approx. 500 m north of the site)
South	Residential dwellings and suburban streets, vacant vegetated land, commercial buildings (shopping centre including retail shops, supermarkets, fast food restaurants, service stations etc.), educational facilities, grassed land, sporting ovals and Werrington Creek.	▪ Patterson Oval / Cambridge Park Reserve (<140 m south) ▪ Cambridge Park Public School Preschool (<245 m south) ▪ Cambridge Park Public School (<400 m south)
East	Christie Street, grassed and vegetated land, followed by South Creek and industrial land (including scrap metal yard, service stations and industrial businesses).	▪ South Creek (approx. 380 m east)
West	Richmond Road, followed by individual residential dwellings, commercial buildings (supermarkets), parkland and vacant grassed land and educational facilities.	▪ Illawong Playground (<300 m west) ▪ Kingswood Park Public School (<390 m west)

Based on the review of surrounding lands, one potentially sensitive receptor, Werrington Creek, was identified onsite. Werrington Creek is inferred to flow down-gradient from the site feeding into South Creek (200 m north of the site). Other sensitive receptors identified in **Table 2-2**, including schools, childcare centres were not identified within close proximity (less than 100 m from or hydraulically downgradient) of the site.

2.3 Regional and Site Settings

Site setting information, as listed within publicly available data sets, is summarised in **Table 2-3**.

Table 2-3 Site Setting Information

Item	Details
Regional Soil Landscape	The NSW DPIE *eSPADE v2.1* website indicates the majority of the site overlies the Luddenham (lu) erosional soil landscape. Soils within the Luddenham landscape consisted of shallow dark podzolic soils or massive earthy clays on crests, moderately deep red podzolic soils on upper slopes, and moderately deep yellow podzolic soils and prairies soils on lower slopes and drainage lines. The easternmost part of the site (east of Lockyer Avenue) overlies the South Creek (sc) Alluvial soil landscape. The South Creek landscape consisted of often very deep layered sediments over bedrock or relict soils. Where pedogenesis has occurred structured plastic clays or structured loams in and/or immediately adjacent to drainage lines are present. Red and yellow podzolic soils are most common terraces with small areas of Structured grey clays, leached clays and yellow solodic soils.
Regional Geology	Reference to the Penrith 1:100,000 Geological Series Sheet 9030, published by NSW Department of Minerals and Resources - 1991, indicates that the site is predominantly underlain by Bringelly Shale of Wianamatta Group (Rwb) which is characterised by Shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff. There was some minor intrusion of Alluvial soil (Qal) – fine grained sand, silt and clay towards the eastern boundary of the project. The NSW Surface Geology (ge612), *MinView Online Mapping* indicates that the majority of the site overlies Bringelly Shale (Twib) which is characterised by shale, carbonaceous claystone, laminate, lithic sandstone and rare coal. The easternmost part of the site overlies Alluvial floodplain deposits (Q_af) which are characterised by silt, very fine to medium-grained lithic to quartz-rich sand and clay.
Topography	The NSW DPIE *eSPADE v2.1* website indicates the regional topography for the majority of the site consists of low rolling to steep hills, with local relief ranging from 50 m to 120 m and slopes with a gradient of 5% to 20%. Convex narrow (20-300 m) ridges and hillcrests grade into moderately inclined sideslopes with narrow concave drainage lines are present. Moderately inclined slopes of 10 to 15% are the dominant land forms. The regional topography present in the easternmost part of the site consists of flat to gently sloping alluvial plain with occasional terraces or levees providing low relief. Slopes are generally less than 5% and local relief is less than 10 m.
Regional Groundwater	The WaterNSW *Real Time Water Data Portal* was accessed on 11 January 2022 and identified that no registered groundwater bores were within 500 m radius of the site.
Surface Water Body	The nearest surface water body is Werrington Creek, which intersects the eastern part of the site. Werrington Creek feeds into South Creek which is a tributary of Hawkesbury River. A drainage culvert is located <10 m north of the western part of the site which feeds into South Creek via an unnamed tributary (approx. 500 m north of the site). South Creek is a tributary of the Hawkesbury River which is situated approx. 17 km north of the site. Boundary Creek is situated approximately 1.1 km west of the westernmost part of the site, which feeds into the Nepean River, approximately 2.9 km south-west of the site.
Acid Sulfate Soils	The NSW DPIE *eSPADE v2.1* website indicates that the site does not lie in an area mapped as an acid sulfate soils (ASS) risk. Additionally, based on review of Penrith Local Environmental Plan (LEP) 2010 there are no ASS Risk maps for the LGA. Due to the apparent low risk and likelihood ASS were not expected to be encountered onsite and were not further investigated during this assessment.
Salinity	Based on review of Department of Infrastructure, Planning and Natural Resources (DIPNR) *Salinity Potential in Western Sydney 2002* map the majority of the site lies within an area mapped as moderate salinity potential which can be described as areas on Wianamatta Group Shales and Tertiary Alluvial Terraces where evidence of scattered scalding or vegetation indicators may be observed. The easternmost part of the site adjacent Werrington Creek is mapped as high salinity potential. High salinity potential can be described as areas where soil, geology, topography and groundwater conditions predispose a site to salinity and are likely to occur in areas of lower slopes and drainage systems where water accumulation is high. Based on this, it was considered a preliminary salinity assessment should be undertaken across the site during this investigation, particularly targeting the areas adjacent the creek beds, which have been mapped as high salinity potential.

2.4 Site Description

A site inspection was undertaken by an experienced Environmental Scientist from Cardno on 7 October 2021. Detailed observations made during the inspection are provided below in **Table 2-4**, whilst photographs taken during the inspection are provided in **Appendix C**.

Table 2-4 Site Inspection Details

Item	Observations	Photograph Reference
Weather Conditions	The weather conditions during the site inspection were cloudy and cool early morning warming up and became sunny later. Temperatures ranged between 11.7° to 30.5°C on this day (Source: Bureau of Meteorology, viewed at http://www.bom.gov.au/climate/dwo/202110/html/IDCJDW2111.202110.shtml)	All
Site slope and drainage features	The site undulates along the full extent of Dunheved Road. The site was observed to slope west at the Dunheved and Richmond Road intersection, then sloping east from Trinity Drive to Tasman Street. The slope then rises up to Greenbank Drive before plateauing to the commercial shops, from which Dunheved Road slopes east towards Werrington / South Creek. Two drainage culverts /stormwater channels were observed intersecting the site, with a large man-made channel extending north of Dunheved Road and a small drainage culvert extending south-west adjacent residential properties. The man-made channel feeds into South Creek approximately 500 m north to north-east of the site. Stormwater pits and drains were observed at numerous locations across the extent of Dunheved Road.	1, 3 , 8-9, 12-13, 17, 20 & 24
Nearby surface water bodies	Werrington / South Creek cuts through the easternmost part of the site. One large stormwater channel was observed intersecting the western part of the site near Tasman Street, which feeds into South Creek approximately 500 m north to north-east of the site.	8-9, 13 & 31-32
Site surface coverings	Across the extent of the road corridor, surface coverings consisted of: ▪ Asphalt road – minor potholes, cracking and staining; ▪ Gravels (loose road base) and soil; and ▪ Grass – observed to be relatively maintained, dieback in patches, with exposed soil patches evident.	1-3, 10-11, 14,18-19, 22, 24-25, 29-30 & 34
Surface soils	Minor road base fill and topsoil was observed overlying residual (clays) / alluvial soils.	1-3, 5, 7, 10 & 35-36
Site cut and fill	Cut and fill was observed at various parts along the road corridor, particularly the western half of the site.	1-7
Buildings	No buildings were evident within the site (road corridor). However, immediately adjacent to the site, multiple single to two-storey residential dwellings, low density apartment buildings and single storey commercial buildings were evident. Residential buildings appeared to be externally constructed from exposed or rendered brick, terracotta tiles, and plasterboard. Commercial buildings appeared to be constructed from rendered brick, concrete and steel.	17-18 & 20-21
Hazardous materials	No suspected hazardous materials were observed along visible surfaces of the road corridors.	-
Manufacturing, industrial or chemical processes and infrastructure	None observed within the vicinity of the site. However, along Dunheved Road, some allotments adjacent the site were occupied by two active service stations with fuel storage (including underground storage tanks (USTs)).	16 & 21
Fuel Storage (USTs/ASTs)	Underground storage tank fill points and bowsers were observed at both the Caltex and 7-Eleven Service Stations, immediately north (<10 m) and south (<10 m) of the central part of the site. The tank fill points at Caltex Service Station were situated approx. 20 m north of the site, whilst the tank fill points at the 7-Eleven Service Station were situated approx.30 m south of the site.	16 & 21
Dangerous Goods	None observed.	-

Item	Observations	Photograph Reference
Solid waste deposition	Minor general litter (i.e. soft plastics) was observed along either side of the road corridor.	9
Liquid Waste Disposal features	None observed.	-
Evidence of previous contamination investigations	None observed.	-
Evidence of land contamination (staining or odours)	Minimal evidence of contamination observed.	-
Evidence of groundwater contamination	None observed.	-
Groundwater Use	Not observed.	-
Vegetation	Either side of the road corridors was covered in either bare soil, maintained relatively healthy grasses (yellow to green in colour), or overgrown grasses with sporadic to dense weeds. Large health trees, bushes and shrubs were also observed along majority of the road corridor (sporadic to dense coverage).	2-5, 7-8, 10, 12-14, 23 & 25-28
Services	Along the road corridors, both underground and above ground services were observed, including: ▪ Sewerage manholes and vent points; ▪ Stormwater drainage pits and channels; ▪ Electrical sub-stations; ▪ Telstra service pits; and ▪ Overhead electrical wires and power poles.	2, 6-8, 10, 22 & 33-34
Site fencing	Fencing was evident in some areas either side of the road corridors, from adjacent properties. Fencing was observed to be constructed from either corrugated steel, wire and/or timber palings.	4
Salt Indicators	▪ Salt tolerant plants: There appeared to be Cumbungi plant (reed) species evident within the vicinity of Werrington / South Creek. ▪ Road damage: None observed. ▪ Bare soil: bare exposed soils were evident sporadically along the extent of Dunheved Road corridor. ▪ Efflorescence: None observed.	23 & 32

3 Site History

3.1 Aerial Photograph Review

As part of the desktop assessment a search of available historical aerial photographs pertaining the site and the surrounding land was completed by Cardno. Aerial imagery was supplied in the Lotsearch documents provided in **Appendix G**. The following aerial photographs were reviewed:

- Lotsearch: 1949, 1955/1956, 1961, 1965, 1970, 1978, 1982, 1986, 1991, 1994, 2000, 2005, 2009, 2018 and 2021.

