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Integrated Practical Solutions

Report on Detailed Site Investigation for Contamination

Project Roger
Part Rural Block 2249, Jerrabomberra

Prepared for
Jacobs Group (Australia) Pty Ltd

Project 103028.01
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Table of Contents

Page

Douglas Partners
Geotechnics / Environment / Groundwater

Report on Detailed Site Investigation for Contamination
Project Roger
Part Rural Block 2249, Jerrabomberra

1. Introduction

This report presents the results of a Detailed Site Investigation (DSI) for Contamination undertaken for Project Roger Part Rural Block 2249, Jerrabomberra. The investigation was commissioned with a purchase order dated 29 July dated 24 July 2019 by [redacted] of Jacobs Group (Australia) Pty Ltd and was undertaken in accordance with Douglas Partners Pty Ltd (DP's) proposal CAN200144 dated 2 June 2020.

It is understood that this DSI has been requested to provide information to assist the project civil/structural designers.

The objectives of the investigation included:

- Researching the historical use of the site and reporting on any matters that could prevent the site from being developed with reference to soil and/or groundwater contamination;
- Undertaking soil sampling across the site and interpretation of soil sample laboratory analysis results with reference to published site assessment criteria; and
- Advising on the potential for contamination and the need, or otherwise, for on-going site investigations and management.

The works were carried out with reference to the policies and guidelines endorsed by the ACT Environment Protection Authority (EPA) including the following guidance documents:

- National Environment Protection Council (NEPC), National Environment Protection (Assessment of Site Contamination) Measure, 1999 as amended 2013;
- NSW Environmental Protection Authority (EPA) (2020) Consultants Reporting on Contaminated Land: Contaminated Land Guidelines;
- ACT EPA Information Sheet 7: - Guidance for Undertaking Preliminary Contamination Investigations for Development/Lease Variation Purposes, November 2018;
- ACT EPA, Information Sheet 4: Requirements for the Reuse and Disposal of Contaminated Soil in the ACT, January 2019; and
- ACT's Environmental Standards, Assessment & Classification of Liquid & Non-liquid Wastes, June 2000.

This report must be read in conjunction with the notes entitled *'About This Report'* in Appendix A and other explanatory notes, and the report should be kept in its entirety without separation of individual pages or sections.

2. Scope of Works

The following scope of works was undertaken to meet the project objectives:

- A desktop study of available topographical, geological and hydrogeological maps and plans;
- A review of registered groundwater bores located within a 1 km radius of the site obtained through the ACT Groundwater Abstraction Bore Register;
- Review of site history information incorporating;
    - ACT Government records through the ACT Environment Protection Authority's Contaminated Land Register;
    - Historical title deed information obtained through the Land Titles Office;
    - Historical aerial photography archived with the ACT Planning and Land Authority; and
- Site inspection by an environmental scientist;
- Formulation of a preliminary conceptual site model (CSM) based on the site history review and inspection;
- Subsurface investigation with sampling and laboratory testing for the contaminants of concern as outlined Sections 11 and 12;
- Revision of the CSM based on the results of the subsurface investigation and laboratory testing; and
- Preparation of this report presenting the findings of the DSI, identification of potential sources of contamination, and an assessment of the need for further investigations and/or management.

3. Site Identification and Description

3.1 Site Identification

The site identification information is summarised in Table 1.

Table 1: Site Identification Details

Item	Details
Site Owner	Australian Defence Force
Site Address	McLachlan Street, Jerrabomberra
Current Land Use	Defence Base
Block and Section Number (see Drawing 1, Appendix B)	Part Block 2249, Jerrabomberra
Territory Plan Zoning	NUZ1: Broadacre
District	Jerrabomberra
Approximate Site Area	9,000 m^2
Proposed future land-use	Continued use as part of HMAS Harman

Item		Details
Surrounding Land Use	**North:**	Undeveloped open land within HMAS Harman
	South:	Undeveloped open land within HMAS Harman
	East:	Naval communications infrastructure
	West:	Undeveloped open land with an unnamed waterway beyond.

3.2 Site Layout and Description

The proposed development site comprises a rectangular shaped area of approximately 9,000 m^2 with maximum dimensions of 125 m and 75 m. It is bordered to the north, south and west by undeveloped land. Native Temperate Grassland is located directly to the west and south of the site. To the east, the site is bordered by vacant land, part of McLachlan Street and naval communications infrastructure.

At the time of the investigation, the site was grass and weed covered with some mature trees scattered throughout the site. A large number of mature trees are located along the north, south and west boundaries of the site. McLachlan Street terminates within the eastern portion of the site and driveways from previous structures were noted off McLachlan Street. A footpath is located around the perimeter of McLachlan Street and the surface levels across the site fall gradually to the west from approximately 586 m to 581 m Australian Height Datum (AHD).

4. Regional Soils, Geology and Hydrogeology

4.1 Regional Soils

Reference to the 1:100 000 'Canberra Soil Landscape' Series Sheet 8727 indicated that the site is mapped as being on the Williamsdale Soil Group.

The Williamsdale Soil Group is characterised by undulating rises, alluvial fans and valley flats on Silurian Volcanics of the Canberra Formation. Generally, little or no rock outcrops occur within this soil group. Soils are moderately deep, well drained podzolic soils, red and brown earths on upper rises and fan elements and moderately to very deep, poorly to imperfectly drained, solodic soils on lower rises and fan elements. This soil group is limited by its erodible and dispersible nature, its acidity, potential for seasonal water-logging and localised flooding hazard.

4.2 Geology

Reference to the Canberra 1:100 000 Geological Series Sheet (Ref 2) indicates that the site is underlain by Mount Ainslie Volcanics.

This unit typically comprises dacitic ignimbrite, minor ashstone, agglomerate and shale.

4.3 Hydrology

The nearest surface water feature to the site is an un-named drainage channel located approximately 150 m west of the site. In addition, Molonglo River is located approximately 750 m to the north of the site. These water features are located topographically down-gradient of the site and are therefore considered to be receptors.

4.4 Hydrogeology

The 1:100,000 map 'Hydrogeology of the Australian Capital Territory and Environs' indicates that the site is underlain by geological units of late middle Silurian aged. These typically include: andesitic, dacitic, rhyodactic ignimbrite, minor ashstone, shale, sandstone, limestone and disseminated sulphides. The unit is typically fractured, higher yielding zones are associated with the upper and lower portions of the individual ash-flow tuffs and interbedded sediments. Groundwater quality tends to be poor. The likely yield of the groundwater aquifer is indicated to be less than 0.5 – 1.0 L/s with total dissolved solids (TDS) between 500 – 1000 mg/L.

4.4.1 Groundwater Bore Search

A search of the groundwater bore register database was conducted through ACTmapi.act.gov.au. The database indicated that there was one registered groundwater bore within a 1 kilometre radial search area of the site. Bore 188, was located 760 m north-west of the site and is 90 m in depth with groundwater measured at 15.7 m below ground level (bgl). An investigation groundwater monitoring bore was also observed on site, the bore was 10 m in depth with no observed groundwater

5. Site History

The following sections describe the methodology and outcomes of the site history review. Records obtained during the site history search are presented in Appendix C.

5.1 Regulatory Notices Search

A search was conducted through the ACT Environment Protection Authority (EPA) for regulatory notices that exist for Block 2249 Jerrabomberra. The following details were provided:

The block is recorded on the EPA's contaminated sites database. Block 2249 once formed part of former Block 2062. Block 2062 was formerly occupied by the Bonshaw Naval Receiving Station. The Bonshaw site was assessed, remediated and independently audited between 2009 and 2011, the Bonshaw site is located approximately 2.2 km to the south-west of the site currently under investigation.

