NAPL Apron and Taxiway J

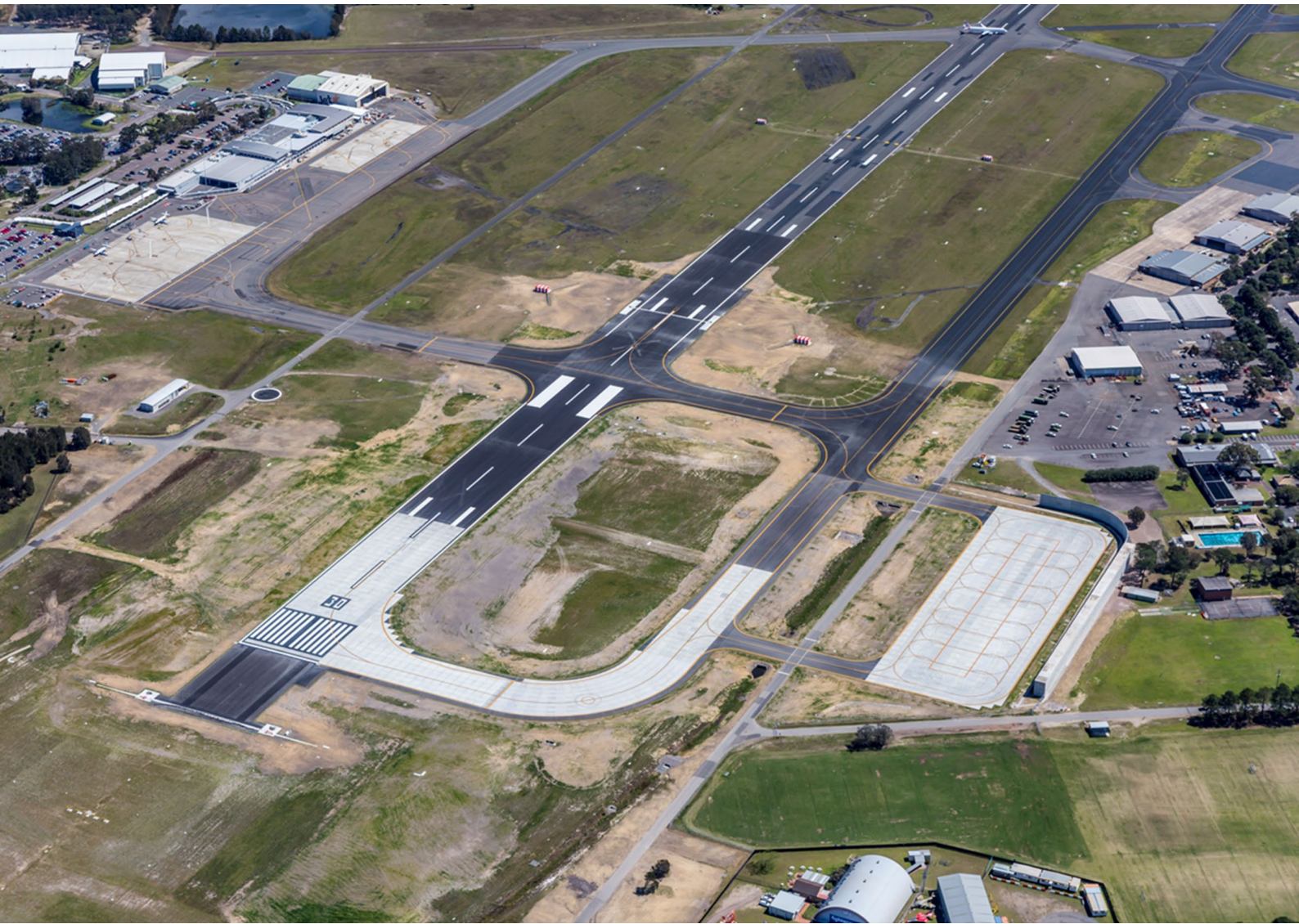
Contamination Investigation

EST01980 – P0008 – National Airfields Works RAAF Base Williamtown

Department of Defence and NAPL

13 May 2022

→ **The Power of Commitment**



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Acronyms and Abbreviations

ACM	Asbestos Containing Material
BaP	Benzo(a)pyrene
BTEX	Benzene, toluene, ethyl benzene and xylenes
CLM Act	NSW Contaminated Land Management Act 1997 (incorporating amendments made by the Contaminated Land Management Amendment Act 2003)
COC	Chain of Custody
CoPC	Contaminant of Potential Concern
EIL	Ecological Investigation Level
EPA	Environment Protection Authority
ESL	Ecological Screening Level
HIL	Health Investigation Level (relating to defined land use scenario)
HSL	Health Screening Level
LOR	Limit of reporting
mbgl	Metres below ground level
NAPL	Newcastle Airport Pty Ltd
NATA	National Association of Testing Authorities of Australia
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NSW EPA	NSW Environmental Protection Authority
NSW OEH	NSW Office of Environment and Heritage
OCP	Organochlorine Pesticide
OPP	Organophosphate Pesticide
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated Biphenyl
pH	-log[H]
PID	Photo-ionisation detector
QAQC	Quality assurance and quality control
RAAF	Royal Australian Air Force
RPD	Relative percentage difference
TCLP	Toxicity Characteristics Leaching Procedure
TEQ	Toxicity equivalent quotient (in reference to BaP)
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
UCL	Upper Confidence Limit

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1. Introduction

1.1 General

GHD Pty Ltd (GHD) was engaged by the Department of Defence (Defence) to undertake a soil contamination investigation to inform additional design services to connect Taxiway J to the existing Newcastle Airport Pty Ltd (NAPL) Code E Apron, as well as undertake Code C taxi lane realignment and apron extension, as part of the National Airfields Works (NAW) program Project P0008 ('the Project') at RAAF Base Williamtown, Medowie Road, Williamtown, NSW 2314 ('the site').