The following online websites and additional aerial photographs were reviewed:

- NSW Government, *Historical Imagery Viewer* (https://portal.spatial.nsw.gov.au/portal/, viewed 25 November 2021):
  - 1947, 1975, 1998 and 2004.
- MetroMap (https://web.metromap.com.au/map#, viewed 25 November 2021):
  - 2007, 2018, 2019 and 2020.

Details from this review regarding the site and surrounding land use have been summarised below in **Table 3-1** and copies of the aerial photographs as part of the Lotsearch documents are provided in **Appendix G.**

Table 3-1 Summary of Historical Aerial Photographs

Dates	Site Use Observations	Surrounding Land Use Observations
1947	The site appeared to be vacant grassed land with sporadic trees across. A creek was evident in the easternmost part of the site, adjacent the creek the land appeared to be used for agricultural purposes with presumed crops and small farm houses evident.	The surrounding land north of the site appeared to be consistent with the majority of the site, being occupied by vacant grassed land with sporadic tree coverage. The surrounding land east of the site appeared to be occupied agricultural land. The surrounding land south of the site appeared to be occupied by dirt roads and tracks, dense to sporadic tree coverage and residential dwellings. The surrounding land west of the site appeared to be occupied by a road, followed by grassed land and sporadic tree coverage. Further south-west of the site the surrounding land appeared to be occupied by multiple industrial warehouses, factories and roads, and industrial goods.
1949	The site appeared to be predominantly unchanged from 1947.	The surrounding land north of the site appeared predominantly unchanged from 1947. However, a dam was noted north of the western part of the site and presumed agricultural land was evident north of the eastern part of the site. The surrounding land east, south and west of the site appeared predominantly unchanged from 1947, however additional residential dwellings were noted south of the western part of the site.
1955/ 1956	The site appeared to be predominantly unchanged from 1949.	The surrounding land north, east and west of the site, appeared predominantly unchanged from 1949. The surrounding land south of the site appeared to be further developed with dirt roads and additional residential dwellings.
1961	The central-western part of the site appeared to be occupied by a dirt road. The remainder of the site appeared predominantly unchanged from 1955/1956.	The surrounding land north, east and west of the site appeared predominantly unchanged from 1955/1956. The land immediately south of the western part of the site had been further developed with residential dwellings and associated structures. Further south of the site the land has been further developed with additional residential dwellings, roads and a rail corridor.

Dates	Site Use Observations	Surrounding Land Use Observations
1965	The site appeared predominantly unchanged from 1961. However, the dirt road within the western central part of the site had been widened since 1961.	The surrounding lands immediately north of the site appeared predominantly unchanged from, however further north of the western part of the site, the land appeared to be developed as some sort of defence site, with multiple buildings/barracks, roads and tunnels evident. The surrounding land west, south and east of the site had been further developed residentially, with additional roads and dwellings evident.
1970	The site appeared predominantly unchanged from 1965, however multiple dirt roads and paths were evident in the westernmost part of the site.	The surrounding land north of the western half of the site appeared predominantly unchanged from 1965. The surrounding land north of the eastern half of the site had been developed as a golf course. Further north of the site some land clearing and two industrial warehouses were evident. South and west of the site the surrounding land appeared to have been further developed residentially, with land clearing, additional roads and dwellings evident. The surrounding land immediately east of the site appeared unchanged from 1965.
1975	The site appeared predominantly unchanged from 1970. However, north of the western and central parts of the site land clearing and the establishment of roads were evident, presumably for residential subdivisions.	The land immediately north of the western and central parts of the site appeared to have been subject to land clearing, with roads and exposed soils evident as part of presumed residential subdivisions. The surrounding land north of the eastern part of the site appeared unchanged from 1970. The surrounding land south and west of the site (full site extents) had now been further developed residentially, with additional dwellings and roads evident. The land immediately east of the site appeared unchanged from 1970. However, the land further east to north-east of the site appeared to have been developed industrially with multiple (varying types) warehouses evident.
1978	The site appeared predominantly unchanged from 1975. However, along the eastern-central part of the site dirt roads were evident, adjoining subdivisions north and south of the site.	The surrounding land north of the western and central parts of the site appeared to have been developed residentially, with multiple dwellings and associated roads evident. The surrounding land west and south of the site now appeared to be densely occupied by residential dwellings. The surrounding land immediately east of the site appeared unchanged from 1975.
1982	The western part of the site appeared to have been subject to some land clearing with some dirt roads evident. Within this part of the site, two asphalt roads were present, associated with the adjoining subdivisions. The central part of the site seemed to be occupied appeared to be occupied by multiple asphalt/gravel roads. Whilst the easternmost part of the site was occupied by grassed land and dirt roads/tracks.	The surrounding land north of the majority of the site extent, now appeared to have been densely occupied by residential dwellings. Former vegetation (dense trees) evident in 1978 had been predominantly cleared as part of this development. The surrounding land north of the easternmost part of the site was covered with grass, multiple dirt roads and tracks and sporadic trees. The surrounding land east, south and west of the site appeared predominantly unchanged from 1978.
1986	The site now appeared to be occupied by an asphalt dual lane road spanning the length of the site, with adjoining cross streets along the road corridor. The road corridor was completed with grass, vegetation and/or dirt. A concrete bridge was evident along the easternmost part of the road (site), above the creek bed.	The surrounding lands north, south, east and west of the site appeared predominantly unchanged in use from 1982. However, at least six commercial-like buildings (presumed shopping centre) and associated open-air carpark was evident immediately south of the sites centre.
1991	The site appeared predominantly unchanged from 1986 However, the road corridor immediately north of the eastern site extent appeared to subject to	The majority of the surrounding lands north, south, east and west of the site appeared predominantly unchanged from 1986. However, the following minor changes in land use were noted from 1986:

Dates	Site Use Observations	Surrounding Land Use Observations
	earthworks, given exposed soils and machinery were evident.	▪ Immediately adjacent the western end of the site and additional road lane had been constructed for the adjacent road that runs perpendicular to the site; ▪ Immediately north of the western end, land had been partially cleared, with three concrete driveways/footpaths and a fence evident; ▪ Immediately south of the centre of the site an additional commercial building was evident immediately east of the buildings evident in 1986; and ▪ North to north-east of the easternmost site extent, the land appeared to have been subject to land clearing with exposed soils and machinery evident.
1994	The site appeared predominantly unchanged from 1991. However, and asphalt and concrete roundabout was now evident at the easternmost extent of the site.	The majority of the surrounding lands north, south, east and west of the site appeared predominantly unchanged in use from 1991. However, the following minor changes in land use were noted from 1991: ▪ Two additional turn lanes were evident at the westernmost end of the site, adjoining the road perpendicular to the site; ▪ The land immediately north of the site had been developed residentially with multiple dwellings evident; ▪ Further north of this part of the site had been developed with two commercial-like buildings and associated asphalt carparks; ▪ Immediately north of the centre of the site a commercial-like building was evident; ▪ Immediately south of the centre of the site, an additional two commercial buildings and asphalt carpark were evident; ▪ Immediately south-east of the easternmost part of the site a golf course was evident; and ▪ Immediately north and east of the easternmost site extent, exposed soils were evident adjacent the road.
1998	The site appeared predominantly unchanged from 1994.	The majority of the surrounding lands north, south, east and west of the site appeared predominantly unchanged in use from 1994. However vacant land immediately south of the majority of the road corridor and immediately north of the eastern part of the road corridor consisted of cleared land and exposed soils. The surrounding land further east to south-east of the site appeared to be occupied by cleared land and construction sites with vacant soils and machinery evident for the land adjacent the existing industrial area.
2000	The site appeared predominantly unchanged from 1998.	The majority of the surrounding lands north, south, east and west of the site appeared predominantly unchanged in use from 1998. Large electrical poles and lines appeared to have been constructed north of the easternmost part of the site.
2004	The site appeared predominantly unchanged from 2000.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2000. Land further north of the westernmost part of the site appeared to have been further developed commercially with a large commercial building evident with an associated asphalt carpark. The land south of the westernmost part of the site appeared to have some crops evident.
2005	The site appeared predominantly unchanged from 2004.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2004.

Dates	Site Use Observations	Surrounding Land Use Observations
2007	The site appeared predominantly unchanged from 2005.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2005. Immediately south of the central part of the site two additional commercial buildings were evident, with an associate concrete hardstand carpark. West of these commercial buildings (centre of the site) and immediately south and adjoining the road (the site), an adjoining street appeared to have been altered and traffic lights had been installed with an intersection evident. The land immediately south of the westernmost part of the site appeared to be and construction site/ yard, with multiple stockpiles of soil, trucks, sheds and machinery evident.
2009	The site appeared predominantly unchanged from 2007.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2007.
2018	The site appeared predominantly unchanged from 2016.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2016. The land immediately south of the westernmost appeared to have demolition waste evident. The structures evident in 2016, were no longer present.
2019	The site appeared predominantly unchanged from 2018.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2018.
2020	The site appeared predominantly unchanged from 2019.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2019. The land immediately south of the westernmost part of the site had been completely cleared with exposed soils evident.
2021	The site appeared predominantly unchanged from 2020.	The surrounding land north, south, east and west of the site appeared predominantly unchanged in use from 2020. The land immediately south of the westernmost part of the site had been covered in grass with small stockpiles of soil evident.

3.2 Lotsearch Review

As part of this Desktop Contamination Assessment a Lotsearch report was obtained by Cardno for the site. The findings from the Lotsearch Enviro Lite report (Ref. LS024880 EP, Section 1 and 2, dated 5 October 2021) have been summarised below in **Table 3-2**, whilst a copy has been supplied in **Appendix G**.

Table 3-2 Summary of Lotsearch Findings

Dataset Searched	Details
Former Gasworks	The site and surrounding land were not identified by the NSW EPA records as a former gasworks.
Waste Management & Liquid Fuel Facilities	The site was not identified on the National Waste Management Site Database. However, five surrounding sites were identified within 1 km of the site, including: ▪ Sims Group Limited, classified as multi-purpose (operational), located at 76 Christie Street, St Mary's, approx. 382 m east of the site; ▪ Hallinan's Recycling Services transfer station (operational), located at 37 Lee Holm Road, St Mary's, located approx. 514 m east of the site; ▪ Brandster Services reprocessing (operational), located at 15 Lee Holm Road, St Mary's, approx. 621 m east of the site; ▪ Toxfree Australia Pty Ltd, classified as multi-purpose (operational), located at 40 Christie Street, St Mary's, approx. 907 m east of the site; and ▪ Worth Recycling Pty Ltd, classified as multi-purpose (operational), located at 42-46 Charles Street, St Mary's, approx. 957 m east of the site.
	The site area encountered two facilities that were identified on the National Liquid Fuel Facilities dataset.