The EPA states that they are aware that hazardous materials in the form of fuel stored in twelve underground fuel storage tanks are or were located at the site. A Development Application (DA) for the removal of 12 underground fuel storage tanks was submitted to the EPA for review in February 1999.

The EPA opposed the DA due to insufficient information to assess the application and is currently unaware of the status of the facilities at the site.

The ACT EPA Contaminated Sites Environment Protection Policy 2017 lists petroleum storage as an activity associated with land contamination which may pose a risk to human health and the environment.

Under the precautionary principle, all blocks which contain or have contained fuel storage facilities are identified and persons making enquiries are made aware of potential for impacts due to the ability of hydrocarbons and other contaminants to migrate through the environment.

Other potentially contaminating activities may have also been undertaken at the site associated with past or current permitted uses. For further information on potential contamination of this block, further enquiries could be made directly by the client with the Department of Defence.

5.2 ACT WorkSafe Records Searches

A search of ACT WorkSafe's records of the Dangerous Goods Act, 1975 database and the current Dangerous Substances Act, 2004, register was requested. However, a signature from an appropriate land owner/custodian of HMAS Harman was never received in order to access information from the database at the time of writing the report.

5.3 Historical Title Searches

A Land Title Search was conducted through the ACT Land Information System (ACTLIS) on 31 July 2020 and indicated that there are no records for Block 2249, Jerrabomberra.

5.4 Historical Aerial Photography

Nine historical aerial photographs available from the ACT Planning and Land Authority were reviewed (refer to Aerial Photograph Plates D1 – D9 presented in Appendix D).

The images were examined for signs of potential areas of environmental concern such as planting patterns, previous structures which may have subsequently been removed, existing structures, stripped soil or areas of fill or disturbance or other signs of potentially contaminating activities. Findings of the review are summarised in Table 2.

Table 2: Summary of Historical Aerial Photography Review

Aerial Photograph	On-site Conditions	Surrounding Area
1952 Photograph	The site was developed as a residential dwelling area along McLachlan Street for HMAS Harman. The site appeared to be comprised of numerous houses, driveways and	The surrounding area was undeveloped open land to the west and south of the site. Residential dwellings and roads were present to the north and east of the site. An unnamed waterway was located approximately 175 m to the west of the site.

Aerial Photograph	On-site Conditions	Surrounding Area
	footpaths. Some small grass covered areas appear to be present.	A compound of buildings (assumed to be the Bonshaw site) was located approximately 2.2 km to the south-west.
1961 Photograph	Largely unchanged from the previous aerial photograph.	Trees had been planted to the west of the site and a building had been constructed immediately to the south-east of the site
1973 Photograph	Largely unchanged from the previous aerial photograph.	A number of buildings had been constructed to the east of the site. Approximately 80 m to the south-east of the site, a building had been demolished and redeveloped.
1981 Photograph	Largely unchanged from the previous aerial photograph.	Largely unchanged from the previous aerial photograph.
1993 Photograph	Largely unchanged from the previous aerial photograph.	Largely unchanged from the previous aerial photograph.
1997 Photograph	All dwellings located within the site had been demolished and disturbed ground appears to be present where the dwellings once stood. McLachlan Street, footpaths and driveways appear to still be present. Trees and grass covered areas appear to be undisturbed.	Residential Dwellings located to the east and north east of the site had been demolished and disturbed ground appears to be present where the dwellings once stood.
2004 Photograph	Largely unchanged from the previous aerial photograph.	Largely unchanged from the previous aerial photograph. A car park was constructed to the east of the site.
2012 Photograph	Largely unchanged from the previous aerial photograph. A gravel driveway was placed within the south-east corner of the site.	Largely unchanged from the previous aerial photograph. A gravel road was constructed west of the site and the buildings associated with the Bonshaw site had been demolished.
2019 Photograph	Largely unchanged from the previous aerial photograph.	A small communications building had been constructed immediately east of the site. A small building compound and gravelled area with shipping containers placed within it had been constructed to the north-east of the site.

6. Proposed Development

At the time of writing this report, plans for the proposed development at the site were unavailable. 13

7. Site Walkover

A site walkover was undertaken on 3 August 2020 by an environmental scientist. The walkover was undertaken to check and identify (where possible) the likely presence, or otherwise, of potential sources of contamination with reference to the site history review, and to identify and comment on additional potential sources of contamination which were encountered or observed. Drawing 1, Appendix B, and Photographs 1 to 10, Appendix E shows the layout of the site.

The following features were identified during the site inspection:

- The site was vacant land that slopes from east to west towards an un-named waterway, approximately 175 m west, from the site. Most of the site consisted of grass and weed cover with sporadic mature tree coverage. Paved areas including McLachlan Street, a footpath and driveways were located within the eastern portion of the site. No buildings were observed on the site;
- Across the areas where previous dwellings were located, some bricks, concrete and discontinued service pipes were observed across the ground surface. The bricks and concrete were most likely part of the footings for the previous dwellings and the service pipes were most likely associated with the previous dwellings as well;
- Two shallow drainage lines were located within the site. Two lines are located within the north-western and south-western corners of the site. The two drainage lines run in a south-east to north-west and north-east to south-west orientation, respectively;
- Services including stormwater, sewer, water, gas and communications were noted across the site;
- A groundwater monitoring well was identified in the central portion of the site. The well was measured to 10.65 m depth and was dry. The PID instrument was used to measure any potential volatiles at the head of the well and the PID results indicated that volatiles were less than 1 ppm.
- Trees and Native Temperate Grassland lined the northern, southern and western boundaries of the site;
- Navy communications infrastructure was noted along the eastern boundary;
- No areas of staining or odours were observed; and
- Two fragments of potential asbestos containing material (PACM) were observed within the northern portion of the site (see Drawing 1, Appendix B for the approximate locations).

8. Potential for Contamination

The site history review indicated that the site was used for residential dwellings from at least 1952 to at least 1993. Sometime between 1993 and 1997 the dwellings were demolished, and the site appeared to remain unchanged from 1997 to 2019 with the exception of some minor gravel roads appearing in the 2012 Aerial Photograph. Numerous buildings and other infrastructure associated with HMAS Harman were developed around the site between 1961 to 2019. The site walkover indicated that potential asbestos containing material was present across the site, two fragments of PACM were observed on the ground surface.

The block is recorded on the EPA's contaminated sites database. Block 2249 once formed part of former Block 2062. Block 2062 was formerly occupied by the Bonshaw Naval Receiving Station. The Bonshaw site was assessed, remediated and independently audited between 2009 and 2011, the Bonshaw site is located approximately 2.2 km to the south-west of the site currently under investigation. Given the distance from the site of investigation, DP considers that the identified contamination from the Bonshaw site was unlikely to be impacting the site under investigation.

The EPA states that they are aware that hazardous materials in the form of fuel stored in twelve underground fuel storage tanks that are or were located at HMAS Harman. No further details were provided by the EPA on the exact location of the storage tanks and a response from ACT WorkSafe in relation to the storage of hazardous materials was not received at the time of writing this report.

Legacy firefighting foams containing Per-and poly-fluoroalkyl substances (PFAS) including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) as active ingredients were once used extensively within Australia, including at Defence bases (HMAS Harman), due to their effectiveness in fighting liquid fuel fires.