The soil contamination investigation was undertaken in conjunction with a geotechnical investigation. The geotechnical investigation findings have been reported separately in GHD's (2022) Geotechnical Factual Report.

This report presents a summary of the findings specific to the soil contamination investigation only and should be read in conjunction with the Geotechnical Factual Report (GHD, 2022) and limitations described in Section 9. Where information is common to both the soil contamination investigation and the geotechnical investigation, this report provides reference to the geotechnical report and generally does not duplicate the information.

1.2 Objective

The objective of the contamination investigation was to identify the current contamination status of pavement surfaces and soils within the construction footprint of the Project to inform re-use and disposal requirements for construction.

1.3 Scope of work

The scope of works for the contamination investigation included the following:

- Intrusive soil investigation comprising collection of soil samples from 12 test holes to depths between 2.4 m and 3 m below ground level (mbgl) and two hand auger test holes to a depth of 0.3 mbgl.
- Collection and analysis of four asphalt subsamples from the apron and taxiway.
- Laboratory analysis of selected samples for contaminants of potential concern (CoPC) comprising heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), total recoverable hydrocarbons (TRH), benzene, toluene, ethyl benzene and xylenes (BTEX), polyaromatic hydrocarbons (PAH), phenols (for asphalt samples only), poly-fluoroalkyl substances (PFAS), polychlorinated biphenyls (PCB), organophosphate pesticides (OCP) and/or asbestos.
- Selected samples were also submitted for toxicity characteristic leaching procedure (TCLP) testing for PAH and PFAS, for waste classification purposes.
- Preparation of this report, summarising the findings of the investigation, and recommending further stages of investigation, site management and/or remediation requirements (as required).

2. Site information

2.1 Locality

The RAAF Base Williamtown is located approximately 30 kilometres north of the Newcastle central business district (CBD) and is bounded by Medowie Road to the west, Newcastle Airport to the south and bushland to east and north.

2.2 Investigation area

The investigation targeted the NAPL Apron and Taxiway J, including the proposed extension/widening, as indicated in drawing SK5003 presented in Appendix A.

2.3 Site setting

Detailed site setting information is presented in Section 4 of the Environmental Report (GHD, 2020a) prepared for the Project, including the site setting (hydrology, hydrogeology, soils and geology).

2.4 Contamination status

Refer to the P0008 Environmental Report (GHD, 2020a) for an overview of the contamination status of the Project area, including historical land use and identified sources of potential contamination. Also refer to the P0008 Contamination Investigation (GHD, 2020b) for a summary of relevant previous investigations and key findings from the P0008 Contamination Investigation.

3. Basis of assessment

3.1 Relevant guidelines

The framework on which the soil contamination status of the Project was assessed was based on guidelines published or approved by the NSW EPA under *Section 105* of the *Contaminated Land Management (CLM) Act 1997*.

The guidelines that were referenced include (but are not limited to) the following:

– CRC CARE (2017) Technical Report No. 39, Risk-based management and remediation guidance for benzo(a)pyrene. CRC for Contamination Assessment and Remediation of the Environment, January 2017.
– Friebel, E and Nadebaum, P (2011). Health screening levels for petroleum hydrocarbons in soil and groundwater. CRC CARE Technical Report no. 10. CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia, 2011.
– HEPA (2018). PFAS National Environnemental Management Plan (PFAS NEMP). Heads of EPAs Australia and New Zealand, January 2018.
– NEPC (2013). National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999. National Environment Protection Council, as amended in May 2013.
– NSW EPA (2014). Waste Classification Guidelines, Part 1: Classifying Waste. November 2014.
– NSW EPA (2016). Addendum to the Waste Classification Guidelines (2014) – Part 1: classifying waste. October 2016.
– NSW EPA (2020). Guidelines for Consultants Reporting on Contaminated sites.

In addition to the above, the following Defence guidance was referenced:

– Defence (2021). Defence PFAS Construction and Maintenance Framework. Australian Government, Department of Defence, August 2021 (V3.0).

The adopted assessment criteria are discussed below and shown in the results summary tables in Appendix B.

3.2 Defence PFAS Construction and Maintenance Framework

The Defence PFAS Construction and Maintenance Framework (the Framework) applies to construction and maintenance works on the Defence estate where there is evidence of potential for PFAS contamination.

As stated in the Framework, the goals of the framework comprise:

– Provide options for the management of PFAS contaminated soil, water, construction demolition waste and other materials, that will mitigate the risks associated with PFAS contamination at the works site, on the Base, or in the vicinity of the Base.
– Guide decision-making for efficient and compliant solutions when managing PFAS contaminated materials in this context.
– Minimise the impact of risk-management of PFAS contamination on Defence capability.
– Ensure an integrated approach to PFAS risk management aligned with the PFAS Management Area Plans (PMAPs), any interim actions to manage potential risks, and works requirements.
– Provide guidance that is consistent with the PFAS NEMP.

The following preference hierarchy applies to options for PFAS contamination management:

1. On-work site management: On-work site management of the contamination so that the risks are reduced to an acceptable level.
2. Off-work site, on-Base management: Where work site management is not practicable, other locations on Base for the beneficial re-use of the material may be considered so that the risks are reduced to an acceptable level and other risks are not created.
3. Off-Base management: Where on-Base management is not appropriate, off-Base management of the contamination in order that the risks are reduced to an acceptable level may be required.