Dataset Searched	Details
	▪ Caltex Petrol Station (operational), located at 49 Dunheved Road, Werrington County, situated adjacent the site; and ▪ 7-Eleven Pty Ltd Petrol Station (operational), located at Lot 122 Dunheved Road, Werrington, situated adjacent the site. One surrounding facility was located within 1 km of the site. The following surrounding facility was noted: ▪ Caltex Petrol Station (operational), located at Lot 6 Star Court, Cambridge Gardens, approx. 144 m, west of the site and hydraulically downgradient.
PFAS Investigation & Management Programs	The site and surrounding land were not identified to be contaminated with PFAS, based on the search of the following datasets: ▪ NSW EPA *PFAS Investigation Program*; ▪ Australian Government *Defence PFAS Investigation Program*; ▪ Australian Government *Defence PFAS Management Program*; and ▪ Airservices Australia National PFAS Management Program.
Defence Sites	The site and surrounding land were not listed as a defence site on the Department of Defence (DoD), *Defence 3 Year Regional Contamination Investigation Program*.
Current EPA Licenced Activities	A total of three Current Licenced Activities under the PoEO Act 1997, were identified within 1 km of the site. The licenced activities included: ▪ Railway systems activities; ▪ Waste storage – waste tyres; ▪ Non-thermal treatment of waste tyres; and ▪ Scrap metal processing.
Delicenced & Former Licenced EPA Activities	One Delicenced Activity still regulated by the EPA was identified approx. 745 m east of the site for the activity of concrete works.
	A total of three Former Licenced Activities under the PoEO Act 1997, now revoked or surrendered were encountered onsite for the licenced activity of Other Activities / Non-scheduled Activity – Application of Herbicides. A total of ten Former Licenced Activities under the PoEO Act 1997, were identified within 1 km of the site. The activity types included: ▪ Crushing, grinding or separating; ▪ Wood or timber milling or processing; ▪ Non-thermal treatment of hazardous and other waste; ▪ Container reconditioning; ▪ Hazardous, Industrial or Group A Waste Generation or Storage; ▪ Non-thermal treatment of waste tyres; and ▪ Concrete works.
Historical Business Directories – Premises or Road Intersections	A total of three premises and road intersections held Business Directory Records were within the confides of the site from 1950 to 1991. A summary of notable business activities are listed below: ▪ Retail shops including chemists – pharmaceutical, grocers, butchers, bakers etc. ▪ Paint Anti Corrosive Manufacturers &/or importers &/or distributors; ▪ Builder Suppliers; ▪ Aluminium &/or Aluminium alloy manufacturers &/or distributors; ▪ Joinery Manufacturers; ▪ Carpenters and Joiners; ▪ Veterinary Surgeons.
Historical Business Directories – Dry Cleaners, Motor Garages & Service Stations 1948 – 1993 – Premise or Road Intersection	A total of one premise was registered on the business directories for either the activity of dry cleaners, motor garages & service stations from 1948 to 1993 within 500 m of the site. The notable business activity was motor Service Station – Petrol, Oil etc.
Hydrogeology	Site aquifers were described as porous and extensive of low to moderate productivity and porous, extensive highly productive aquifers.

Dataset Searched	Details
Groundwater Boreholes	The nearest registered groundwater monitoring bore was located approx. 394 m east of the site. The bore was installed for monitoring purposes and no standing water level (SWL) was recorded.
Naturally Occurring Asbestos Potential	The site and surrounding land was not identified to be situated in an area of naturally occurring asbestos.
Acid Sulfate Soils	Based on review of the Atlas of Australian Acid Sulfate Soils, the site was located in an area of extremely low probability of occurrence, with a 1-5% chance of occurrence in small localised areas.
Dryland Salinity	Based on review of the Dryland Salinity – National Assessment dataset the assessment given for the site was that there is a high hazard or risk defined for 2000, 2020 and 2050.
	Based on review of the Dryland Salinity Potential of Western Sydney, the site lies within and area of moderate to high salinity potential.
Mining & Exploration Titles	The site and surrounding lands are not situated in a mining subsidence district.
	The site and surrounding land are not subject to current mining and exploration titles or applications.
	Historically the site has encountered twelve mining and exploration titles. The titles were for minerals and petroleum, held by multiple owners ranging from 1967 to 2015.
SEPP	The site was not recognised as State Significant Project under the State Environmental Planning Policy (SEPP).
Heritage	One heritage item described as Western Sydney Shale Woodland was listed on the Commonwealth Heritage List, within 1 km of the site.
	One heritage item described as Former ADI Site was listed on the National Heritage Item List, within 1 km of the site.
	The site and surrounding land were not listed as heritage items on the State Heritage Register.
	There were three Environmental Planning Instrument (EPI) – Heritage items located within 1km of the site. The items listed under the Penrith Local Environmental Plan (LEP) 2010 were both of local and state significance including item – general classification types.
Natural Hazards	The easternmost part of the site encounters land that is categorised as Vegetation Category 1 and 2 Land and Vegetation Buffer Land.

3.3 EPA Record Search

3.3.1 Contaminated Land Records of Notices

The Contaminated Land Record of Notices is maintained by the Office of Environment and Heritage (OEH) in accordance with part 5 of the Contaminated Land Management (CLM) Act 1997 and contains regulatory notices issued by the Environment Protection Authority (EPA) in relation to the contaminated sites. The Record of Notices searched on 8 October 2021 for notices and did not identify the site or any surrounding land parcels (within 500 m radius) registered on the list.

3.3.2 PoEO Public Register

The PoEO Public Register under Section 308 of the Protection of the Environment Operations (PoEO) Act 1997 contains Environmental Protection Licences (EPLs), applications and notices issued by the EPA. The Public Register was searched on 8 October for the suburbs of Werrington, Werrington County, Werrington Downs, Cambridge Park and Cambridge Gardens, to identify any issues of relevance to the site. The PoEO public register search confirmed that no licenced activities were identified for the site or any surrounding land parcels within 500 m.

3.3.3 List of NSW Contaminated Sites Notified to the EPA

The list of NSW contaminated sites notified to the EPA are properties that are contaminated to an extent that warranted reporting to the NSW EPA; however, contamination may or may not be significant enough to warrant

regulation by the EPA. The EPA needs to review and, if necessary, obtain more information before can determine the requirement regulation.

A search of the List of NSW Contaminated Sites notified to the EPA was undertaken on 8 October 2021 identified three contaminated land parcels within 500 m radius of the site on the list. A summary of the identified land parcels is presented in **Table 3-3** below.

Table 3-3 Summary of NSW Contaminated Sites List

Organisation	Address	Activity Type	Management Class	Distance	Direction
Caltex Service Station	Corner Dunheved Road & Henry Lawson Drive, Werrington County NSW	Service Station	Regulation under CLM Act not required.	<5 m (adjacent site)	North, hydraulically cross-gradient
7-Eleven Werrington	Lot 122 Dunheved Road, Werrington County NSW	Service Station	Regulation under CLM Act not required.	<5 m (adjacent site)	South, hydraulically up- to cross-gradient
Caltex Cambridge Park	1 Boomerang Place, Cambridge Gardens	Service Station	Regulation under CLM Act not required.	Approx. 190 m	North, hydraulically up- to cross-gradient

3.4 Planning Information

The site currently encompasses four zones under the Penrith Local Environmental Plan (LEP) 2010. The four zones and their objectives under the LEP are outlined below:

The LEP states the following objectives for each zone:

- **SP2 – Infrastructure: Classified Road:**
  - To provide for infrastructure and related uses; and
  - To prevent development that is not compatible with or that may detract from the provision of infrastructure.
- **R2 – Low Density Residential:**
  - To provide for the housing needs of the community within a low-density residential environment;
  - To enable other land uses that provide facilities or services to meet the day to day needs of residents;
  - To promote the desired future character by ensuring that development reflects features or qualities of traditional detached dwelling houses that are surrounded by private gardens;
  - To enhance the essential character and identity of established residential areas; and
  - To ensure a high level of residential amenity is achieved and maintained.
- **RE1 – Public Recreation:**
  - To enable land to be used for public open space or recreational purposes;
  - To provide a range of recreational settings and activities and compatible land uses;
  - To protect and enhance the natural environment for recreational purposes;
  - To ensure that development is secondary and complementary to the use of land as public open space, and enhances public use, and access to, the open space; and
  - To provide land for the development of services and facilities by public authorities for the benefit of the community.
- **E2 – Environmental Conservation:**
  - To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values;
  - To prevent development that could destroy, damage or otherwise have an adverse effect on those values;

- To protect, manage, restore and enhance the ecology, hydrology and scenic values of riparian corridors and waterways, wetlands, groundwater resources, biodiversity corridors, areas of remnant indigenous vegetation and dependent ecosystems; and
- To allow for low impact passive recreational and ancillary land uses that are consistent with the retention of the natural ecological significance.

3.5 Site History Summary

Overall, the site was historically vacant land from at least 1947 to sometime before 1961, assumedly used for agricultural purposes with minor crops evident. From at least 1961 to 1994 the site had been developed in multiple stages as a dirt to asphalt roads with associated infrastructure. From 1982 onwards, the surrounding land appeared to be cleared and developed as residential subdivisions. Finally, from 1996 to present day the site has remained unchanged from its land use as an asphalt road.

4 Conceptual Site Model

Outlined within NEPM (2013) *Schedule B2 – Guideline on Site Characterisation,* a Conceptual Site Model is required to aid the assessment of data collected for the site.

4.1 Controlled Chemicals

The NSW EPA uses chemical control orders (CCO) as a primary legislative tool under the Environmentally Hazardous Chemicals Act 1985 to manage chemicals of concern and limit their potential impact on the environment. Cardno provide a preliminary screening of the site history for the likelihood of chemicals of concern within the CCO framework in **Table 4-1** below.

Table 4-1 Preliminary Controlled Chemicals Screening

Chemical of Concern	Likelihood of Occurrence
Were aluminium smelter wastes used or stored on the site (CCO, 1986)?	Low
Do dioxin contaminated wastes (CCO, 1986) have the potential to impact the site?	Low
Were organotin products (CCO 1989) used or stored on site?	Low
Were polychlorinated biphenyls (PCBs) used or PCB waste (CCO 1997) stored on site?	Low
If Yes to any of the above, has site sampling suite been optimised to include specific sampling for other chemicals of concern in soil, air, water?	N/A

4.2 Per and Poly Fluoroalkyl Substances (PFAS)

The likelihood of PFAS occurring at the site was considered through a desktop survey which is provided in **Table 4-2** and has been undertaken on the basis of information provided in the PFAS National Environmental Management Plan (NEMP 2020). PFAS are known to be present in Aqueous Film Forming Firefighting Foams (AFFF) and Alcohol-Type Concentrate (ATC). The historic use of AFFF is reported as being used by Fire & Rescue NSW between 1976 and 2007, while other agencies used AFFF during training exercises as late as 2010 (Source: Fire & Rescue NSW, Information Sheet, Firefighting Foam and PFAS, reference D16/82523).