Based on observations made during the site history review, site inspection and off-site inspection, the main sources of potential contamination are considered to be as follows:

- PAEC 1: impacts from fill of unknown origin associated with the previous residential dwellings and surrounding infrastructure. Potential contaminants associated with fill from unknown and contaminated sources include: metals: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), zinc (Zn); total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene, xylene (BTEX); polycyclic aromatic hydrocarbons (PAH); organochloride pesticides (OCP); phenols and asbestos;
- PAEC2: Spills and leaks associated with the use and storage of petroleum hydrocarbons at the site which may have flowed onto or beneath the site in the soil, surface water or groundwater. Contaminants of potential concern are considered to be total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene, xylene (BTEX); polycyclic aromatic hydrocarbons (PAH) and metals: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), zinc (Zn);
- PAEC 3: Residual hazardous building material (HBM) associated with the previous residential dwellings on-site (dwellings established at least prior to 1952). Contaminants of potential concern are considered to be asbestos, lead, synthetic mineral fibres (SMF) and PCBs; and
- PAEC 4: PFAS associated with the use of Defence legacy firefighting foams. PFAS is also known to occur in some paints, pesticides, carpets, clothes and paper. Contaminants of potential concern are considered to be PFOS, PFOA and PFHxS (an impurity in the manufacturing process of PFAS legacy firefighting foam).

9. Preliminary Conceptual Site Model

A conceptual site model (CSM) is a representation of site-related information regarding potential contamination sources, receptors and exposure pathways between those sources and receptors. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future, i.e. it enables an assessment of the potential source – pathway – receptor linkages (complete pathways).

9.1 Potential Contamination Sources

S1 – Filling
S2 – Potential impacts from the use and storage of petroleum hydrocarbons
S3 – Residual hazardous Building Material
S4 – Potential impacts from Defence legacy firefighting foams

9.2 Potential Receptors

9.2.1 Human Health Receptors

Potential human health receptors include the following:

R1 – Current Users (HMAS Harman, naval personal and associated workers on the naval base)
R2 – Future Users (HMAS Harman, naval personal and associated workers on the naval base)
R3 – Construction and maintenance workers

9.2.2 Environmental Receptors

Potential Environmental Receptors include the following:

R4 – Groundwater
R5 – Surface water (on-site drainage lines and unnamed waterway 175 m west of the site)
R6 – Ecology

9.3 Potential Pathways

Potential pathways for contamination present include the following:

P1 – Incidental ingestion and dermal contact of soil and dust particulates
P2 – Outdoor inhalation of dust particulates
P3 – Indoor/Outdoor inhalation of vapours
P4 – Surface water run-off
P5 – Leaching of contaminants and vertical migration into groundwater
P6 – Lateral migration of groundwater providing base-flow to watercourses
P7 – Direct contact with ecology

9.4 Summary of Potential Complete Pathways

A Conceptual Site Model (CSM) has been prepared for the site with reference to the National Environment Protection (Assessment of Site Contamination) Measure Schedule B2. The CSM identifies potential contaminant sources and contaminants of concern, contaminant release mechanisms, exposure pathways and potential receptors. The CSM is presented in Table 3.

Table 3: Summary of Potentially Complete Pathways

Source	Receptor	Transport Pathway	Comments
S1 – Fill	R1	P1, P2 and P3	Fill was identified at the site, surface fill was observed during the site inspection. The source and quality of the fill is unknown. Given the presence of fill, an intrusive investigation is required to assess possible site contamination, including chemical testing of the soils. If soil contamination is identified, assessment of groundwater and identified surface water receptors may be necessary.
	R2	P1, P2 and P3	
	R3	P1, P2 and P3	
	R4	P5 and P6	
	R5	P4 and P6	
	R6	P7	
S2 – Past and present hydrocarbon storage	R1	P1 and P2	The letter from the ACT EPA mentioned that they are aware that hazardous materials in the form of fuel stored in twelve underground fuel storage tanks that are or were located at HMAS Harman. An intrusive investigation is required to assess possible site contamination, including chemical testing of the soils.
	R2	P1 and P2	
	R3	P1 and P2	
	R4	P5 and P6	
	R5	P4 and P6	
	R6	P7	
S3 – Residual Hazardous Building Material	R1	P3	The site dwellings (that were established at least before 1952) were demolished sometime between 1993 and 1997. The results of hazardous material assessment and any clearance certificates issues post demolition have not been made available to DP. PACM was noted during the site walkover, imbedded in the surface fill. An intrusive investigation is required to establish the extent of hazardous building materials in fill materials present at the site.
	R2	P3	
	R3	P3	
S4 – Historical use of PFAS	R1	P1 and P2	HMAS Harman is a defence base. Defence bases in Australia have been linked to the use of PFAS in legacy firefighting foams. Some other PFAS sources include paints, pesticides, carpets, clothes and paper An intrusive investigation is required to assess possible site contamination, including chemical testing of the soils.
	R2	P1 and P2	
	R3	P1 and P2	
	R4	P5 and P6	
	R5	P4 and P6	
	R6	P7	

The fieldwork undertaken to investigate the potential pathways of contamination are described in the following sections.

10. Fieldwork, Analysis and QA/QC

10.1 Sample Rationale

The site area is understood to be approximately 9,000 m^2 and for the purpose of this detailed assessment, it was considered that 19 locations would be appropriate to give an indication of the contamination status of the site. Nineteen borehole locations were selected for systematic grid sampling. Samples were selected for analysis in order to gain a general representation of the soil/fill conditions across the site.

10.2 Methods and Sampling Locations

The fieldwork comprised the drilling of 19 boreholes (Bores 1 to 19) to a maximum depth of 6.65 m below ground level (bgl) using a truck mounted auger/ rotary soil sampling and rock coring drilling rig. Samples were collected directly from the auger blades at regular intervals during the drilling process. All test locations were selected for the collection of soil samples.

Fieldwork was undertaken on 4 – 12 August 2020 by a suitably qualified environmental scientist who undertook the following:

- Marking out the test locations;
- Logging of the subsurface profile; and
- Collection of samples to assist in strata identification and for laboratory testing purposes.

A calibrated photo-ionisation detector (PID) was used during the fieldwork to screen the collected soil samples to assess whether volatile organic compounds were present. The approximate test locations are shown on Drawing 1 in Appendix B. Sampling depths are shown on the borehole logs in Appendix F.

10.3 Soil Sampling Procedure

All sample locations were checked for underground services by a review of dial before you dig (DBYD) plans and by a services locator.

All sampling data was recorded on DP borehole logs with essential information included on the chain-of-custody sheets. The general sampling procedure adopted for the collection of environmental samples is summarised below:

- The use of disposable gloves for each sampling event;
- Transfer of samples into laboratory-prepared glass jars, and capping immediately;
- Transfer of PFAS samples into laboratory-prepared plastic jars, capping immediately, and double bagging;

- Collection of replicate soil samples in zip-lock plastic bags at each depth for PID screening;
- Collection of replicate samples for QA/QC purposes;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth;
- Placement of the sample jars and replicate sample bags into a cooled (with ice), insulated and sealed container for transport to the laboratory; and
- Use of chain of custody (COC) documentation so that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory.

Samples for environmental purposes were generally collected from the near surface, and at regular depth intervals or changes in strata within each borehole.

Soil samples were collected from the auger blades or directly from the exposed soil within the borehole at the shallow sampling depth intervals.

10.4 Analytical Rationale

The analytical scheme was designed to obtain an indication of the presence of a broad range of contaminants of potential concern (COPC) that may be attributable to past and present activities and features that may reasonably be expected to have occurred within the site as identified in the CSM (see Section 10).

Selected primary soil samples were analysed for the various COPC namely metals (As, Cd, Cr, Cu, Pb, Hg, Mn, Ni, Zn), TRH, BTEX, PAH, PCB, OCP, OPP, asbestos and PFAS.

Laboratory analytical methods are as stated in the certificate of analysis in Appendix G.

10.5 Quality Assurance and Quality Control (QA/QC)

The field QA/QC procedures for sampling as prescribed in Douglas Partners' *Field Procedures Manual* were followed during the assessment. The QA/QC procedures and results are summarised in Appendix H.

Envirolab Services Pty Ltd (Envirolab) (NATA accreditation number: 2901) was used for the analysis of soil samples. The laboratory is required to carry out routine in-house QC procedures. Envirolab is NATA accredited and is required to conduct in-house QA/QC procedures. These are normally incorporated into every analytical run and include reagent blanks, spike recovery, surrogate recovery and duplicate samples.