The need for management of contaminated materials (e.g., remediation or reuse) is prompted by an exceedance of trigger values stated in the framework, with consideration to the hierarchy and based on a site-specific assessment. The trigger values are not intended to be used for remediation targets, health-based criteria or for regulatory purposes.

Milled asphalt generated by the resurfacing works is expected to be a fine granular material. The Framework does not specify criteria for this type of waste material; however, it does indicate that asphalt pavement from areas with likely PFAS contamination should be tested with sampling representative of the proposed action. Therefore, assessment (screening) was completed using the soil categories defined in the Framework as follows:

– Category 1 – Excavated soils with PFOS+PFHxS concentrations of 20 mg/kg or more (Human health direct contact for industrial land use, PFAS NEMP). Soils to be excavated and treated or temporarily stockpiled for later treatment.
– Category 2 – Excavated soils with PFOS+PFHxS concentrations less than 20 mg/kg but greater than 1 mg/kg (Human health criterion for direct soil contact for public open space, PFAS NEMP). Soils can be reused within the works site provided that exposure to receptors, and water more generally, is minimised. Otherwise, an assessment of risk should be undertaken for off-base disposal or on-Base encapsulation.
– Category 3 – Excavated soils with PFOS+PFHxS concentrations less than 1 mg/kg but greater than 0.01 mg/kg (Interim soil – ecological indirect exposure for all land uses, PFAS NEMP). Soils can be reused within the works site with no additional mitigation, or on Base if the risk to human health or the environment is not increased or otherwise results in unacceptable risk.
– Category 4 – Excavated soils with PFOS+PFHxS concentrations less than 0.01 mg/kg. Soils can be reused on site or within the Base without further assessment or mitigation (unless a previous site assessment suggests otherwise).
– Non-detect – Excavated soils with PFOS+PFHxS concentrations less than the laboratory LOR. Soils can be reused within the works site or on Base without further assessment or mitigation.

Extensive testing for PFAS on the Defence estate has not identified PFOA as a limiting factor for decision making. Categorisation of soil is usually determined by PFOS and PFHxS concentrations, as relevant guidelines for PFOA are significantly higher than PFOS and the frequency and levels of PFOA detected are less than combined PFHxS and PFOS.

3.3 Soil assessment criteria

The NEPM includes a range of ecological and health investigation and screening levels for a range of contaminants and for a range of land use and exposure scenarios.

The selection of the assessment criteria was based on the following considerations, some of which are specific to the site being used as a RAAF Base / airport:

– There is potential for direct contact within contaminated soils, especially for intrusive maintenance workers.
– There is a potential for vapour intrusion from hydrocarbon contamination for future buildings.
– The commercial/industrial land use scenario investigation/screening levels are considered applicable to the site.

PFAS investigation levels were sourced from the PFAS National Environmental Management Plan (PFAS NEMP) (HEPA, 2018), as they are not presented in the NEPM (as amended 2013).

3.3.1 Health investigation and screening levels

Health investigation levels (HILs) have been developed for a broad range of metals and organic substances and are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types. Site specific conditions determine the depth to which HILs apply for land uses other than residential (generally to depth of 3 m).

Health screening levels (HSLs) for petroleum compounds, which comprise total recoverable hydrocarbons (TRH) including benzene, toluene, ethylbenzene and xylenes (BTEX) have been developed for assessing human health risk via the vapour exposure pathway. The HSLs apply to the same land use settings as HILs and include additional dimensions of soil type and depth.

Given the considerations outlined above (in Section 3.2), the following assessment criteria were adopted for this investigation:

– HIL/HSL D (commercial/industrial).
– HSLs for Intrusive Maintenance Workers.
– Direct Contact for TRH Fractions in Soil – HSL D.

3.3.2 Ecological investigation levels and ecological screening levels

Ecological investigation levels (EILs) have been developed for selected metals and organic substances and are applicable for assessing risk to terrestrial ecosystems. EILs depend on land use scenarios and generally apply to the top 2 m of soil. EILs have been developed for three generic land use settings including areas of ecological significance, urban residential areas and public open space, and commercial and industrial land uses. Added contaminant limit (ACL) based EILs have been derived for As, Cu, Cr III, DDT, naphthalene, Ni, Pb and Zn. ACL-based EILs are dependent on the site specific soil pH and cation exchange capacity (CEC).

Given pH and CEC analysis was not undertaken, conservative EILs (which disregard the site specific pH and CEC) were used in this assessment. Generic EILs have been derived for aged As, fresh DDT and fresh naphthalene.

Ecological Screening Levels (ESLs) have been developed for selected petroleum hydrocarbon compounds and TRH fractions and are applicable for assessing risk to terrestrial ecosystems. ESLs also depend on land use scenarios (identical to EILs) and broadly apply to coarse- and fine-grained soils and various land uses. They are generally applicable to the top 2 m of soil.

Given the proposed development of the site, the following assessment criteria were adopted:

– Soil Specific ACL-based EILs for commercial/industrial land use
– Generic EILs (for arsenic and fresh DDT) for commercial/industrial land use
– ESLs for commercial/industrial land use

In regard to benzo(a)pyrene (BaP), revised, high reliability ESLs were derived from Technical Report No.39 *Risk-based management and remediation guidance for benzo(a)pyrene* (CRC CARE 2017). Use of this criteria is based on the justification provided by CRC CARE (2017) which states “The NEPM ESLs are based on an older set of Canadian soil quality guidelines, which have been subsequently revised. For this guidance document higher reliability screening levels have been developed using additional and more recent information following the NEPM methodology. The derived screening levels are more than an order of magnitude greater than the ESLs previously listed in the NEPM, and more generally accord with the revised Canadian guidelines levels.” The higher reliability ESL for a commercial industrial land use for BaP is 172 mg/kg, which has been considered in this assessment.