Table 4-2 PFAS Desktop Survey

Preliminary Screening	Likelihood of Occurrence
Is the past or present site activity listed in the NEMP 2020 as being an activity with risk of fire. If so, list activity:	Low
Is the past or present off-site activity up-gradient or adjacent to the site listed in the NEMP 2020 as being an activity with risk of fire. If so list activity:	Low
Did fire training involving the use of suppressants occur on-site between 1970 and 2010?	Low
Did fire training occur up-gradient of or adjacent to the site between 1970 and 2010?	Low
Have “fuel” fires ever occurred on site between 1970 and 2010? (i.e. ignition of fuel storage tanks - solvent, petrol diesel, kerosene, other)?	Low
Have PFAS been used in manufacturing or stored on-site?	Low
Could PFAS have been imported to the site in fill materials from a site with activity listed in NEMP 2020 and subject to exposure to PFAS from 1970 to 2010?	Low
Could PFAS-contaminated groundwater or run-off have migrated beneath or on to the site?	Low
Is the site or adjacent sites listed in the NSW EPA PFAS Investigation program [4]?	Low
If the likelihood is medium or high in any of the above factors, does the site analytical suite need to be optimised to include preliminary sampling and testing for PFAS in soil and waters (incl. ASLP or TCLP)? Provide rationale.	N/A

Notes:

1 Likelihood: **Low** – All necessary documentation has been reviewed and there is no recorded instance of potential PFAS use or exposure

2 **Medium** - All necessary documentation has been reviewed and there is potential evidence of a recorded instance of potential PFAS use or exposure

3 **High** - All necessary documentation has been reviewed and there is evidence of a recorded instance of potential PFAS use or exposure

4 https://www.epa.nsw.gov.au/your-environment/contaminated-land/pfas-investigation-program

4.3 Preliminary CSM

A preliminary conceptual site model (CSM) provides an assessment of the fate and transport of contaminants of potential concern within the context of site-specific subsurface conditions with regard to their potential risk to human health and the environment. Risk to human health and the environment is identified through complete Source – Pathway – Receptor (SPR) linkages. In order to identify SPR linkages the CSM considers site specific factors including:

- Source(s) of contamination;
- Identification of contaminants of concern associated with past (and present) source(s);
- Site specific information including soil type(s), depth to groundwater, effective porosity, groundwater flow velocity and surface water bodies and interactions;
- Locations of any identified sources relative to the proposed site development; and
- Actual or potential receptors considering both current and future land use both for the site, adjacent properties and any sensitive ecological receptors.

4.3.1 Identified Contamination Sources

Based on review of the historical site and surrounding land uses (**Section 3.1**), and the site walkover inspection, Cardno have identified the following sources of contamination that may be encountered onsite:

- Imported fill material or road base used beneath the existing road surface and on the road embankments;
- Potential fly tipping long the road corridor;
- Potential use of pesticides and herbicides along the road corridor (including beneath the road surface and adjacent bridges/causeways);
- Potential contamination associated with offsite neighbouring sources, including:
  - Any fuel leakages associated with any underground storage tanks (USTs), fuel pumps, bowsers and breather pipes from the former service stations.
- Potential contamination associated with any former site structures or uses, including:
  - Demolition waste from residential dwellings potentially containing hazardous materials (including lead-based paint, asbestos etc.);
  - Application of herbicides (former EPA licenced activities, previous agricultural land use, beneath former building footprints); and
  - Industrial businesses, including anti-corrosive paint, aluminium and joinery manufacturers and builder suppliers.

Whilst not considered a contaminant source, the potential presence of saline soils at the site is also considered a notable constraint.

4.3.2 Identified Receptors

A high-level summary of potential receptors considered to be susceptible to site contamination include:

- Future site workers;
- Ecological receptors; and
- Neighbouring land users.

The preliminary CSM applicable for the site during this investigation, which is inclusive of a more detailed list of receptors, is summarised in **Table 4-3** and applies to the future land use of commercial and industrial site settings.

Table 4-3 Preliminary Conceptual Site Model

Contaminant Source	Impacted Media	Contaminants of Potential Concern	Potential Exposure Pathways	Receptors
Imported fill material and/or road base	Surficial soils	▪ Asbestos ▪ TRH ▪ BTEX ▪ Metals ▪ PAHs ▪ OCP/OPP	▪ Direct contact ▪ Incidental Inhalation ▪ Incidental Ingestion	**Human** ▪ Future Site Workers during construction ▪ Neighbouring site users ▪ Workers during maintenance activities **Ecological** ▪ Downgradient ecological receptors including waterways and associated flora and fauna
Potential Fly Tipping				
Pesticide and herbicide application (on-site and off-site)		▪ OCP/OPP		
Former site uses (building material manufacturers and suppliers, residential dwellings)	▪ Surficial soils ▪ Soils at depth ▪ Groundwater	▪ Metals ▪ TRHs ▪ PAHs ▪ BTEX ▪ Asbestos		
Offsite contamination sources (service stations)	▪ Soils at depth ▪ Groundwater	▪ VOCs ▪ TRH ▪ Lead ▪ BTEX ▪ PAHs		
Salinity	▪ Natural soils ▪ Groundwater	▪ CEC ▪ EC ▪ ECe	▪ Excavated and exposed soils ▪ Erosion and weathering of soils ▪ Mobilisation of salts in surface run-off ▪ Infiltration of slats into shallow groundwater	**Ecological** ▪ Downgradient ecological receptors including waterways and associated flora and fauna

4.4 Data Gaps

Based on Cardno's assessment of the site historical information, which included a desktop search, site history review, and a site walkover, the following data gaps were identified:

> The environmental quality of the on-site soils either side of the road surface were not investigated and are unknown; and

> The environmental quality of the on-site soils beneath the road surface was not investigated and is unknown;

Based on the preliminary CSM (provided above in **Table 4-3**) and data gaps outlined above, a program of limited soil sampling and analyses was undertaken as detailed below.

Groundwater was not investigated during Cardno's limited investigation. Cardno considers that groundwater investigation was not warranted at the time of the investigation given that the proposed development will be largely surficial (new road) and the vertical extent of earthworks is unlikely to intercept groundwater.

5 Data Quality Objectives

5.1 Data Quality Objective

The NEPC (2013) which is endorsed by the NSW EPA under s105 of the *Contaminated Land Management Act 1997*, requires that Data Quality Objectives (DQOs) are adopted for all assessment and remediation programs. The DQO process as adopted by the NSW EPA is described within the US EPA (2000) *Guidance for the Data Quality Objectives Process and Data Quality Objectives Process for Hazardous Waste Site Investigations.*

The DQOs for the assessment are summarised in **Table 5-1,** below.

Table 5-1 Data Quality Objectives

DQO Step	Discussion
Step 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).	Available information indicates that the site was historically developed as a road corridor from 1961 and remains to present day. The proposed development will involve upgrades to existing road corridors and include additional lanes and widening. This assessment was undertaken to: ▪ Identify historical site uses and potential contaminant sources ▪ Preliminarily determine the extent and composition of contaminated fill and soils (if any); ▪ Preliminarily classify the soils waste classifications; and ▪ Specify what further action is required (if any). A preliminary Conceptual Site Model (CSM) is resented in **Section 4.3**.
Step 2: Identify the decision / goal of the study (Identify the decisions that need to be made on the contamination problem and the new environmental data required to make them).	The decision / goals of the study are: 1. Has the nature, extent and source of any soil contamination onsite been preliminarily defined? 2. What impact do the site specific, geologic and hydrogeological conditions have on the fate and transport of any impacts that may be identified? 3. Does the level of impact coupled with the fate and transport of identified COPCs represent an unacceptable risk to identified human and/or environmental receptors on or offsite? 4. Does the collected data provide sufficient information to allow for appropriate recommendations to be made regarding the proposed land use? 5. Are there CoPC detectable in the soil associated with historic activities at the site? 6. Is there any existing data and is this data valid?
Step 3: Identify the information inputs (Identify the information needed to support any decision and specify which inputs require new environmental measurements).	Inputs to the decision-making process included: ▪ Guidelines made or approved by the NSW EPA under the Contaminated Land Management Act 1997; ▪ Client information provided; ▪ The current land use; ▪ The proposed land use; ▪ Available site historical information; ▪ Assessment of soil analytical results in relation to the adopted human health and ecological criteria; and ▪ Visual observation and documentation (i.e. field notes, photographs) during site works. At the end of the assessment, conclusions will be made based on the preliminary contamination findings from site soils and recommendations should be given regarding future land development.
Step 4: Define the boundaries of the study (Specify the spatial and temporal aspects of the environmental	The boundaries of the study are: Lateral - the intrusive investigation is limited to the lateral extent of proposed development illustrated in **Figure1** of **Appendix A**, and limited to the specific location of sampling points within the site.