Inter-laboratory replicates were also analysed at the secondary laboratory ALS Laboratory Services Pty Ltd (ALS) as an internal check of the reproducibility within the primary laboratory Envirolab as a measure of consistency of sampling techniques.

These results are included in the laboratory certificates and are evaluated in the QA/QC procedures and results summary in Appendix H.

11. Site Assessment Criteria

The site is proposed to continue to be used as part of HMAS Harman navy base. Given the continued use of the site as a naval base, the site has been assessed against the industrial/commercial land use setting.

The Site Assessment Criteria (SAC) applied in the current investigation are informed by the CSM (refer to Section 10*)* which identified human and environmental receptors to potential contamination on the site. Analytical results were assessed (as a Tier 1 assessment) against the SAC comprising the investigation and screening levels of Schedule B1, *National Environment Protection (Assessment of Site Contamination) Measure* 1999, as amended 2013 (NEPC, 2013). The NEPC guidelines are endorsed by the ACT EPA under the *Environment Protection Act* 1997. Petroleum based health screening levels for direct contact and vapour inhalation from the *Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report no.10 Health screening levels for petroleum hydrocarbons in soil and groundwater* (2011) as referenced by NEPC (2013) have not been considered in this assessment as these values are significantly higher than the soil vapour HSL adopted.

The investigation and screening levels are applicable to generic land use settings and include consideration of, where relevant, the soil type and the depth of contamination. The investigation and screening levels are not intended to be used as clean up levels. Rather, they establish concentrations above which further appropriate investigation (e.g. Tier 2 assessment) should be undertaken. They are intentionally conservative and are based on a reasonable worst-case scenario.

11.1 Health Investigation and Screening Levels

The Health Investigation Levels (HIL) and Health Screening Levels (HSL) are scientifically-based, generic assessment criteria designed to be used in the first stage (Tier 1) of an assessment of potential human health risk from chronic exposure to contaminants.

HILs are applicable to assessing health risk arising via all relevant pathways of exposure for a range of metals and organic substances. The HIL are generic to all soil types and apply generally to a depth of 1 m below the surface for industrial/commercial land use. A depth of 1 m below the surface has been adopted for this investigation for industrial/commercial land use.

HSLs are applicable to selected petroleum compounds and fractions to assess the risk to human health via inhalation. HSL have been developed for different land uses, soil types and depths to contamination.

The generic HIL and HSL are considered to be appropriate for the assessment of contamination at the site. Given the proposed land use the adopted HIL and HSL are:

- HIL-D/HSL-D – industrial/commercial.

In addition, the HSL adopted are predicated on the inputs summarised in Table 4.

Table 4: Inputs to the Derivation of HSLs

Variable	Input	Rationale
Potential exposure pathway	Soil vapour intrusion (inhalation)	Potential exposure pathways include vapour intrusion through concrete slabs from potentially contaminated fill beneath the slab. There is also the risk of soil vapours during any excavation of potentially contaminated fill.
Soil Type	Clay	A mixture of gravel, silt, clay and rhyodacite bedrock was encountered during the intrusive investigation. Silt has been adopted as an initial conservative screen.
Depth to contamination	0 m to <1 m	A conservative approach has been adopted for this DSI. A depth of 1 m bgl has been adopted in the areas where filling was encountered.

The adopted soil HIL and HSL for the potential contaminants of concern are presented in Table 5.

Table 5: Health Investigation and Screening Levels (HIL and HSL) in mg/kg unless otherwise indicated

Contaminants		HIL-D	HSL-D
			0 m to <1m
Metals	Arsenic	3,000	NC[3]
	Cadmium	900	NC
	Chromium (VI)	3,600	NC
	Copper	240,000	NC
	Lead	1,500	NC
	Mercury (inorganic)	730	NC
	Nickel	6,000	NC
	Zinc	400,000	NC
PAH	Benzo(a)pyrene TEQ[1]	40	NC
	Naphthalene	NC	NL
	Total PAH	4,000	NC
TRH	C6 – C10 (less BTEX) [F1]	NC	310
	>C10-C16 (less Naphthalene) [F2]	NC	NL
	>C16-C34 [F3]	NC	NL
	>C34-C40 [F4]	NC	NL
BTEX	Benzene	NC	4
	Toluene	NC	NL
	Ethylbenzene	NC	NL
	Xylenes	NC	NL
Phenol	Phenol	100	NC
OCP	Aldrin + Dieldrin	45	NC

Contaminants		HIL-D	HSL-D 0 m to <1m
	Chlordane	530	NC
	DDT+DDE+DDD	3,600	NC
	Endosulfan	2,000	NC
	Endrin	100	NC
	Heptachlor	50	NC
	HCB	80	NC
	Methoxychlor	2,500	NC
OPP	Chlorpyrifos	2,000	NC
PCB [2]		7	NC

Notes:

1 sum of carcinogenic PAH

2 non dioxin-like PCBs only.

3 NC: No Criteria

4 NL: Not-limiting – Derived soil HSL exceeds the theoretical soil saturation concentration. A soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable risk for the given scenario.

11.2 Ecological Investigation Levels

Ecological Investigation Levels (EIL) have been derived for selected metals and organic compounds and are applicable for assessing risk to terrestrial ecosystems (NEPC, 2013). EIL depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 1 m of soil, which corresponds to the root zone and habitation zone of many species. The EIL is determined for a contaminant based on the sum of the ambient background concentration (ABC) and an added contaminant limit (ACL). The ABC of a contaminant is the soil concentration in a specific locality that is the sum of naturally occurring background levels and the contaminants levels that have been introduced from diffuse or non-point sources (e.g. motor vehicle emissions). The ACL is the added concentration (above the ABC) of a contaminant above which further appropriate investigation and evaluation of the impact on ecological values is required.

The EIL is calculated using the following formula:

EIL = ABC + ACL,

The ABC is determined through direct measurement at an appropriate reference site or through the use of methods defined by Olszowy et al *Trace element concentrations in soils from rural and urban areas of Australia*, Contaminated Sites monograph no. 4, South Australian Health Commission, Adelaide, Australia 1995 (Olszowy, 1995) or Hamon et al, *Geochemical indices allow estimation of heavy metal background concentrations in soils*, Global Biogeochemical Cycles, vol. 18, GB1014, (Hamon, 2004). ACL is based on the soil characteristics of pH, CEC and clay content.

EIL (and ACLs where appropriate) have been derived in NEPC (2013) for only a short list of contaminants comprising As, Cu, Cr (III), DDT, naphthalene, Ni, Pb and Zn. An *Interactive (Excel) Calculation Spreadsheet* may be used for calculating site-specific EIL for these contaminants, and has been provided in the ASC NEPM Toolbox available on the SCEW (Standing Council on Environment and Water) website (http://www.scew.gov.au/node/941).

The adopted EIL, derived from the *Interactive (Excel) Calculation Spreadsheet* are shown in the following Table 6. The following site specific data and assumptions have been used to determine the EILs:

- A protection level of 60% for industrial/commercial land uses has been adopted;
- The EILs will apply to the top 1 m of the soil profile;
- Given the likely source of soil contaminants (i.e. potential filling and potential historical pesticide use) the contamination is considered as "aged" (>2 years);
- ABCs have been derived using the *Interactive (Excel) Calculation Spreadsheet* using input parameters of NSW for the State in which the site is closest to, and high for traffic volumes. No background concentration is assumed for lead (conservative);
- Based on average pH, CEC and clay content values for soils collected across the site, the following values have been used for the soil profile: pH = 6.5, CEC = 20 cmol$_c$/kg and clay content = 62%. The Calculation Spreadsheets are included in Appendix I and the EILs are presented in Table 6 below.