Note, EILs / ESLs are not applicable for areas covered by permanent paving given the absence of a sensitive ecological setting.

3.3.4 Management limits

The NEPM includes “Management Limits” which are considered after application of the HSLs and ESLs, to address a number of policy considerations which reflect the nature and properties of petroleum hydrocarbons:

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

The management limits have been adopted in the NEPM as interim Tier 1 guidance to avoid or minimise these potential effects. The NEPM states that application of the management limits will require consideration of site-specific factors such as the depth of building basements and services and depth to groundwater, to determine the maximum depth to which the limits should apply, and that the management limits may have less relevance at operating industrial sites (including mine sites) which have no or limited sensitive receptors in the area of potential impact. As part of the Tier 1 screening, GHD will consider the management limits for commercial/industrial land use.

3.3.5 Health screening levels for asbestos contamination in soil

The NEPM provides guidance relating to the assessment of known and suspected asbestos contamination in soil and addresses both friable and non-friable forms of asbestos. The health screening levels for asbestos in soil have been adopted from the Western Australian Department of Health (WA DoH) *Guidelines for Remediation and Management of Asbestos Contaminated Sites in Western Australia* (WA DoH 2021).

The NEPM guidance emphasises that the assessment and management of asbestos contamination should take into account the condition of the asbestos materials and the potential for damage and resulting release of asbestos fibres. Therefore, for the purposes of assessing the significance of asbestos in soil contamination, three terms are used as summarised below:

– Bonded asbestos containing material” (Bonded ACM) – sound condition although possibly broken or fragments and the asbestos is bound in a matrix.
– Fibrous asbestos (FA) – friable asbestos materials such as severely weathered ACM and asbestos in the form of loose fibrous materials such as insulation.
– Asbestos fines (AF) – including free fibres of asbestos, small fibre bundles and also fragmented ACM that passes through a 7 mm x 7 mm sieve.

From a risk to human health perspective, FA and AF are considered in the NEPM to be equivalent to “friable” asbestos in Safe Work Australia (2011), which is defined therein as ‘material that is in a powder form or that can be crumbled, pulverised or reduced to a powder by hand pressure when dry, and contains asbestos’.

Bonded ACM in sound condition represents a low human health risk. However, both FA and AF materials have the potential to generate, or be associated with, free asbestos fibres and may represent a significant human health risk if disturbed and fibres are made airborne.

For the purposes of this investigation, soil samples were analysed for the presence or absence of asbestos. Where asbestos is detected in a sample, further qualitative sampling and analysis may be required to inform reuse options for the material.

As per Section 3.3.1, the following commercial/industrial health screening levels were adopted.

Table 3.1 Commercial/industrial health screening levels adopted

Form of Asbestos	Health Screening Level (w/w)		
	Residential A	Recreational C	Commerical / Industrial D
Bonded ACM	0.01%	0.02%	0.05%
FA and AF (friable asbestos)	0.001%		
All forms of asbestos	No visible asbestos for surface soil		

3.3.6 Aesthetics

An assessment of aesthetic issues was undertaken as outlined in Schedule B(1) of the NEPM, which states that 'there are no specific numeric aesthetic guidelines, however site assessment requires balanced consideration of the quantity, type and distribution of foreign material or odours in relation to the specific land use and its sensitivity'.

General assessment considerations included:

– That chemically discoloured soils or large quantities of various types of inert refuse, particularly if unsightly, may cause ongoing concern to site users.
– The depth of the materials, including chemical residues, in relation to the final surface of the site.
– The need for, and practicality of, any long-term management of foreign material.

The NEPM notes that in some cases, documentation of the nature and distribution of the foreign material may be sufficient to address concerns relating to potential land use restrictions.

3.3.7 Application of adopted assessment criteria

To assess the contamination levels in soils during the site investigation, the EILs/ESLs and HILs/HSLs were used as cut off points to classify soils either as:

– **Soils not contaminated** e.g. those which are likely to pose no risk to the environment or human health and warrant no further action, i.e. concentrations less than or equal to the EILs/ESLs and HILs/HSLs.
– **Soils containing elevated concentrations of contaminants**, e.g. those which may pose a potential risk to the environment (in particular plant species or soil organisms) but pose no risk to human health under the proposed land use scenarios i.e. concentrations greater than the ecological values (EILs/ESLs) and less than the adopted HILs/HSLs. A qualitative risk assessment may be sufficient to evaluate the potential impact for the proposed land use.
– **Soils significantly contaminated** e.g. those which are likely to pose a risk of harm to the environment and / or human health, i.e. concentrations significantly greater than relevant investigation or screening levels. Soils in this category would likely require site-specific health and/or ecological risk assessment (Tier 2 or 3) carried out as appropriate for the proposed land use, remediation or removal from site for disposal at landfill. Risk assessment would usually require the collection of additional site data.

3.4 Waste classification criteria

Materials that may require offsite disposal were classified using the Waste Classification Guidelines – Part 1: Classification of Waste (NSW EPA, 2014) and the Addendum to the Waste Classification Guidelines (2014) – Part 1: classifying waste (NSW EPA, 2016).

In accordance with NSW EPA 2014, the following six-step guide to the classification of waste and waste classification principles apply:

– **Step 1**: establish if the waste should be classified as a special waste.