DQO Step	Discussion
media that the data must represent to support decision)	Vertical – the maximum anticipated depth of soil sampling will be the target depth of 1.5 mBGL, depending on the subsurface conditions encountered. Temporal - Results are valid on the day of data / sample collection and remain valid as long as no changes occur on site or contamination (if present) does not migrate on site or on to the site from off-site sources.
Step 5: Develop the analytical approach (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).	Parameters of interest include the laboratory results of primary and quality control soil analytical testing. Decision rules for soil and criteria exceedance are outlined as follows: ▪ If the laboratory quality assurance/ quality control data are within the acceptable ranges, the data will be considered suitable for use. ▪ The Practical Quantitation Limit (PQL) for all analyses is at or below the adopted criteria level; ▪ Soil: The laboratory soil test results will be considered to have met the adopted soil criteria when the following occur: ▪ The laboratory reported result is below the investigation human health and ecological criteria for the site; or, ▪ The calculated 95% Upper Confidence Level of the arithmetic mean (95%UCL) contaminant concentration does not exist in soil samples at concentrations in excess of Tier 1 Assessment Criteria; and ▪ The standard deviation of the results is less than 50% of the relevant adopted criteria; and, ▪ No single analytical result for a COPC should exceed 250% of the relevant investigation level or screening level. ▪ The laboratory results and site observations associated with the assessment of asbestos in soil must meet the following criteria: ▪ No asbestos detected in laboratory results.
Step 6: Specify performance or acceptance criteria (Specify the decision-maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data).	Decision errors are incorrect decisions caused by using data that is not representative of site conditions due to sampling or analytical error. The two types of decision errors are: the sampling program does not detect the variability of a contaminant from point to point across the site; and errors made during sample collection, handling, preparation, analysis and data reduction. Decision errors will be minimised by the following: ▪ The field sampling design, frequency, and methodology, sample preservation techniques and laboratory analytical procedures will be conducted in accordance with accepted NSW EPA, NEPM (2013) and NATA accredited methodologies; ▪ A check of the field and laboratory works is to be made against the Data Quality Indicators for precision, accuracy, representativeness, completeness and comparability as outlined in NEPM (2013) Schedule B2, Site Characterisation and included in **Section 5.2** ▪ A decision that soil is acceptable for the site land use is based on calculation of the 95% Upper Confidence Level of the arithmetic mean (95%UCL) and standard deviation for contaminant concentration and comparison with the adopted soil criteria. Therefore, the acceptable limit of a decision error is 5% that a conclusive statement may be a false positive or false negative. ▪ Sampling errors may occur when the sampling program does not adequately detect the variability of a contaminant from point to point across the site or is not representative. Some examples of this scenario include but are not limited to: – Restrictions in borehole depth due to drilling refusal. – Proposed samples are not collected due to access being restricted to a given location. Measurement errors can occur during sample collection, handling, preparation, analysis and data reduction. To address this the following measures are proposed: a. Field staff to follow a standard procedure when undertaking samples, including decontamination of tools, removal of adhered soil to avoid false positives in results, collection of representative samples and use of appropriate sample containers and preservation methods.

DQO Step	Discussion
	b. Laboratories to follow a standard procedure when preparing samples for analysis and undertaking analysis. c. Laboratories to report quality assurance/ quality control data for comparison with the DQIs established for the project.
Step 7: Develop the plan for obtaining data (Identify the most resource-effective sampling and analysis design for general data that are expected to satisfy the DQOs).	The preliminary works were designed to meet the project objectives in **Section 1-3** and the DQOs outlined above. To ensure resource-effective sampling, analysis and data collection that satisfied the DQOs, the following actions are to be taken: ▪ Written instructions will be used to guide field personnel in the required fieldwork activities; ▪ Representative soil samples will be collected from the site and analysed for characterisation purposes; and ▪ Field works and analyses will be undertaken in accordance with Cardno Standard Operating Procedures.

5.2 Data Quality Indicators

To ensure that the investigation results were of an acceptable quality, the data set was assessed against the data quality indicators (DQIs) outlined in **Table 5-2.**

Table 5-2 Data Quality Indicators

QAQC Measure	Field Quality Indicator	Laboratory Quality Indicator
Precision: A quantitative measure of the variability (or reproducibility) of data.	SOPs are appropriate and complied with. Field duplicates and Blind field duplicates are collected and analysed at a rate of 5% (1 per 20 samples). Use of calibrated equipment.	Laboratory analyses of laboratory and inter-laboratory duplicates, field duplicates, laboratory prepared volatile trip spiles. Relative Percent Difference (RPD) calculation results: <30% Relative Percentage Difference (RPD). The RPD values are calculated using the following equation: $RPD = \frac{I C_O - C_R I}{[(C_O + C_R) / 2]} \times 100$ Where, C_O = Analyte concentration of the original sample C_R = Analyte concertation of the duplicate sample
Accuracy: A quantitative measure of the closeness of reported data to the "true" value.	SOPs are appropriate and complied with. Use of calibrated equipment. Field interlaboratory duplicates sampled and analysed at a rate of 1 per 20 samples. <30% Relative Percentage Difference (RPD) Analysis of rinsate sample collected at rate of 1 per day. Trip spike and trip blanks were used.	Laboratory holds NATA-accreditation for the analyses. Laboratory limit of reporting is below the adopted investigation level. Laboratory analysis of: field blanks, rinsate blank, reagent blank, method blank, matrix spike, matrix spike duplicate, surrogate spike, reference material, laboratory control sample, laboratory-prepared spikes. The nominal acceptance limits on laboratory control samples are: Laboratory spikes: 70-130% recovery for metals 60-140% for organics Laboratory duplicates. If contaminant concentration is: < 10 x PQL, no RPD limit 10-20 x PQL, RPD is 0% to 50% >20 x PQL, RPD is 0% to 20% Laboratory surrogates: 60-140% recovery.

QAQC Measure	Field Quality Indicator	Laboratory Quality Indicator
		Laboratory blanks: <PQL Laboratory control samples, 70-130% recovery
Representativeness: The confidence (expressed qualitatively) that data are representative of each media present on site and the conditions encountered in the field	Appropriate media sampled. Preservation and storage of samples upon collection and during transport to the laboratory occurs. Sampling is undertaken by an experienced sampler.	Blank samples run in parallel with field samples to confirm there are no unacceptable instances of laboratory artefacts. Review of RPD values for field and laboratory duplicates to provide an indication that the samples are generally homogeneous, with no unacceptable instances of significant sample matrix heterogeneities The appropriateness of collection methodologies, handling, storage and preservation techniques will be assessed to ensure/confirm there was minimal opportunity for sample interference or degradation (i.e. volatile loss during transport due to incorrect preservation / transport methods). Rinsate samples used when sampling equipment is reused have analytical results <LOR.
Completeness: A measure of the amount of useable data from the data collected during the fieldwork program	All critical locations sampled. All samples collected (from grid and at depth). Standard operating practices (SOPs) appropriate and complied with. Sampling is undertaken by an experienced sampler. Suitable records of field work are documented. Completed laboratory sample chain-of-custody and documentation.	All critical samples are analysed according to the SAQP. All COPC are analysed. Appropriate methods and PQLs are implemented. Sample documentation is complete. Samples are analysed within holding times.
Comparability: The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event	Same SOP is used on each field occasion. Climatic conditions are documented. Experienced sampler Sample type, preservation and handling are consistent at sampling events. Use of calibrated equipment.	Sample analytical methods used (including clean-up) Sample PQLs (justify/quantify if different) Same laboratories are used and justification is given where differences occur. Same analytical methods, Practical Quantification Limits (PQLs), and units of measurement are used.

6 Methodology

6.1 Assessment Criteria

6.1.1 Soil Assessment Criteria

6.1.1.1 Human Health Criteria

The criteria that has been adopted from National and State Guidelines for human health exposure settings for the site has been provided below in **Table 6-1**, along with the rationale behind the application of these criterion.

Table 6-1 Adopted Human Health Criteria

Guidelines	Specific Criteria	Justification
NEPM (2013)	HIL-D	Health Investigation Level (HIL) D thresholds have been adopted to assess the risk to site users for industrial and commercial settings. This land setting is consistent with the proposed future land use as a road corridor.
	HSL-D	Health Screening Level (HSL) D thresholds for soil vapour have been adopted to assess the potential for a vapour intrusion risk present from site soils. These criteria were applicable for commercial and industrial settings, which is consistent with the future use as a road corridor.
	For asbestos	▪ No visible asbestos for surface soils. ▪ HSL-D: 0.05% for bonded ACM. ▪ 0.001% w/w for friable asbestos in soil.

6.1.1.2 Ecological Criteria

Ecological Investigation Levels (EIL) and Ecological Screening Levels (ESL) have been adopted from NEPM (2013) Guidelines to assess the risk to future ecological receptors (i.e. flora and fauna in potential landscaped areas and nearby waterbodies) under a commercial and industrial land use scenario, as well as general leachability to groundwater.

Notes regarding the adopted EIL/ESL Criteria include:

> The application of the commercial and industrial EIL and ESL are considered appropriate to capture risk to unidentified ecological receptors;

> ESLs for coarse grained soil textures were utilised for TRH, BTEX and B(α)P;

> Generic EIL were utilised for arsenic and naphthalene;

> For metals, the EIL was calculated by adding the generic added contaminant limit (ACL) to the ambient background concentration (ABC) for NSW, high traffic, old suburb from Schedule B5c of the NEPM; and

> Considering the assessed soils were generally undisturbed, the 'Aged' EIL screening criteria was still applied for site soils.

A summary of the EIL criteria for applicable contaminants are provided below in **Table 6-2** along with the pH, CEC and clay content that were utilised in deriving EIL.

Table 6-2 EIL Criteria

Analytes		EIL (mg/kg)	Inputs
Metals	Arsenic	160	▪ pH: 6.89 ▪ CEC: 14.13 ▪ Clay content (conservative assumed): 10%
	Copper	320	
	Chromium III	680	
	Lead	1,800	
	Nickel	370	
	Zinc	940	
PAHs	Naphthalene	370	

Analytes		EIL (mg/kg)	Inputs
OCPs	DDT	640	

6.1.2 Other Soil Criteria

6.1.2.1 Waste Classification Criteria

In-situ soils were assessed preliminarily for Waste Classification purposes. The criteria assessed against have been detailed below in **Table 6-3** and included within the summary data tables provided in **Appendix B**.

Table 6-3 Adopted Waste Classification Criteria

Authority	Guidelines	Justification
NSW EPA (2014)	Waste Classification Guidelines	Analytical results were compared to the CT1 and SCC1 criteria present in Table 1 and Table 2 of the Waste Classification Guidelines. Should leachability testing be required the results will be compared to the TCLP1 criteria in Table 2. Based on which the material could be preliminarily classified as either General Solid Waste, Virgin Excavated Natural Material, Restricted or Hazardous Waste.
	RRO: ENM Order	Analytical results were preliminary screened against both the Maximum Average and Absolute Maximum concentrations for pH and EC outlined in Table 4 of the ENM Order. Based on which the material could be preliminarily classified as ENM for offsite reuse or disposal.

Notes:
RRO Resource Recovery Order
ENM Excavated Natural Materials

6.1.2.2 Salinity Criteria

Based on the preliminary review of the DIPNR (2002) *Salinity Potential in Western Sydney Map*, it was determined that natural soils would undergo a preliminary salinity assessment. Soils were assessed for salinity based on the extract electrical conductivity (ECe) value in comparison to the criteria outlined in Table 6.2 of the DWLC (2002) *Site Investigations for Urban Salinity* Guidelines. This assessment would determine if soils are classed from either non-saline to highly saline.

Sodicity will be expressed as an exchangeable sodium percentage (ESP%), calculated in accordance with DWLC (2002) *Site Investigations for Urban Salinity* Guidelines, where the sodicity rating of the soil will be able to be determined. The ESP is calculated by the following equation:

$$ESP = (\text{Exchangeable sodium} / CEC) \times 100\%$$

The soil analytical data compared against the above criteria, is shown in the summary data tables provided in **Appendix B**.