Table 6: Ecological Investigation Levels (EIL) in mg/kg

Analyte		EIL	Comments
Metals	**Arsenic**	160	Adopted pH of 6.5, CEC of 20 cmol$_c$/kg and clay content 62%
	Copper	320	
	Nickel	460	
	Chromium III	1200	
	Lead	1,800	
	Zinc	1000	
PAH	**Naphthalene**	370	
OCP	**DDT**	640	

11.3 Ecological Screening Levels – Petroleum Hydrocarbons

Ecological Screening Levels (ESL) are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. ESL apply to the top 1 m of the soil profile as for EIL.

ESL have been derived in NEPC (2013) for petroleum fractions F1 to F4 as well as BTEX and Benzo(a)pyrene. Site specific data and assumptions as summarised in Table 7 have been used to determine the ESL. The adopted ESL, from Table 1B(6), Schedule B1 of NEPC (2013) are shown in Table 8.

Table 7: Inputs to the derivation of ESL

Variable	Input	Rationale
Depth of ESL application	Top 1 m of the soil profile	The top 1 m depth below ground level corresponds to the root zone and habitation zone of many species.
Land use	Industrial/Commercial	It has been assumed for this site contamination assessment that the activities on site will be industrial/commercial land uses, i.e. continued defence base facility use.
Soil Texture	Fine	The approach adopted for this investigation is based on the silty clay soils encountered during the investigation

Table 8: Ecological Screening Levels (ESL) in mg/kg

Analyte		ESL	Comments
TRH	**C6 – C10 (less BTEX) [F1]**	215*	*All ESLs are low reliability apart from those marked with * which are moderate reliability
	>C10-C16 (less Naphthalene) [F2]	170*	
	>C16-C34 [F3]	2500	
	>C34-C40 [F4]	6600	
BTEX	**Benzene**	95	
	Toluene	135	
	Ethylbenzene	185	
	Xylenes	95	
PAH	**Benzo(a)pyrene**	0.7	

11.4 Management Limits – Petroleum Hydrocarbons

In addition to appropriate consideration and application of the HSL and ESL, there are additional considerations which reflect the nature and properties of petroleum hydrocarbons, including:

- Formation of observable light non-aqueous phase liquids (LNAPL);
- Fire and explosion hazards; and
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services.

Management Limits to avoid or minimise these potential effects have been adopted in NEPC (2013) as interim Tier 1 guidance. Management Limits have been derived in NEPC (2013) for the same four petroleum fractions as the HSL (F1 to F4). The adopted Management Limits, from Table 1B(7), Schedule B1 of NEPC (2013) are shown in the following Table 9. The following site specific data and assumptions have been used to determine the Management Limits:

- The Management Limits will apply to any depth within the soil profile;
- The Management Limits for industrial/commercial land use apply;

- A mixture of sand, silt and clay was encountered during the PSI. Clay (fine) has been adopted as an initial conservative screen.

Table 9: Management Limits in mg/kg

Analyte		Management Limit
TRH	**C_6 – C_{10} (F1) #**	800
	>C_{10}-C_{16} (F2) #	1,000
	>C_{16}-C_{34} (F3)	3,500
	>C_{34}-C_{40} (F4)	10,000

\# Separate management limits for BTEX and naphthalene are not available hence these have not been subtracted from the relevant fractions to obtain F1 and F2

11.5 Asbestos in Soil

Bonded asbestos-containing material (ACM) is the most common form of asbestos contamination across Australia, generally arising from:

- Inadequate removal and disposal practices during demolition of buildings containing asbestos products;
- Widespread dumping of asbestos products and asbestos containing filling on vacant land and development sites; and
- Commonly occurring in historical filling containing unsorted demolition materials.

Mining, manufacturing or distribution of asbestos products may result in sites being contaminated by friable asbestos including free fibres. Severe weathering or damage to bonded ACM may also result in the formation of friable asbestos comprising fibrous asbestos (FA) and/or asbestos fines (AF).

Asbestos only poses a risk to human health when asbestos fibres are made airborne and inhaled. If asbestos is bound in a matrix such as cement or resin, it is not readily made airborne except through substantial physical damage. Bonded ACM in sound condition represents a low human health risk, whilst both FA and AF materials have the potential to generate, or be associated with, free asbestos fibres. Consequently, FA and AF must be carefully managed to prevent the release of asbestos fibres into the air.

A detailed asbestos assessment was not undertaken as part of these works as asbestos was not identified as a contaminant of concern at the time of writing the proposal. Therefore, the presence or absence of asbestos at a limit of reporting of 0.1 g/kg has been adopted for this assessment as an initial screen.

11.6 PFAS Site Assessment Criteria

The laboratory analytical results for soil PFAS have been assessed against the PFAS NEMP of HEPA (2020) in Table 2 of HEPA (2020). The guideline values represent a nationally-agreed suite that should be used to inform site investigations.

The screening values are intentionally conservative and an exceedance of these criteria may not constitute a risk if other exposure pathways are controlled. An exceedance of the screening values should trigger further investigations, such as a site-specific risk assessment. At the time of this investigation, screening values were available only for PFOS, PFHxS and PFOA.

The PFAS criteria values for the most conservative land use scenario were adopted as follows:

- Human Health Investigation Levels for Soil (HIL) -D – Industrial/Commercial.
- Interim Ecological Screening Values – All land uses

The guideline values adopted are shown in Table 10 below.

Table 10: PFAS Assessment Criteria for Soil Samples

Analyte		Assessment Criteria (µg/kg)		
		HIL-D – Industrial/Commercial [1]	IESV Ecological direct exposure – All land uses[4]	IESV Ecological indirect exposure – All land uses[4]
PFAS	PFOA	50000	10000	NC
	Sum of PFHxS and PFOS[2]	20000	1000[3]	10[3]

[1] HEPA (2020) Table 2, Soil Human Health Screening Values (HHSV) for industrial/commercial land use

[2] Where the guideline values refer to the sum of PFOS and PFHxS, this includes PFOS only, PFHxS only, and the sum of the two.

[3]PFOS only

[4] HEPA (2020) Table 3 Interim soil ecological screening values (IESV) direct and indirect exposure for all land uses

12. Results of the Investigation

12.1 Subsurface Conditions

The borehole logs are provided in Appendix F together with notes that define classification methods and descriptive terms. The boreholes encountered variable subsurface conditions underlying the site with the principal succession of strata broadly summarised below:

- PAVEMENT: 20 mm thick spray seal overlying 180 mm of gravelly sand in Bore 14.
- TOPSOIL/TOPSOIL FILL: moist to dry silty clay with rootlets and various anthropogenic materials to depths of 0.1 – 0.3 m.
- GRAVELLY/SILTY CLAY FILL: very stiff, moist to dry, medium plasticity gravelly clay fill in Bores 4, 8, 9 and 13 to depths of 0.15 – 0.6 m.

- SILTY CLAY/CLAY: variably stiff to hard, moist to dry, low to high plasticity clay and silty clay to depths of 0.6 – 1.6m. It is noted that the majority of the basal depths of this strata were logged as extremely weathered dacite.
- DACITE ROCK: initially very low to low strength, highly weathered, highly fractured dacite below depths of 0.9 – 2.0 m, becoming variably low to high strength with depth to the limit of investigation depths of 3.0 – 6.65 m.

No groundwater was encountered during the investigation. However, the boreholes were backfilled immediately following excavation precluding longer term monitoring of groundwater levels. Groundwater conditions rarely remain constant and can change seasonally due to variations in rainfall, temperature and soil permeability. For these reasons, it is noted that the moisture condition of the site soils may vary considerably from the time of the investigation compared to at the time of construction.

12.2 Field Screening and Contamination Observations

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination within the soils investigated noted. Results of the PID screening were below 5 ppm indicating the presence of VOCs to be very low to unlikely.