  'Special waste' is a class of waste that has unique regulatory requirements. The potential environmental impacts of special waste need to be managed to minimise the risk of harm to the environment and human health. Special wastes are:

  - Clinical and related waste
  - Asbestos waste
  - Waste tyres

  Asbestos waste means any waste that contains asbestos. If asbestos is mixed with other waste to form asbestos waste, the waste must continue to be assessed in accordance with the guidelines to enable the disposal of the asbestos waste at an appropriate waste facility. Asbestos waste must be managed to meet the management and disposal requirements of both asbestos and the other class of waste with which it is mixed (if any).

- **Step 2**: If not a special waste, establish whether the waste should be classified as a liquid waste.
- **Step 3**: If not special waste or liquid waste, establish whether the waste is of a type that has already been pre classified. A number of commonly generated wastes have been pre-classified.
- **Step 4**: If the waste is not a special waste, liquid waste or is not suitable for pre classification, establish whether it has certain hazardous characteristics and should therefore be classified as hazardous.
- **Step 5**: If the waste does not possess hazardous characteristics, chemically assess to determine what class of waste.
- **Step 6**: The first test used to chemically assess waste is the Specific Contaminant Concentration (SCC) test, which determines the total concentration of each contaminant in the waste sample. The guidelines set different maximum levels for the total concentration of each contaminant in order for waste to be classified as either general solid waste or restricted solid waste.

  The toxicity characteristic leaching potential (TCLP) test estimates the potential for waste to release chemical contaminants into a leaching liquid. The guidelines set different maximum levels of the leachable concentration of each contaminant in order for waste to be classified as general solid waste, restricted solid waste or hazardous waste.

The following principles must be applied at all times when using the step-by-step waste classification process.

- If special waste is mixed with another class of waste, the waste must be managed to meet the requirements of both the special waste and the other class of waste.
- If asbestos waste is mixed with any other class of waste, all the waste must be classified as asbestos waste. For example, asbestos waste mixed with building and demolition waste must be managed as asbestos waste.
- If liquid waste is mixed with a hazardous or solid waste and retains the characteristics of liquid waste, the waste remains liquid waste.
- Two or more classes of waste must not be mixed in order to reduce the concentration of chemical contaminants. Dilution of contaminants is not an acceptable waste management option.
- Where practicable, it is desirable to separate a mixture of wastes before classifying them separately. For example, if waste tyres (a special waste) are mixed with lead acid batteries (a hazardous waste) it would be desirable to separate the wastes so that only the hazardous component needs to be managed as hazardous waste.

4. Field investigation methodology

4.1 General

The contamination soil sampling was undertaken in conjunction with the intrusive geotechnical investigations, under the guidance of a suitably qualified environmental consultant. Refer to Section 2 of the Geotechnical Factual Report (GHD, 2022) for more details.

4.2 Field investigations

4.2.1 Overview

All fieldwork was undertaken by trained and experienced GHD professional personnel, with reference to GHD Standard Operating Field Procedures. All sampling was conducted using carefully documented and supervised quality assurance (QA) procedures.

4.2.2 Sampling locations and rationale

The selection of contamination sampling locations was based on the pavements scope of works, with consideration to site access and environmental constraints, as well as the location of existing services and design input requirements, and the geotechnical investigation locations. GHD considers that the number and location of the sampling points was sufficient to provide an indicative characterisation of the Project soil disturbance footprint in regard to potential contamination.

The locations of test holes are shown on the *Geotechnical and Contamination Investigations Location Plan* (Drawing SK5003) presented in Appendix A.

4.2.2.1 Asphalt sampling

Four asphalt subsamples were collected from the apron and taxiway (proposed for pavement resurfacing):

– CTH001_0.0-0.05_A
– CTH002_0.0-0.05_A
– CTH004_0.0-0.05_A
– CTH005_0.0-0.05_A

Asphalt samples were crushed prior to submission to the laboratory for analysis.

4.2.2.2 Soil sampling

Soil contamination samples were collected from the following locations:

– Five geotechnical investigation locations targeting proposed pavement resurfacing (CTH001 to CTH005).
– Seven geotechnical investigation locations targeting the proposed apron extension (TH001 to TH007).
– Two hand auger locations targeting the proposed taxiway pavement widening (HA001 and HA002).

Soil samples were collected from significant soil horizons encountered during the subsurface investigation and from any material that exhibited obvious contaminant indicators e.g., staining, odours, anthropogenic material.

As a minimum, soil samples were collected from the following approximate depths:

– Surface (e.g. 0.0-0.2 mbgl)
– 0.5 mbgl (e.g. 0.4-0.6 mbgl)
– Every metre below ground level (e.g. 0.8-1.0, 1.8-2.0 mbgl) to the base of each test location

Volatile organic compounds were measured using a photoionisation detector (PID) during sample processing (from the headspace of zip lock bags for all soil samples) and recorded in a sample register.

4.3 Laboratory analysis

Selected samples were analysed by the primary laboratory (ALS Environmental). A secondary laboratory (Eurofins) was used for inter-laboratory duplicate analysis. Both ALS and Eurofins are accredited by the National Association of Testing Authorities (NATA) for the required analyses.

Soil samples were selected for analysis based on the test hole location, sample depth and observations during excavation. A minimum of two samples per location were submitted for analysis.

Analyses comprised heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), TRH, BTEX, PAH, OCP, PCB, PFAS and asbestos. Selected samples were also analysed for TCLP of PAH and PFAS for waste classification purposes.