6.2 Site Investigation Program

Fieldwork was undertaken by an experienced environmental scientist from Cardno, with all works completed in accordance with the agreed scope of works outlined in **Section 1.4** The records and observations made during fieldwork are presented in **Table 2-4** and shown in photographs provided in **Appendix C**, with the geological logs presented in **Appendix D**.

The Quality Assurance / Quality Control (QA/QC) program is discussed in **Appendix E** Copies of NATA-accredited laboratory reports and chain of custody documentation is provided in **Appendix F.**

Table 6-4 Investigation Activity Summary

Activity	Details
Dates of Field Activity	Underground service locating, site inspection, drilling and soil sampling were all undertaken on 7 October 2021.Drilling and soil sampling continued on the following dates: ▪ 8 October 2021; ▪ 11 to 13 October 2021; ▪ 21 & 22 October 2021; and

Activity	Details
	▪ 25 October 2021.
Service Location	A Telstra accredited service locater was engaged to locate and mark underground services in the vicinity of each borehole location to avoid damage to subsurface utilities. A geotechnical engineer from Cardno supervised the service locator.
Traffic Control	Safeway Traffic Management Solutions established and maintained safe work zones along the road corridor and managed the traffic at each location.
Drilling	A total of forty-two (42) boreholes were advanced using a ute-mounted drill rig at the approximate locations shown in **Figure 2** of **Appendix A**. Boreholes were drilled to the target depths of 1.5 mBGL. A total of four (4) deeper boreholes were advanced using a track-mounted rig in the vicinity of the bridge to maximum depths of 14.40 mBGL. Borehole logs and photographs of the borehole locations and excavated cuttings are provided in **Appendix D** and **Appendix C.**
Soil Logging	Soils encountered during the investigation were described and logged in accordance with Australian Standard AS 1726:2017 by the geotechnical engineer.
Soil Sampling	Soil samples were placed into laboratory-supplied 250 ml glass jars and zip-lock bags. Samples of' clean material' (with no residual soil) was collected directly off the auger, using a new dedicated, unused pair of nitrile gloves per sample. For the QA/QC samples, the material was carefully mixed and distributed evenly between sampling containers.
Soil Sample Collection	Samples collected during the investigation are summarised below: ▪ A total of sixty (60) primary samples were selected for chemical laboratory analysis; ▪ A total of six (6) samples of bitumen pavement were collected and selected for analysis for coal tar presence / absence, method T542 as specified in RMS Technical Direction 21; ▪ A total of seven (7) soil samples were selected for additional analysis for salinity/sodicity purposes; ▪ A total of sixteen (16) soil samples were collected and analysed for asbestos; ▪ Four (4) soil duplicate samples were collected for QA/QC purposes; and ▪ One rinsate (1) sample was collected for decontamination purposes. All primary and duplicate samples were submitted to Eurofins Environmental Testing, inter-laboratory duplicate samples were submitted to Envirolab Services, both are NATA accredited for the analyses completed. Samples and analytes are summarised in **Appendix F**.
Asbestos Sampling Methodology	Asbestos samples were collected in one zip-lock bag per sample location.
Road Base Sampling Methodology	Samples of bitumen pieces were placed into glass jars for coal tar presence / absence testing in accordance with test method RTA T542.
Decontamination Procedure	▪ Sampling Equipment – nitrile gloves were disposed of and replaced between each sampling location. ▪ Drilling Equipment – the drill rod (solid flight auger) was cleared of residual soil waste between each test location.
Sample Analysis Selection	Generally, soil samples were selected for analysis based on contaminant indicators such as odours, staining or anthropogenic materials mixed through the fill / soil profile. In the absence of contaminant indicators samples were selected to provide site characterisation to a level appropriate to the limitations of the assessment. Samples analysed to assess for salinity were evenly spaced at intervals of approx. 500 m, where possible, along the road corridor (for areas of moderate potential) and targeted to the areas mapped as high salinity potential.
Sample Preservation and Transport	Following collection, soil samples were placed directly in laboratory-supplied glass jars, zip-lock bags, bottles and stored on ice in an esky while on site and in transit to the laboratory under standard Chain of Custody documentation.
Borehole Reinstatement	Boreholes were backfilled with the soil removed during drilling and reinstated and levelled to ground surface.

7 Results

7.1 Soil Observations

Observations from the site walkover and soil sampling are summarised in **Section 2.4**, with photographs shown in **Appendix C** and complete borehole logs are provided in **Appendix D**. Details regarding the typical sub-surface soil profile encountered onsite have been summarised below in **Table 7-1**.

Table 7-1 Typical Soil Profile

Sub-Surface Horizon	Typical Depth Range (mBGL)	Description
Hardstand	0.0 – 0.12	Asphalt
	0.0 – 0.05	Asphaltic Concrete
	0.00 – 0.4	Concrete
Topsoil	0.0 – 0.1	Silty Clay: low to medium plasticity, brown, trace organics.
Fill	0.0 – 3.5	Silty Clay: low to medium plasticity, brown, trace gravel, with coal fines.
	0.1 – 0.2	Sandy Gravel: fine to coarse grained, sub-angular to angular, dark grey, fine to coarse grained sand, dry.
	0.12 – 0.18	Silty Sand: fine to medium grained, brown – yellow, with fine grained angular gravels, moist.
	0.0 – 0.8	Silty Gravel: fine to coarse, angular, orange brown, trace clay, moist.
	0.0 – 0.2	Clayey Silt: low plasticity, brown, trace fined grained gravel, trace fine grained sand, dry to moist.
	0.0 – 0.3	Gravelly Sand: fine to coarse grained, dark brown, fine to coarse gravel, with occasional cobbles, dry to moist.
	0.0 – 0.2	Sandy Clayey Silt: low plasticity, dark brown, fine to medium grained sand, with fine to coarse, sub-angular gravel.
	0.1 – 4.0	Clay: low to medium plasticity, light brown to dark brown / dark grey, with fine to coarse grained gravel, trace silt.
	0.0 – 3.0	Gravelly Clay: low to medium plasticity, light brown, trace silt.
Residual	0.2 – 1.5 +	Silty Clay: medium to high plasticity, pale grey to grey brown, trace ironstone gravel.
	0.4 – 1.1	Clayey Silt: low plasticity, pale brown to yellow brown mottled grey.
Alluvium	3.0 – 7.2	Sandy Clay: low to medium plasticity, yellow brown mottled black, to red orange, fine to medium grained sand, fine to medium grained gravel.
	5.5 – 8.1	Clayey Sand: fine to medium grained sand, yellow brown, with gravel, wet.
	2.9 – 4.8	Clay: medium plasticity, black and mottled brown, trace silt.
	4.8 – 8.0	Gravelly Clay: medium to high plasticity, black mottled orange and brown, trace silt.
	5.0 – 7.2	Silty Gravelly Clay: medium to high plasticity, light brown to brown, fine to coarse grained gravel, with fine to medium grained sand.
	4.2 – 5.0	Sandy Gravel: fine to coarse gravels, orange and brown, fine to medium grained sand, with coal fines, moist.
	7.2 – 8.0	Silty Clay: medium to high plasticity, grey, light brown and orange, with fine to medium grained sand, with fine to coarse grained gravel, trace fine to medium, sub-angular ironstone gravels.
Bedrock	0.4 – 14.40+	Siltstone: grey to dark grey, orange brown, fine to medium grained, interlaminated with sandstone, with occasional carbonaceous laminations, highly weathered.

Note: + borehole termination depth

All examined soils were evaluated on a qualitative basis for odour and visual signs of contamination (e.g. hydrocarbon odours, oil staining, petrochemical filming, asbestos fragments, ash, charcoal etc) and the following observations were noted:

- Loose road base and asphalt materials were encountered within the fill material across most borehole locations;
- No additional anthropogenic inclusions were observed in the fill material;
- PID readings ranged between 0.2 ppm to 9.8 ppm;
- No visible asbestos containing material (ACM) was observed within the material sampled during the investigation;
- No olfactory or visual signs of contamination were observed during drilling; and
- No groundwater, perched water or saturated soil was encountered during drilling.

7.2 Laboratory Analysis

The laboratory analytical results obtained during Cardno's investigation presented in the laboratory summary tables provided in **Appendix B**, alongside the adopted assessment criteria, are summarised below in **Table 7-2**.

Table 7-2 Summary of Soil Analytical Results

Sample Numbers		Analytes	Concentrations (mg/kg)		Exceedances
			Minimum	Maximum	
60	Metals	Arsenic	<2	21	None
60		Cadmium	<0.4	<0.4	None
60		Chromium	<5	69	None
60		Copper	<5	76	None
60		Lead	<5	110	The following samples exceeded the NSW EPA (2014) Waste Classification CT1 Criteria: ▪ PC04_0.15-0.2 (110 mg/kg); and ▪ PC37_0.05-0.1 (110 mg/kg).
60		Mercury	<0.1	<0.1	None
60		Nickel	<5	120	The following samples exceeded the NSW EPA (2014) Waste Classification CT1 Criteria: ▪ PC26_0.2-0.3 (73 mg/kg); and ▪ PC38_0.3-0.4 (120 mg/kg).
60		Zinc	<5	350	None
60	PAHs	Benzo(α)pyrene	<0.5	<10	Samples PC16_0.1-0.2 and PC17_0.1-0.2 had raised PQL's of <2 and <10 mg/kg which exceed the ESL (1.4 mg/kg) and the NSW EPA (2014) Waste Classification CT1 and/or CT2 criteria.
60		Carcinogenic PAHs as B(α)P TEQ	<0.5	<10	None
60		Naphthalene	<0.5	<0.5	None
60		Total PAHs	<0.5	<20	None

Sample Numbers		Analytes	Concentrations (mg/kg)		Exceedances
			Minimum	Maximum	
60	BTEX	Benzene	<0.1	<0.1	None
60		Toluene	<0.1	<0.1	None
60		Ethylbenzene	<0.1	<0.1	None
60		Total Xylenes	<0.3	<0.3	None
60	TRHs	F1	<20	<20	None
60		F2	<50	<500	Samples PC36_0.1-0.2, PC16_0.1-0.2, PC17_0.1-0.2, PC31_0.1-0.2, PC32_0.1-0.2, PC27_0.1-0.2 and PC33_0.0-0.1 had raised PQLs of <250 and <500 mg/kg which exceeded the generic ESL.
60		F3	<100	<1,000	None
60		F4	<100	<1,000	None
60		c6 – c9	<20	<20	None
60		c10 – c36	<50	680	None
17	Pesticides	OCP	<0.05	<0.5	None
17		OPP	<0.2	<5	None
17	-	PCB	<0.1	<1	None
31	-	pH	4.6	9.7	N/A
38	-	EC (uS/cm)	14	770	N/A
7	-	ESP (%)	6.9	46	N/A
16	-	Asbestos (presence / absence)	No	No	None
6	-	Coal Tar	Absent	Absent	N/A

Notes:
N/A Non-applicable

7.2.2 Human Health Criteria

Based on review of Table 7-2 above and **Table 1** provided in **Appendix B,** concentrations for metals, TRH, BTEX, PAHs, OCPs/OPPs and PCBs were below the applicable laboratory LOR or below the adopted NEPM Tier 1 human health screening criteria.