There were no obvious indications of asbestos containing material within the exposed soil at each borehole location. However, during the site walkover two fragments of PACM were observed along the ground surface of the site. These fragments were tested for asbestos identification.

Inert anthropogenic material/items were observed within the boreholes that encountered fill. These materials/items included concrete and brick fragments, food packaging waste, plastic, terracotta pipe fragments and glass.

12.3 Analytical Results

A summary of the results of the laboratory analysis undertaken on the soil samples is presented in Tables J1, J2, J3 and J4 in Appendix J along with the laboratory certificate.

12.4 Discussion of Laboratory Results

Analytical results of soil samples were all within the adopted health-based (i.e. HIL-D / HSL-D) and ecological (i.e. EIL / ESL/ IESV) criteria, and management limits for industrial/commercial land use.

All soil results for BTEX, OCP, OPP, PCB and phenols were below the laboratory's practical quantitation limit (PQL) except for the following:

- TRH F2 (52 mg/kg) in Bore 1/0.1 m which was recorded above the PQL but below the ESL criteria (170 mg/kg);

- TRH F3 (190 mg/kg) in Bore 1/0.1 m which was recorded above the PQL but below the ESL criteria (2500 mg/kg); and
- Benzo(a)pyrene (BaP) in Bore 14/0.1 m (3.9 mg/kg) was recorded above the ESL criteria (1.4 mg/kg). Bore 14/0.1 m was sampled within the asphalt/road base of McLachlan Street and the asphalt pieces in the sample are likely to be the reason for the BaP levels exceeding the ESL criteria.

All soil results for metals were above the PQL with the exception of arsenic in Bores 2, 3, 4, 6, 9, 10 and 19 and cadmium and mercury in all boreholes, but below the adopted screening criteria.

M1 and M2 (PACM fragments observed on site) were tested positive for containing asbestos.

Soil results for PFOA, PFHxS and PFOS were below PQL in Bores 6, 8, 10, 14 and 17. Bores 1, 3, 7, 12, and 19 were above PQL, but below the adopted screening criteria.

13. Revised Conceptual Site Model

The preliminary CSM in Section 10 has been updated to incorporate the findings of this DSI. The updated CSM is presented in Table 11.

Table 101: Revised Summary of Potentially Complete Pathways

Source	Receptor	Transport Pathway	Comments
S1 – Fill	R1	P1, P2 and P3	Fill was encountered in all boreholes excavated at the site to a maximum depth of 1.3 m bgl. Reported concentrations of CoPC in samples collected from the fill were below the adopted SAC. In addition, reported concentrations of CoPC in natural soils were also below the adopted SAC. It is considered that the potential for chemical contamination associated with fill at the site is low, however, a construction environmental management plan (CEMP) is recommended to be prepared for construction activities so that potential unexpected finds of contamination can be managed, should they be encountered.
	R2	P1, P2 and P3	
	R3	P1, P2 and P3	
	R4	P5 and P6	
	R5	P4 and P6	
	R6	P7	
S2 – Past and present hydrocarbon storage	R1	P1 and P2	The letter from the ACT EPA mentioned that they are aware that hazardous materials in the form of fuel stored in twelve underground fuel storage tanks are or were located at HMAS Harman. The results of the investigation indicated that reported concentrations of hydrocarbons were below the
	R2	P1 and P2	

Source	Receptor	Transport Pathway	Comments
	R3	P1 and P2	laboratory PQL. In addition, the results of field screening for volatile organic compounds with a PID did not report any elevated readings. The ACT WorkSafe search was not conducted due to not having the authorisation for an information search from the land custodian/owner and therefore DP were unable to accurately locate the former tanks on site. It is considered that the risk of significant accumulation of contamination associated with the former use and storage of petroleum hydrocarbons is low. However, it is recommended that a CEMP be prepared and implemented during construction so that potential unexpected finds of contamination can be managed should they be encountered.
	R4	P5 and P6	
	R5	P4 and P6	
	R6	P7	
S3 – Residual Hazardous Building Material	R1	P3	The PACM fragments were analysed for asbestos. Lab results indicated that the material was asbestos. Small amounts of asbestos were also detected in soil samples. A CEMP should include an asbestos finds protocol. Asbestos affected fill should be stockpiled separately for waste classification. A licensed asbestos removalist and a licensed asbestos assessor should inspect the excavation of the fill and provide a clearance certificate following the removal of the impacted fill.
	R2	P3	
	R3	P3	
S4 – Historical use of PFAS	R1	P1 and P2	HMAS Harman is a defence base. Defence bases in Australia have been linked to the use of PFAS in legacy firefighting foams. Some other PFAS sources include paints, pesticides, carpets, clothes and paper The results of the investigation indicated that reported concentrations of PFAS were below the site assessment criteria. A formal waste classification and leachate testing is recommended for fill material that requires off-site disposal
	R2	P1 and P2	
	R3	P1 and P2	
	R4	P5 and P6	
	R5	P4 and P6	
	R6	P7	

14. Conclusions and Recommendations

Areas that may be impacted by potential contamination were identified on the basis of the available desktop site information, previous environmental works and a site inspection. Based on the findings of the assessment, the potential for gross chemical contamination to be present within the site is considered to be low to moderate.

Results of the laboratory analysis for TRH, BTEX, PAH, OCP, OPP, PCB, phenols, PFAS and metals were reported that concentrations of COPC were below the applicable site assessment criteria.

Fill material was identified at the site, associated with the previous residential dwellings. Asbestos was detected within samples Bore 15/0.1 m and Bore 2/0.1 m but detected below the PQL and therefore below the site assessment criteria, however ACM fragments were observed on the surface of the fill across the site. BaP was detected above the ESL criteria in Bore 14/0.1 m but it is considered that the exceedance was due to the quantity of asphalt in the sample and likelihood of BaP being a potential for gross chemical contamination to be present within the site is considered to be low.

Due to the identified presence of ACM on the surface of the fill, the fill would need to be excavated and removed under the supervision of a licensed asbestos removalist and a licensed asbestos assessor should inspect the base and walls of the excavation to provide a clearance certificate following the removal of the impacted fill. A suitably qualified environmental consultant should also inspect the base and walls of the excavation to confirm that the extent of the fill has been removed from site

Given the results of the current assessment, it is considered that the site can be made suitable (from a site contamination perspective) for the proposed development subject to:

- The formulation and implementation of site specific asbestos management/remediation plan to advice on the management and removal of asbestos impacted fill;
- The removal of asbestos impacted fill under the supervision of a licensed asbestos removalist;
- Receiving a clearance certificate from a licensed asbestos assessor;
- Once fill has been removed, an inspection from a suitably qualified environmental consultant will need to confirm that the extent of fill has been removed from site; and
- The implementation of a Construction Environment Management Plan which should include an 'unexpected finds protocol'.

The results of the soil contaminant testing were also compared to ACT waste classification criteria in order to provide a preliminary waste classification for material that is understood to be excavated and disposed off-site during the removal of asbestos impacted fill as well as the construction of the proposed development.

Due to the presence of concentrations of metals greater than the Inert Waste (CT1) criteria, the fill material will likely be classified as Solid Waste. However, DP recommends that prior to removal of material from the site, it should be excavated, stockpiled and subject to a formal waste classification assessment including leachate testing for metals and PFAS with reference to ACT EPA Information Sheet 4 Requirements for the Reuse and Disposal of Contaminated Soil in the ACT and ACT's Environmental Standards: Assessment, Classification and Management of Liquid & Non-liquid Wastes and PFAS NEMP of HEPA (2020).