It is noted that asphalt material may be pre-classified as general solid waste (GSW) if it does not contain coal tar or asbestos. Hence, the asphalt subsamples were analysed for PAH and phenols (to assess the absence/presence of coal tar) and asbestos identification.

Given the identified PFAS contamination at the Base, the asphalt samples were also analysed for PFAS.

The analytical program undertaken is summarised in Table 4.1.

Table 4.1 Primary sample analytical program

Media	Analysis	Number of primary samples analysed
Soil	Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	31
	BTEXN	31
	BTEXN (Naphthalene)	35
	TRH	31
	PAH	35
	OCP	14
	PCB (Total)	14
	PFAS	30
	Asbestos (presence / absence)	17
Asphalt	BTEXN (Naphthalene), PAH, Phenols, PFAS	4
	Asbestos (presence / absence)	3
Leachate (soil) – TCLP	PAH	19
	PFAS	6

4.5 Quality control samples

The following quality control (QC) samples were collected during the investigation program and are summarised in Table 4.2.

– Field duplicate: generally collected and analysed at a rate of 1 in 10 primary samples for PFAS and 1 in 20 primary samples for the remainder of the analytes
– Field split: generally collected and analysed at a rate of 1 in 10 primary samples for PFAS and 1 in 20 primary samples for the remainder of the analytes
– Trip blank and trip spike: one pair per day

Table 4.2 QC sample analytical program

Sample type	Naming convention (where XX is a sequential number independent of sample or matrix type)	Analysis	Total number of samples
Field duplicate	QC1XX	Heavy metals, BTEXN, TRH, PAH, OCP, PCB, PFAS, asbestos	2
		Heavy metals, BTEXN, TRH, PAH, PFAS, asbestos	1
		PAH, PFAS (asphalt)	1
		TCLP PAH	1
Field split	QC2XX	Heavy metals, BTEXN, TRH, PAH, OCP, PCB, PFAS, asbsestos	2
Trip blank	QC5XX	BTEXN, TRH (C_6-C_{10} fraction) (C_6-C_9 fraction)	3
Trip spike	QC6XX	BTEXN, TRH (C_6-C_{10} fraction) (C_6-C_9 fraction)	3

4.6 Level of confidence in findings

There are a number of methods for statistical evaluation of results, including the confidence level for detection of circular hot spots, number of samples required for determining an average concentration, geostatistical sampling methods, and probabilistic estimations (e.g. Monte Carlo simulations). The applicability of any of these will depend on the contaminant mechanisms – e.g. whether the contamination has spread from a source, or whether it may be randomly distributed in fill.

At this stage of investigation GHD cannot estimate a level of confidence that contamination (if present) was found or missed. However, it can be expected that any areas of gross contamination should be identified by the investigations, but smaller areas of unexpected contamination (e.g. incidental disposal of wastes in predominantly clean fill, including potential asbestos wastes) are unlikely to be detected.

A “lines of evidence” assessment is considered to provide the highest level of confidence from the investigations, where historical site use is considered in conjunction with the findings of previous investigations, overall uniformity of results and comparability with the findings of the proposed investigations.

5. Results and discussion

5.1 Field observations

Test hole logs are presented in Appendix C of the *Geotechnical Factual Report* (GHD, 2022).

The subsurface profiles are summarised in Section 4 of the *Geotechnical Factual Report* (GHD, 2022).

In general, soil fill comprising Sand / Gravel / Sandy Silt and Gravely Sand up to 0.7 to 1.8 mbgl typically overlayed natural fluvial Sandy Silt, Clayey Sand and Sandy Clay.

No anthropogenic material (including asbestos) was observed during the investigation.

A slight hydrocarbon odour was noted at approximately 1 mbgl in TH003. Material from 0.3-0.4 mbgl was sampled and analysed, with concentrations reported below the laboratory LOR.

The PID measurements did not identify any significantly elevated volatile organic compounds – the highest recorded reading was 1.4 ppm.

Groundwater was encountered between 0.4 and 1.0 mbgl, coinciding with high rainfall preceding the investigations.

5.2 Asphalt analytical results

The tabulated asphalt analytical results are presented in Tables 1 to 5 in Appendix B. Laboratory documents are provided in Appendix C.

5.2.1 Human Health Assessment Criteria

All asphalt analytical results for CoPC (including PFAS and PAH) were below the laboratory limit of reporting (LOR) and the adopted health assessment criteria in the NEPM 2013 for commercial / industrial land use (HIL D).

It is important to note that the adopted assessment criteria are not applicable for asphalt, though have been applied for comparative purposes.

5.2.2 Ecological Assessment Criteria

The asphalt analytical results (including PFAS and PAH) were below the adopted ecological assessment criteria in the NEPM 2013 for commercial / industrial land use (EIL and ESL).

5.2.3 Defence PFAS Framework Assessment Criteria

Reported PFAS concentrations in asphalt samples were below the laboratory LOR and therefore considered to be within the non-detect category (Defence, 2021).

It is noted that the re-use criteria are not intended for application to construction and demolition waste (such as asphalt). However, it is considered that the re-use criteria provide an indication as to the potential feasibility for re-use on the site, subject to further risk-based assessment once the re-use option / location has been confirmed and based on specific design solutions enabling re-use of asphalt millings are identified.

With respect to re-use, the reported PFAS concentrations indicate that the asphalt millings can be considered non-detect with reference to Defence (2021) and are therefore likely to be suitable for re-use on site without further assessment or mitigation.

5.2.4 Preliminary waste classification

All PFAS and PAH concentrations in the asphalt samples were below the threshold for general solid waste. Furthermore, all samples were reported as negative for asbestos and coal tar (as indicated by PAH and phenols concentrations).