No asbestos was identified within the fill samples subject to laboratory analysis, nor observed during site works.

7.2.3 Ecological Criteria

Based on a review of **Table 7-2** above and **Table 1** provided in **Appendix B** concentrations for metals, BTEX, OCPs/OPPs and PCBs were all either below the applicable laboratory LOR or below the adopted NEPM Tier 1 ecological screening criteria with the following exceptions:

> Sample PC20_0.6-0.7 exceeded the generic ESL (0.7 mg/kg) with a concentration of 0.8 mg/kg.

An additional two samples (PC16_0.1-0.2 and PC17_0.1-0.2) had raised PQLs of <2 and <10mg/kg respectively, which exceeded the adopted ESL criteria. The laboratory raised their PQL during analysis as a results of matrix interference. Based on observations of samples soils it is considered that the matrix interference was due to the presence of asphalt within the sampled soils.

7.2.4 Waste Classification Criteria

Based on review of the analytical results in comparison to the NSW EPA (2014) Waste Classification Guidelines, as outlined above in **Table 7-2**and provided in **Appendix B**. Concentrations for all analytes were below the CT1 criteria (for General Solid Waste), with the following exceptions:

- Samples PC04_0.15-0.2 (110 mg/kg) and PC37_0.05-0.1 (110 mg/kg) exceeded CT1 criteria for lead (100 mg/kg); and
- Samples PC26_0.2-0.3 (73 mg/kg) and PC38_0.3-0.4 (120 mg/kg) exceeded CT1 criteria for nickel (40 mg/kg).

Furthermore, as outlined above in **Table 7-2** and provided in **Appendix B,** no asbestos was identified in the sampled material.

Based on review of the analytical results in comparison to the NSW EPA (2014) ENM Order criteria, as outlined above in **Table 7-2** and provided in **Appendix B**. Concentrations of fill soils were below both the Maximum Average and Absolute Maximum values adopted, with the following exceptions:

- Samples PC04_0.15-0.2 and PC37_0.05-0.1 exceeded the absolute maximum criteria for lead (100 mg/kg) with concentrations of 110 mg/kg;
- Sample PC26_0.2-0.3 and PC38_0.3-0.4 exceeded the absolute maximum criteria for nickel (60 mg/kg) with concentrations of 73 mg/kg and 120 mg/kg respectively;
- Samples PC36_0.1-0.2 and PC37_0.05-0.1 exceeded the absolute maximum criteria for zinc (300 mg/kg) with concentrations of 320 mg/kg and 350 mg/kg respectively;
- Samples PC31_0.1-0.2, PC32_0.1-0.2 and PC16_0.1-0.2 exceeded the absolute maximum criteria for TRH C10 – C36 (500 mg/kg) with concentrations of 510 mg/kg, 540 mg/kg and 680 mg/kg respectively;
- Sample BH03_0.5-0.6 exceeded the maximum average criteria for arsenic (20 mg/kg) with a concentration of 21 mg/kg, however was below the absolute maximum concentration; and
- Samples PC13_0.5-0.6 and PC38_0.3-0.4 exceeded the maximum average criteria range for pH (5 to 9) with pH values of 4.5 and 9.7 respectively, however the pH values were within the absolute maximum pH range (4.5 to 10).

Residual soil samples were below the maximum average value and the absolute maximum values for all analytes, with the exception of pH for maximum average value. However, as shown in **Table 1** in **Appendix B**, the average for pH (6.49) was within the maximum average value range for pH.

7.2.5 Other Criteria & Analysis

7.2.5.1 Coal Tar

Based on the laboratory results provided in **Appendix B**, the six samples (PC12_0.1-0.2, PC22_0.1-0.2, PC41_0.1-0.2, PC04_RB1(0.0), PC13_0.2-0.3 and PC24_0.1-0.2) analysed for coal tar (presence / absence) in accordance with RTA T542 test method were found to be absent of coal tar.

7.2.5.2 Salinity

Based on the ECe calculations derived from the reported EC values from the laboratory (presented in **Table 2** in **Appendix B**), the residual soils analysed were considered to be non-saline to slightly saline in comparison with the criteria outlined in the DWLC (2002) *Site Investigations for Urban Salinity* Guidelines.

7.2.5.3 Sodicity

Based on the exchangeable sodium percentage (ESP) calculated by the laboratory for selected residual soils (presented in **Table 2** in **Appendix B**), indicated that soils ranged between sodic to highly sodic in lower lying areas, in comparison with the criteria outlined in the DWLC (2002) *Site Investigations for Urban Salinity* Guidelines.

7.3 Data Quality Assessment

An assessment of the data quality was undertaken in accordance with the Data Quality Indicators for field work and laboratory. Details of this assessment are provided in **Appendix E**.

8 Site Characterisation

8.1 Soil

Soils encountered along the assessed areas of the road corridors generally consisted of silty gravelly clay fill, overlying residual clays, alluvial sandy clay and siltstone bedrock.

The following key observations were noted during the assessment:

- The fill profile encountered across the site ranged from 0.1 m to 4.0 m thick, with the average depth of fill is approximately 0.95 m;
- No major anthropogenic inclusions were identified within the fill material; and
- Groundwater, perched water or saturated soils was not observed during drilling.

Concentrations of metals, TRH, BTEX, PAHs, OCP/OPPs and PCBs in the collected samples of both fill and natural soils were all either below the applicable laboratory LOR or below the adopted NEPM 2013 Tier 1 human health screening criteria.

Concentrations for metals, PAHs, BTEX, OCPs/OPPs and PCBs were all either below the applicable laboratory LOR or below the adopted NEPM Tier 1 ecological screening criteria.

However, two samples (PC16_0.1-0.2 and PC17_0.1-0.2) had raised PQLs of <2 and <10mg/kg for B(α)P respectively, which exceeded the adopted ESL criteria (1.4 mg/kg). The laboratory raised their PQL during analysis as a results of matrix interference. Based on observations of samples soils it is considered that the matrix interference was due to the presence of asphalt within the sampled soils.

The localised exceedances were considered to be low risk in regards to the proposed project, and the soils would be suitable to remain onsite either beneath structures or the road surface (i.e. hardstand), limiting their access to ecological receptors. If the soils are proposed to remain onsite outside of the hardstand land uses, then additional testing should be undertaken to determine re-use suitability.

No asbestos was identified within the fill samples subject to laboratory analysis, nor observed during site works.

Additionally, the asphaltic road base was identified to not contain coal tar.

8.1.1 Salinity

Based on a preliminary review of the DIPNR (2002) *Salinity Potential in Western Sydney Map*, the site was identified to intersect areas of moderate to high salinity potential. Furthermore, some vegetation indicators (see **Table 2-4**) for salinity were identified near the creek bed along the easternmost part of the site, Cardno considered it necessary to preliminarily assess residual soils for potential salinity.

Cardno selected specific evenly spaced ~500m intervals (where possible) and (targeted high salinity potential) residual soil samples from along the road corridors to be tested for electrical conductivity. Based on the laboratory analysis and the calculated electrical conductivity extract (ECe's) the residual soils were identified to be non-saline to slightly saline in comparison with the criteria outlined in the DWLC (2002) *Site Investigations for Urban Salinity* Guidelines (see **Table 2**, **Appendix B**). Slightly saline soils were identified at boreholes PC04, PC05, PC09, PC13, PC17 and PC39 largely located in the western-central part of the site from depths ranging between 0.8 to 1.5 mBGL overlying shale bedrock. However, given only shallow samples (0.2 – 0.6 mBGL) from the boreholes within the vicinity of South/Werrington Creek, should further works be undertaken here, then deep alluvial soils should be assessed for salinity potential.

Based on this, no further measures would need to be considered during future works to mitigate salinity risk, however, we note that the salinity assessment was preliminary in nature and relate specifically to the locations sampled.

Soils were also assessed for exchangeable sodium in accordance with DWLC (2002) *Site Investigations for Urban Salinity* Guidelines. Based on the exchangeable sodium percentage (ESP %) (see Table 2, **Appendix B**), residual soils were identified to range from sodic to highly sodic. Highly sodic soils were identified within the vicinity of boreholes PC04, PC05, PC07, PC08, PC09, PC13, PC17, PC32, PC38, PC39 and PC42 from depths ranging between 0.8 to 1.5 mBGL. These boreholes were located across the majority of Dunheved Road and overlying shale bedrock.

Sodic soils are very hard when dry and water infiltrates through them very slowly. Exposed sodic soils are subject to severe erosion, whilst waterlogged sodic soils (clay) can be subject to extreme swelling. In order to mitigate the risks of sodic soils it is important if they are sub-surface, that disturbance is minimised and the

overlying soil is retained. Should sodic soils be exposed then they may require treatment by adding either gypsum or lime (Ref. DLWC, 2002).

Given that the highly sodic soils were identified at depth (>0.8 m), it is unlikely that they will impact the proposed development, provided they remain undisturbed and at depth. Should sodic soils be exposed then treatment may need to be undertaken prior to the installation of any overlying infrastructure, and the project designed considerate of associated risks.

8.1.2 Preliminary Waste Classification

Based on the preliminary assessment of fill soils against the NSW EPA (2014) Waste Classification Criteria and RRO: ENM Order (see **Table 1** in **Appendix B**), the fill soils were preliminarily classified as Restricted Solid Waste (RSW). The fill material could potentially be classified as General Solid Waste (GSW) (non-putrescible) subject to further laboratory analysis including an assessment of contaminant leachability (i.e. TCLP testing).

The physical and chemical attributes of residual and alluvial soils indicate that the material may be suitable for classification as either Virgin Excavated Natural Material (VENM) or can be classified as Excavated Natural Material (ENM), subject to further assessment that satisfies applicable guidelines. Cardno's preliminary classification was based on the average of the laboratory analytical results compared against the Absolute Maximum Criteria presented in the ENM Order (**Table 1**, in **Appendix B**).

Cardno note, that this preliminary classification does not act as a standalone waste classification certificate and does not enable off-site disposal or re-use of soil within the site. The data obtained during this assessment may be considered during future classification.