15. References

ACT Environment Protection Authority (2019), 'Information Sheet 4: Requirements for the Reuse and Disposal of Contaminated Soil in the ACT', dated January 2019

ACT EPA (2018) 'Information Sheet 7: Guidance for Undertaking Preliminary Contamination Investigations for Development/Lease Variation Purposes ', dated November 2018:

ACT Environment Protection Authority (2019), 'Information Sheet 10: Virgin Excavated Natural Material (VENM)', dated August 2019

ACT's Environmental Standards (2000), 'Assessment & Classification of Liquid & Non-liquid Wastes', dated June 2000.

Bureau of Mineral Resources (1992), 'Geology of Canberra Geological Series Sheet 8727, 1:100 000 scale map', dated 1992.

Bureau of Mineral Resources, Geology and Geophysics (1984) 'Hydrogeology of the Australian Capital Territory and Environs 1:100,000 scale map', dated 1984

Friebel, E. and Nadebaum, P. (2011) 'Technical Report no.10 Health screening levels for petroleum hydrocarbons in soil and groundwater, Summary' Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), Adelaide, Australia

HEPA (2020), *PFAS National Environmental Management Plan Version 2.0*, 'Heads of EPAs Australia and New Zealand 2020'

National Environment Protection Council (NEPC) (1999), 'National Environment Protection (Assessment of Site Contamination) Measure', dated 1999 as amended May 2013

NSW Department of Land and Water Conservation (2000): Canberra Soil Landscape Series Sheet 8727 1:100 000 scale map.

NSW Environment Protection Authority (2020). *Consultants Reporting on Contaminated Land*. Sydney: NSW Environment Protection Authority

NSW EPA (1995), 'Contaminated Sites – Sampling Design Guidelines', dated September 1995

16. Limitations

Douglas Partners (DP) has prepared this report for this project at Part Rural Block 2249, Jerrabomberra in accordance with DP's proposal CAN200144.P.003 dated 2 June 2020 and a purchase order received from Mr Andrew Lonie of Jacobs Group (Australia) Pty Ltd dated 28 July 2020. The work was carried out under Jacobs Group (Australia) Pty Ltd modified contract. This report is provided for the exclusive use of Jacobs Group (Australia) Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the environmental components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

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

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

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

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

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

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

About this Report

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

Information for Contractual Purposes
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

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

Appendix B

Drawings

Locality Plan

LEGEND

- Approximate Area of Investigation Boundary
- Approximate Borehole Location
- Storm water Drainage Lines
- Observed ACM Fragments

0 7.5 15 22.5 30 37.5

1:750 @ A3

Base drawing from nearmap.com.au dated 6 August 2020

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Jacobs Group (Australia) Pty Ltd		TITLE: **Site Layout and Test Location Plan**	PROJECT No: 103028.01
OFFICE: Canberra	DRAWN BY: SDG	**Project Roger**	DRAWING No: 1
SCALE: As Shown	DATE: 14.09.2020	**Part Rural Block 2249, Jerrabomberra**	REVISION: 0

Appendix C

Site History Searches

[redacted]

From: Zhang, Jianmin <Jianmin.Zhang@act.gov.au> on behalf of Contaminated Sites <ContaminatedSites@act.gov.au>
Sent: Monday, 3 August 2020 11:35 AM
To: [redacted]
Subject: Contaminated Land Search Result for Block 2249 Jerrabomberra

Dear [redacted]

RE: CONTAMINATED LAND SEARCH

Thank you for your search form request of 30/07/2020 enquiring about:

Block 2249 Jerrabomberra

Records held by the Environment Protection Authority (EPA) for the above block(s) indicate the following:

The block is recorded on the EPA's contaminated sites management database and geographic information system.

Block 2249 Jerrabomberra formed part of former Block 2062 Jerrabomberra. Block 2062 was formerly occupied by the Bonshaw Naval Receiving Station which was operated by the Department of Defence.

The EPA is aware that hazardous materials in the form of fuel stored in twelve underground fuel storage tanks are located or were located at the site. A Development Application (DA) for the removal of 12 underground fuel storage tanks was submitted to the EPA for review in February 1999. The EPA opposed the DA due to insufficient information to assess the application and is currently unaware of the status of the facilities at the site.

The ACT EPA Contaminated Sites Environment Protection Policy 2017 lists petroleum storage as an activity associated with land contamination which may pose a risk to human health and the environment.

Under the precautionary principal all blocks which contain or have contained fuel storage facilities are identified and persons making enquiries are made aware of potential for impacts due to the ability of hydrocarbons and other contaminants to migrate through the environment.

Other potentially contaminating activities may have also been undertaken at the site associated with past or current permitted uses. For further information on potential contamination of this block you or your client should contact the Department of Defence.

The EPA has not issued any orders of assessment or remediation under sections 91C (1) or 91D (1) respectively, environment protection orders under sections 125 (2) or (3), requested an audit under section 76 (2) or received an audit notification under section 76A (1) of the *Environment Protection Act 1997* (the Act) over the site and as a result the site is not recorded on the Register of contaminated sites under section 21A of the Act.

The information detailed above only relates to records held by the EPA and may not represent the actual condition of the site.

At present the EPA has no information on contamination of the above block(s) other than as detailed above. However, this does not absolutely rule out the possibility of contamination and should not be interpreted as a warranty that there is no contamination.

I appreciate that this does not absolutely rule out the existence of contamination of the soils. If you or your clients wish to be completely sure you, or they, should arrange to conduct independent tests.

Regards

Jianmin Zhang | Environment Protection Officer, Environmental Quality
Office of the Environment Protection Authority
Access Canberra | Chief Minister Treasury and Economic Development Directorate | ACT
Phone: 02 6207 2157|Email: jianmin.zhang@act.gov.au
480 Northbourne Avenue, Dickson | GPO Box 158 Canberra ACT 2601 | www.act.gov.au/accessCBR

ACT Government
Chief Minister, Treasury and Economic Development

[redacted]
Douglas Partners Pty Ltd
Unit 2, 73 Sheppard Street
Hume ACT 2620

Dea[redacted]

RE: CONTAMINATED LAND SEARCH

Thank you for your search form request of 20/05/2019 enquiring about:

Block 14 Section 18 Hume Jerrabomberra

Records held by the Environment Protection Authority (EPA) for the above block(s) indicate the following:

The block is not recorded on the EPA's contaminated sites management database or geographic information system.

The site is currently used as a prison. Whilst there is no recorded information on site contamination, prisons have been associated with site contamination due to some on-site activities undertaken such as the storage of chemicals.

The ANZECC 1992, Guidelines for the Assessment and Management of Contaminated Sites and the ACT Contaminated Sites Environment Protection Policy 2017 list chemical storage as an activity associated with land contamination.

The block is also adjacent to the former Bonshaw Naval Receiving Station on Blocks 2060, 2061, 2062 Jerrabomberra and Block 12 Section 110 Symonston (the Bonshaw site). Contaminating activities have been undertaken at the site associated with its permitted uses such as fuel and chemical storage.

The Bonshaw site was asessed, remediated and independently audited during 2009 to 2011.

The EPA reviewed the Site Audit Statement (SAS01R) dated 18 May 2011 and Site Audit Report titled "Former Bonshaw Naval Receiving Station (BNRS) & Grazing Land, Harman ACT" (00002983SAR01FINAL) dated 18 May 2011 by Ms Rebeka Hall of WSP Environment & Energy, an approved site Auditor, under the *Environment Protection Act 1997*.

The Site Audit Statement (SAS) detailed that the area subject to this SAS is suitable for "Nature Conservation Area, Outdoor Recreation Facility and Parkland uses which are uses permitted by its zoning NUZ1 Broadacre Zone as detailed in the ACT Territory Plan 2008" subject to compliance with the following environmental management plan (EMP) titled "Former Bonshaw Naval Receiving Station Groundwater Monitoring Plan" dated 13 April 2011 by GHD Pty Ltd.