It is important to note that the waste classification is indicative for costing purposes associated with the 30% CDR and additional confirmation sampling may be required prior to off-Base disposal to satisfy either state regulatory requirements or local landfill acceptance criteria.

5.3 Soil analytical results

The soil analytical results are summarised in Tables 1 to 5 in Appendix B. Laboratory documents are provided in Appendix C.

5.3.1 Asbestos

No asbestos was identified within the 21 soil samples analysed based on absence / presence screening.

5.3.2 Human Health Assessment Criteria

All reported concentrations of CoPC in soil samples were below the adopted health-based assessment criteria for commercial / industrial land use (e.g., HIL-D and HSL-D) and intrusive maintenance workers for potential exposure pathways including vapour inhalation and/or direct contact, as presented in the NEPM (2013).

5.3.3 NEPM Ecological Assessment Criteria and Management Limits

All reported concentrations of CoPC in soil samples were below the adopted ecological assessment criteria for commercial / industrial land use (e.g. EIL D and ESL D) presented in the NEPM (2013), except for those summarised in Table 5.1.

Table 5.1 NEPM Ecological Assessment Criteria and Management Limits Exceedances

Field ID	Analyte	Result	Assessment criteria source	Assessment criteria value
TH007_0.0-0.1	Zinc	116 mg/kg	EILs – Comm/Ind	110 mg/kg

The exceedance in Table 5.1 is relatively marginal and appears to be isolated. The concentration of zinc in TH007_0.0-0.1 is unlikely to pose a significant ecological risk.

5.3.4 Management Limits

None of the analytical results for the soil samples reported CoPC at concentrations that exceed the NEPM Management Limits.

1.1.1 PFAS Assessment Criteria

All analytical results (including the asphalt samples) were below the adopted assessment criteria, except for those summarised in Table 5.

Table 5.2 PFAS NEPM Exceedances

Field ID	Analyte	Result	Assessment criteria source	Assessment criteria value
CTH005_0.9-1.0	Perfluorooctane sulfonic acid (PFOS)	0.0130 mg/kg	NEMP Ecological indirect exposure	0.01 mg/kg

Overall, the soil PFAS results indicate that:

– Soils within the Project footprint that are likely to be disturbed during the construction works are not likely to pose an unacceptable risk to human health from exposure to PFAS.
– Flora and fauna may be indirectly (i.e. exposure through the food chain) exposed to elevated PFOS concentrations in the soil; however, it is noted that there was only one reported exceedance and it was relatively marginal. Concentrations of PFAS in the soil samples are generally consistent with those previously identified more broadly across the Base.

5.3.5 Defence PFAS Framework Assessment Criteria

All analytical results were below the Category 3 trigger value, except for those summarised in Table 5.

Table 5.3 Defence PFAS Framework

Field ID	Analyte	Result	Assessment criteria source	Assessment criteria value
CTH005_0.9-1.0	Sum of PFHxS and PFOS	0.0145 mg/kg	Defence PFAS Framework - Cat 3	0.01 mg/kg

According to the Defence PFAS Framework, the above sample would be considered Category 3, and therefore the associated soils can be reused within the works site with no additional mitigation, or on Base if the risk to human health or the environment is not increased or otherwise results in unacceptable risk.

Of the remaining 29 primary soil samples, 20 would be considered Category 4, and 9 were non-detect (i.e. PFAS concentrations below the laboratory LOR).

5.3.6 Preliminary waste classification

A preliminary waste classification, based on the limited sampling undertaken, was carried out using the analytical results from this investigation, with some additional TCLP testing for PAH and PFAS on selected samples based on initial results.

The concentrations were below the thresholds for General Solid Waste (CT1 (no Leaching) or SCC1 (with TCLP) and TCLP1), with the exception those summarised in Table 5.

Table 5.4 NSW waste classification

Field ID	Analyte	Result	Assessment criteria source	Assessment criteria value
TH002_0.0-0.1	Benzo(a) pyrene	18.9 mg/kg	General Solid Waste SCC1 (with TCLP)	10 mg/kg
	PAHs (Sum of total)	222.0 mg/kg	General Solid Waste CT1 (no leaching)	200 mg/kg

If it is necessary to dispose soil off-site (i.e., if design solutions enabling re-use are not identified), the reported contaminant concentrations indicate that:

– The majority of the soil excavated as part of works is likely classified as General Solid Waste.
– Surface soils (up to 0.3 mbgl) excavated from the vicinity of TH002 may need to be disposed of as Restricted Solid Waste due to elevated PAH concentrations.

It is important to note that the waste classification is indicative for costing purposes associated with the 30% CDR and additional confirmation sampling may be required for off-Base disposal to satisfy either state regulatory requirements or local landfill acceptance criteria.

6. Quality assurance and control

Results and discussion regarding quality assurance and control (QAQC) are presented below.

6.1 Field QAQC

6.1.1 Duplicate RPDs

Four intra-laboratory duplicates and two inter-laboratory duplicates were submitted to the laboratories for analysis. Relative percent differences (RPDs) were calculated for the duplicate pairs, with results summarised in Table 6 in Appendix B.