Should site soils be subject to offsite disposal during future development, then further sampling and testing of the soils would be required prior to offsite disposal in accordance with the NSW EPA (2014) Waste Classification Guidelines. Furthermore, waste classification certificates will need to be prepared accordingly for the material to be disposed of offsite, which clearly state the classification type of the waste. All waste needs to be disposed of at appropriately licenced facilities, with all disposal and waste tracking documentation retained.

8.2 Conceptual Site Model Review

Based on the assessment findings, it was considered that the CSM outlined in Section was suitable for the assessment as it appropriately identified the SPR linkages.

8.3 Data Gaps and Uncertainties

Based on the findings of Cardno's investigation, the following data gap exists:

- The presence and nature of potential contamination has not been assessed anywhere within the site outside of the borehole locations from which soil samples were collected and submitted for laboratory analysis;
- The presence and nature of potential contamination beneath road surfaces, within embankments and beneath other road related infrastructure (such as bridges and drains) has not been assessed;
- This assessment was completed in consideration of the project design current at the time of the intrusive sampling program; and
- Groundwater was not assessed for potential contamination. The proposed development activities are unlikely to interact with groundwater so assessment was not considered necessary.

9 Conclusions and Recommendations

Cardno has completed a Desktop Contamination Assessment with Limited Sampling along Dunheved Road within the LGA of Penrith City Council ("the site") for the proposed Dunheved Road upgrade works.

Based on the findings of this limited assessment, the following conclusions are made:

- The site can be defined as the road corridors along Dunheved Road. At the time of the assessment the site surfaces were covered with asphaltic and concrete hardstand, gravels, grass and exposed soils;
- Historically the site has been vacant land from at least 1947 to sometime before 1961, assumedly used for agricultural purposes with minor crops evident. From at least 1961 to 1994 the site had been developed in multiple stages as a dirt to asphalt roads with associated infrastructure. From 1982 onwards, the surrounding land appeared to be cleared and developed as residential subdivisions. Finally, from 1996 to present day the site has remained unchanged from its land use as an asphalt road; The site was not subject to regulation by the NSW EPA and was found to be free of statutory notices and licencing agreements under both the CLM Act 1997 and PoEO Act 1997. The site was also not included on the List of NSW Contaminated Sites;
- Surrounding land use has historically ranged in use from vacant land, agricultural, residential and commercial purposes (i.e. service stations, retail shops etc.). Two active service stations are located immediately adjacent the site (<10 m);
  - Despite the high risk of contamination to be present associated with the adjacent service stations, the risk to the project is considered to be low, due to the proposed shallow earthworks. Should the project design be modified to include deeper excavations, the adjoining land users may need to be reconsidered more extensively as a construction constraint and contaminant risk.;
- Soils encountered along the assessed areas of the road corridors generally consisted of silty gravelly clay fill, overlying residual clays, alluvial sandy clay and siltstone bedrock;
- All concentrations of metals, TRH, BTEX, PAHs, OCP/OPPs and PCBs in the collected samples of both fill and natural soils were all either below the applicable laboratory LOR or below the adopted NEPM 2013 Tier 1 human health screening criteria. From a human health perspective, the soils assessed at these discrete locations were considered suitable to remain onsite under the proposed land use;
- All concentrations of metals, TRH, BTEX, PAHs, OCP/OPPs and PCBs in the collected samples were below the adopted ecological criteria, with the exceptions of samples PC16_0.1-0.2 and PC17_0.1-0.2 which exceeded the ESL criteria for B(α)P. Based on the limited data gathered during this assessment, the material within these discrete locations may not be suitable to remain onsite unless placed under a structure or roadway (hardstand) and isolated from potential interaction with ecological receptors. If the material cannot be placed under a structure or roadway further assessment may be necessary to determine the suitability for onsite re-use or to classify for off-site disposal purposes (should that be required);
- No asbestos was observed during sampling nor identified within the laboratory analytical reports;
- Coal tar was not identified to be present within the sampled asphalt;
- Laboratory analysis indicated that the deeper (>0.8 m) residual soils along the assessment area were found to be non-saline to slightly saline within the western and central parts of the site, and sodic to highly sodic in nature;
- Fill soils encountered were preliminarily classified as Restricted Solid Waste (RSW), however, could potentially be reclassified to General Solid Waste (GSW) subject to additional laboratory testing such as leachibility (TCLP); and
- Residual and alluvial soils may be suitable for classification as either Excavated Natural Material (ENM) or Virgin Excavated Natural Material (VENM), however, this would need to be confirmed through further assessment that satisfies applicable NSW EPA guidelines.

These preliminary waste classifications do not constitute a waste classification certificate that enables removal of material from the site.

9.1 Recommendations

Based on the findings of this assessment and with reference to the purpose and objectives of this investigation, the following recommendations are made:

- The shallow fill material within the vicinity of PC16 and PC17 is suitable to remain onsite if situated beneath road infrastructure of structures during redevelopment. Should the material remain onsite within the vicinity of landscaping or an area of ecological significance / value, then additional testing will be required to confirm re-use suitability or if offsite disposal is required;
- Highly sodic soils were identified at depth (>0.8 m) and based on an assumption of shallow earthworks during construction it is unlikely that they will impact the proposed development, provided they remain undisturbed and at depth. Should sodic soils be exposed by the redevelopment then treatment may be required prior to the installation of any overlying infrastructure, and the project designed considerate of associated risks.
- Construction Environmental Management Plan:
  - A Construction Environmental Management Plan (CEMP) should be prepared prior to undertaking any future works. This CEMP will include details regarding waste classification, stockpile and waste and management procedures for any soils being excavated and requiring offsite disposal. The CEMP will be prepared in accordance with appropriate guidelines and regulatory authorities;
    - During construction all material proposed for removal from site will require sampling and analysis for Waste Classification purposes, which must be outlined in the CEMP. Waste classification sampling and certificates will be completed in accordance with the NSW EPA (2014) Waste Classification Guidelines;
- Unexpected Finds Protocol:
  - Preparation of an unexpected finds protocol (UFP) which outlines the procedures to be followed should contamination be identified during future works. The limited soil sampling and analysis completed as part of this assessment indicate a generally low contaminant risk at the location from which samples were collected. Despite this, large portions of the site remain unassessed and require implementation of a UFP.

10 Limitations

This assessment has been undertaken in general accordance with the current "industry standards" for a Contamination Assessment for the purpose and objectives and scope identified in this report. These standards are set out in:

- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) *1999* (NEPC, 1999) as varied May 2013 (the 'NEPM 2013').
- AS4482.1- 2005: Guide to the sampling and investigation of potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds. Standards Australia (2005).

The agreed scope of this assessment has been limited for the current purposes of the Client. The assessment may not identify contamination occurring in all areas of the site, or occurring after sampling was conducted. Subsurface conditions may vary considerably away from the sample locations where information has been obtained.

This Document has been provided by Cardno subject to the following limitations:

- This Document has been prepared for the particular purpose outlined in Cardno's proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.
- The scope and the period of Cardno's services are as described in Cardno's proposal, and are subject to restrictions and limitations. Cardno did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Cardno in regards to it.
- Conditions may exist which were undetectable given the limited nature of the enquiry Cardno was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.
- In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Cardno's opinions are based upon information that existed at the time of the production of the Document. It is understood that the services provided allowed Cardno to form no more than an opinion of the actual conditions of the site at the time this Document was prepared and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.
- Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.
- Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Cardno for incomplete or inaccurate data supplied by others.
- Cardno may have retained sub consultants affiliated with Cardno to provide services for the benefit of Cardno. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any direct legal recourse to, and waives any claim, demand, or cause of action against, Cardno's affiliated companies, and their employees, officers and directors.

This assessment report is not any of the following:

- A Preliminary Site Investigation (PSI) or Detailed Site Investigation (DSI) as stipulated in the NSW EPA *Consultants reporting on contaminated land* (2020)
- A Site Audit Report or Site Audit Statement as defined under the *Contaminated Land Management Act, 1997*.

- A Detailed ESA or Environmental Site Investigation sufficient for an Environmental Auditor to be able to conclude a Site Audit Report and Site Audit Statement.
- A geotechnical report and the bore logs or test pit logs may not be sufficient as the basis for geotechnical advice.
- A detailed hydrogeological assessment in conformance with NSW DEC (2007) Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination.
- An assessment of groundwater contaminants potentially arising from other sites or sources nearby.

A total assessment of the site to determine suitability of the entire parcel of land at the site for one or more beneficial uses of land.

11 References

Australian Standard 4482.1-2005: Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil.

DIPNR (2002) *Salinity Potential in Western Sydney 2002*, Department of Infrastructure, Planning and Natural Resources, Sydney, 2002.

DLWC (2002) *Guidelines to Accompany Map of Salinity Potential in Western Sydney*, Department of Land and Water Conservation, Sydney, 1 August 2002.

DLWC (2002) *Site Investigations for Urban Salinity*. Department of Land and Water Conservation, Sydney, 2002.

DNR (2006) *Introduction to Urban Salinity*. Department of Natural Resources, Sydney, 2006.

Guideline on the Investigation Levels for Soil and Groundwater' of the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) *1999* (NEPC, 1999) as varied May 2013 (the 'NEPM 2013'); Standards Australia (2005).

NSW DPIE (2021) *eSPADE v2.1,* NSW Department of Planning Industry and Environments (DPIE), Retrieved from: https://www.environment.nsw.gov.au/eSpade2Webapp.

NSW EPA (2014) *Waste Classification Guidelines, Part 1: Classifying Waste*. NSW, Environment Protection Agency, Sydney. November 2014.

NSW EPA (2014) *Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014, The Excavated Natural Material Order 2014*. NSW Environment Protection Authority, Sydney. November 2014.

NSW EPA (2015) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*. NSW Environment Protection Authority, Sydney. September 2015.

NSW EPA (2017) *Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme (3rd edition).* NSW Environment Protection Authority, Sydney. October 2017.

NSW EPA (2020) *Consultants Reporting on Contaminated Land*, Contaminated Land Guidelines, NSW Environment Protection Authority, Sydney, April 2020.

NSW Government (2021) *MinView*, Mining, Exploration and Geoscience, NSW Government, Regional NSW, Retrieved from: https://minview.geoscience.nsw.gov.au/#/?lon=148.9143&lat=-32.65607&z=6&bm=bm1&l=.

Office of Environment and Heritage (OEH) (2017) *Acid Sulfate Soils*. NSW Government, November 2017.

Spatial Services (2020) *Historical Imagery Viewer,* NSW Government Spatial Services, Retrieved from: https://portal.spatial.nsw.gov.au/portal/apps/webappviewer/index.html?id=f7c215b873864d44bccddda8075238cb.