The EPA endorsed the SAS for the beneficial uses identified subject to the implementation of the above EMP and compliance with the Auditor's overall comments as stated in the SAS.

The EPA has no information to suggest the past activities undertaken a the Bonshaw site has adversely impacted Block 14 Section 18 Hume.

The EPA has not issued any environment protection orders under sections 91C (1), 91D (1) or 125 (4), requested an audit under section 76(2) or received a notification under section 76A (1) of the *Environment Protection Act 1997* (the Act) over the site and as a result the site is not recorded on the Register of contaminated sites under section 21(A) of the Act.

The information detailed above only relates to records held by the EPA and may not represent the actual condition of the site.

At present the EPA has no information on contamination of the above block(s) other than as detailed above. However, this does not absolutely rule out the possibility of contamination and should not be interpreted as a warranty that there is no contamination.

I appreciate that this does not absolutely rule out the existence of contamination of the soils. If you or your clients wish to be completely sure you, or they, should arrange to conduct independent tests.

Yours sincerely

Jianmin Zhang
Project Officer
Office of the Environment Protection Authority
Ground Floor TransACT House
470 Northbourne Avenue
Dickson 2602

20/05/2019

ACT Government

Product	Title
Date/Time	31/07/2020 11:44AM
Customer Reference	
Order ID	20200731000727

Volume N/A **Folio** N/A **Edition** N/A

AUSTRALIAN CAPITAL TERRITORY

ADMINISTRATIVE PARCEL - NO TITLE ISSUED

LAND

Jerrabomberra Section Block 2249 on Deposited Plan 11108

End of interests

ACTmapi

User Input Title

Notes:

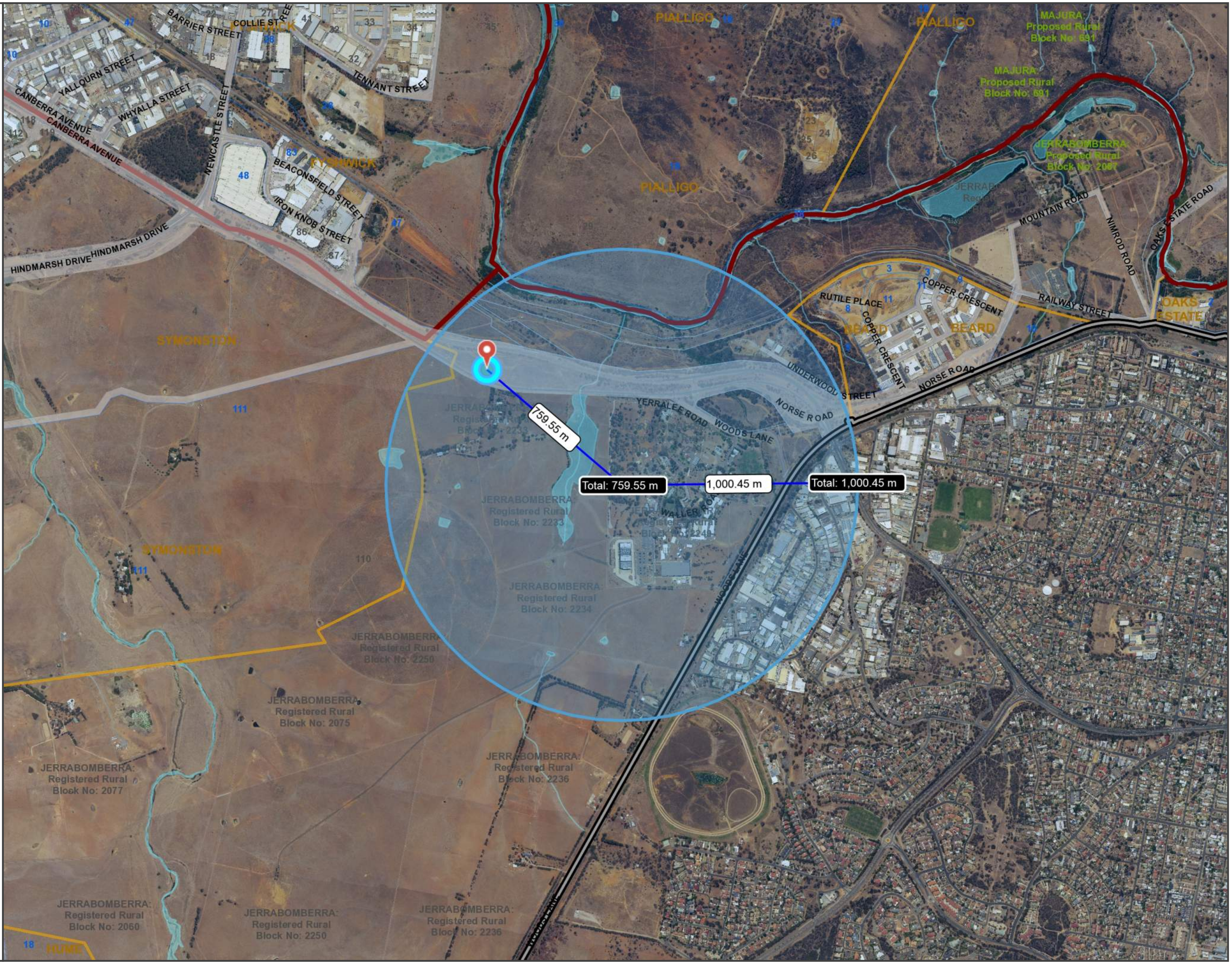
Notes to be added

1: 15,000

30-Jul-2020 *Page 1 of 1*

DISCLAIMER

The map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current or otherwise reliable.



Appendix D

Historical Aerial Photographs D1 – D9

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Jacobs Group (Australia) Pty Ltd	TITLE: **Aerial Photograph 1952**	PROJECT No: 103028.01
	OFFICE: Canberra — DRAWN BY: SDG	**Project Roger**	PLATE No: D1
	SCALE: NTS — DATE: 31.07.2020	**Part Rural Block 2249, Jerrabomberra**	REVISION: 0

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Jacobs Group (Australia) Pty Ltd		TITLE: **Aerial Photograph 1961** **Project Roger** **Part Rural Block 2249, Jerrabomberra**
	OFFICE: Canberra	DRAWN BY: SDG	
	SCALE: NTS	DATE: 31.07.2020	

N

PROJECT No:	103028.01
PLATE No:	D2
REVISION:	0

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Jacobs Group (Australia) Pty Ltd		TITLE: **Aerial Photograph 1973** **Project Roger** **Part Rural Block 2249, Jerrabomberra**
	OFFICE: Canberra	DRAWN BY: SDG	
	SCALE: NTS	DATE: 31.07.2020	

PROJECT No:	103028.01
PLATE No:	D3
REVISION:	0

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Jacobs Group (Australia) Pty Ltd		TITLE: **Aerial Photograph 1981**
	OFFICE: Canberra	DRAWN BY: SDG	**Project Roger**
	SCALE: NTS	DATE: 31.07.2020	**Part Rural Block 2249, Jerrabomberra**

PROJECT No:	103028.01
PLATE No:	D4
REVISION:	0

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Jacobs Group (Australia) Pty Ltd		TITLE: **Aerial Photograph 1993** **Project Roger** **Part Rural Block 2249, Jerrabomberra**
	OFFICE: Canberra	DRAWN BY: SDG	
	SCALE: NTS	DATE: 31.07.2020	

PROJECT No:	103028.01
PLATE No:	D5
REVISION:	0

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Jacobs Group (Australia) Pty Ltd		TITLE: **Aerial Photograph 1997**	PROJECT No: 103028.01
OFFICE: Canberra	DRAWN BY: SDG	**Project Roger**	PLATE No: D6
SCALE: NTS	DATE: 31.07.2020	**Part Rural Block 2249, Jerrabomberra**	REVISION: 0