RPD exceedances for soil are summarised in Table 6.1. RPD exceedances were not included in the table below if both the primary and duplicate concentrations were less than 10 times the LOR or for sums of analytes

Table 6.1 Duplicate RPD exceedances

QC Sample	Parent Sample	Analyte	RPD (%)	Comment
QC102	TH004_0.0-0.1	Nickel	40	Concentrations were relatively low and the difference in concentrations between the primary and duplicate samples was marginal and generally the same order of magnitude. The difference in concentrations is likely attributed to the heterogeneity of the sample material.
		Acenaphthylene	82	
		Anthracene	95	
		Benz(a)anthracene	94	
		Benzo(a)pyrene	96	
		Benzo[b+j]fluoranthene	88	
		Benzo(k)fluoranthene	90	
		Benzo(g,h,i)perylene	87	
		Chrysene	104	
		Fluoranthene	101	
		Indeno(1,2,3-c,d)pyrene	93	
		Phenanthrene	108	
		Pyrene	103	
QC202	TH004_0.0-0.1	Arsenic	63	
		Lead	47	
		Nickel	32	
		F3 (>C16-C34 Fraction)	67	
		Benz(a)anthracene	53	
		Benzo(a)pyrene	54	
		Benzo(k)fluoranthene	111	
		Chrysene	87	
		Fluoranthene	65	
		Indeno(1,2,3-c,d)pyrene	54	
		Phenanthrene	85	
		Pyrene	71	
QC105	TH001_0.9-1.1	Chromium (III+VI)	67	
QC107	CTH003_0.3-0.4	Copper	67	

QC Sample	Parent Sample	Analyte	RPD (%)	Comment
QC207	CTH003_0.3-0.4	Copper	67	
		Zinc	34	

The above duplicate RPD exceedances are relatively marginal and likely attributed to sample heterogeneity, which is expected given the soils encountered. GHD considers that the indicated variability is unlikely to affect the outcome of the assessment, given the general consistency of the maximum contaminant concentrations.

6.1.2 Trip spikes and blanks

A total of six soil trip blank and spike sets (QC501 to QC503 and QC601 to QC603 respectively) were submitted to the primary laboratory for analysis, the results of which are presented in the laboratory certificate of analysis (COA) provided in Appendix C.

The trip spike concentrations were comparable to the trip spike control (TSC), indicating minimal volatile contaminant loss. The trip blank concentrations were all below the LOR, indicating that no detectable contamination was introduced during sample transport and handling, and also confirmed that the testing laboratory was not reporting “false positives”.

6.2 Laboratory QAQC

The laboratory carried out internal QC procedures as part of its NATA accreditation, which included analysis of QC samples (duplicates, method blanks, control samples, laboratory-controlled spikes, matrix spikes, and sample surrogates). Laboratory QAQC documentation, including holding time compliance, frequency of QC samples, and QC results are provided in Appendix C).

The documents were reviewed by GHD and indicated that the laboratory was generally operating and providing results within its acceptable limits.

7. Conclusions and recommendations

Based on the scope of works carried out, the objectives outlined above and subject to the limitations set out in Section 9, the following conclusions are made:

Asphalt

– Asphalt sample results indicate the material would likely be suitable for reuse on site (all four samples reported concentrations of PFAS below the laboratory LOR), or otherwise disposed off site, indicatively pre-classified as General Solid Waste (GSW).

Soil

– Detections of TRH F3 and/or F4 in soil, above the laboratory LOR, were identified at six out of the 12 investigation locations. While detections were predominantly associated with surface soils (except for CTH005_0.9-1.0) there was no clear pattern in the spatial distribution to determine the specific source. However, concentrations of TRH in the samples did not exceed the adopted health or ecological assessment criteria.

– Results from the contamination investigation indicate that the soils likely to be encountered during the works do not pose a risk to human health or the environment. As such, they are considered to be suitable for on-site reuse, subject to appropriate management and handling measures.

– According to the Defence PFAS Framework and consistent with previous investigations, the majority of samples were considered Category 4 or were below the laboratory LOR (non-detect), whereby the associated soils can be reused on site without assessment or mitigation. One sample (CTH005_0.9-1.0) was considered Category 3, whereby the associated soils can be reused within the works site with no additional mitigation, or on site if the risk to human health or the environment is not increased or otherwise results in unacceptable risk.

– Preliminary waste classification of the soil indicates the majority of the soil is General Solid Waste with the exception being shallow soil at TH002, to a depth of approximately 0.3 mbgl, which is Restricted Solid Waste due to elevated PAH concentrations.

7.1 Recommendations

Based on the results the following is recommended:

– Further characterisation of materials if it is identified that:
  - The design options include disturbance or excavation of soil or asphalt beyond the extent that has been investigated in this report.
  - Reuse of soil or asphalt is proposed in the vicinity of a more sensitive land use (e.g., residential or recreational/parkland setting) or an ecologically sensitive area.
  - Off-site disposal of surface soil from TH002 is required due to concentrations of benzo(a)pyrene and total PAHs that are classified as a Restricted Solid Waste.
  - Additional controls are required to reduce mobilisation of contaminants to receiving environments during any demolition/removal of existing infrastructure (e.g., drainage headwalls).

– Consideration of key findings of this investigation in the P0008 contaminated soil management plan (CSMP).

– Given the large volumes of material that will be generated by the project, it is recommended that where possible soils and asphalt millings are reused on Base.

8. References

CRC CARE (2017) Technical Report No. 39, Risk-based management and remediation guidance for benzo(a)pyrene. CRC for Contamination Assessment and Remediation of the Environment, January 2017.

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NSW EPA (2014). Waste Classification Guidelines, Part 1: Classifying Waste. November 2014.

NSW EPA (2016). Addendum to the Waste Classification Guidelines (2014) – Part 1: classifying waste. October 2016.

Defence (2021). Defence PFAS Construction and Maintenance Framework. Australian Government, Department of Defence, August 2021 (V3.0).

NSW EPA (2020). Guidelines for Consultants Reporting on Contaminated sites.

9. Limitations

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