

# **Appendix D**

## **Contamination Assessment**



# **Department of Infrastructure, Transport, Regional Development and Communications**

## **Norfolk Island MPS DSC Contaminated Land Assessment**

October 2025

# Executive summary

GHD Pty Ltd (GHD) has been engaged by The Department of Infrastructure, Transport, Regional Development and Communications to undertake a contaminated land assessment that included a site history assessment and initial intrusive investigation within the infrastructure footprint of a proposed Multi Purpose Service (MPS) health facility on Norfolk Island.

The purpose of this contaminated land assessment is to identify the presence of contamination within soils associated with the infrastructure footprint of the proposed MPS facility and assess whether the soil in the infrastructure footprint area poses unacceptable risks to human health or the environment.

## Site history assessment

Based on the known site information, current and historical site use, a number of potential sources of contamination which could have impacted soils within the vicinity of the infrastructure footprint of the proposed MPS facility were identified:

- The use and storage of groundwater from the Norfolk Island Airport (where elevated concentrations of PFAS have been detected)
- Construction and demolition of buildings containing asbestos
- Historical and current operation of a laundry facility and maintenance workshop
- Use of soil fill material
- Fuel storage at the service station and vehicle maintenance workshop, located adjacent to the site
- Historical storage of Norfolk Island Airport fire trucks, located adjacent to the site

## Visual observations of soil fill material

- Minor amounts of inert waste including construction and demolition materials and asbestos containing materials (ACM) were identified below the ground surface.
- Potential ACM fragments were observed on the ground surface east of Mawson House (adjacent to the eastern property boundary / mechanical workshop) and along the steep unsealed track that extends north from the site towards Broken Bridge Creek.

## Soil analytical results

- Three soil samples collected at the site positively identified friable asbestos by laboratory analysis, described as either asbestos sheeting, fibrous asbestos fragments and / or asbestos fibre bundles. The detections of asbestos occurred within near surface soil fill material in two areas of the site:
  - Adjacent to the archive store room / COVID-19 testing tent (nearby to Burglars Lane)
  - Adjacent to the residential house / garage in the southern portion of the site.
- PFAS was detected above the human health assessment criteria in one sample collected from near surface soils adjacent to the maintenance workshop in the northern portion of the site. The detections of PFAS may be attributed to the identified former use of groundwater originating from the Norfolk Island Airport and previously stored in a below ground tank located adjacent to the maintenance workshop.
- The concentrations of lead within three near surface samples collected from soil fill material exceeded the adopted the human health assessment criteria. Lead concentrations greater

than the adopted human health screening criteria are not widespread, but localised within selected samples collected nearby where the operation, storage or re-fuelling of motor vehicles has occurred.

## Conclusions

Based on the site history assessment and field investigations, some contamination is present within the infrastructure footprint of the proposed development, which may pose a risk to human health or the environment. The following conclusions are made:

- Asbestos identified in some areas of the site may present a risk to human health during any intrusive works or ground disturbance activities at the site. The extent of asbestos and the concentration of asbestos within soil is currently unknown.
- The former storage and use of groundwater from Norfolk Island Airport may have resulted in some localised PFAS contamination of soils.
- Elevated lead concentrations are not widespread, but localised to certain areas and material types. The identified concentrations of lead within selected samples may present a risk to human health.
- The depth of soil fill generally extended to a depth of 0.4 mbgl at the site, but was encountered to depth of at least 1.3 mbgl in the northern portion of the site.
- Further investigation and assessment will be required to assess the risk of soil impacts within the infrastructure footprint of the proposed MPS facility.

## Recommendations

There are a number of potential remediation and management pathways available to manage the potential risks associated with the soil contamination identified at the site.

Based on the findings of the assessment, the following initial recommendations are made:

- Undertake a supplementary investigation with the aim to close out identified data gaps by:
  - Delineation of the lateral extent asbestos detected within the soil fill and assessing the concentration of ACM in soil and the risk this presents to human health.
  - Identifying the contamination status of the tank formerly used to store groundwater from the Norfolk Island Airport, in addition to analysis of adjoining infrastructure and deeper surrounding soils the tank.
  - Determine the lateral and vertical extent of soil fill in the northern portion of the site.
- Prepare a Remediation Options Assessment and Management Strategy. This assessment would be based on the identified contamination to date and the findings of the supplementary contamination investigation with the infrastructure footprint of the proposed MPS facility. Options may include:
  - Excavations to the lateral and vertical extent of identified contamination and placement within an engineered containment cell. This would require consideration during the 50% design phase.
  - On site remediation.
  - Design alterations, to consider leaving contaminated pipes or other structures in-situ.
- Notification to NHIRACS that:
  - Asbestos is present in near surface soils adjacent to the COVID-19 tent. The purpose of this is to ensure that an unexpected find protocol is in place to safely manage any potential ACM (if) encountered when removing the COVID-19 tent.

- Potential ACM fragments were identified along the site boundary between Mawson House and the mechanical workshop. The purpose of this is to ensure that human health risks are managed according by hand picking the fragments and disposal off site in consultation with NIRC.

# List of abbreviations

Acronyms	
ACM	Asbestos Containing Material
AHD	Australian Height Datum
ALS	Australian Laboratory Services
AQIS	Australian Quarantine and Inspection Service
AS	Australian Standard
AST	Above ground Storage Tank
BH	Borehole
BTEXN	Benzene, Toluene, Ethylbenzene, Xylenes and Naphthalene
CLM Act	NSW <i>Contaminated Land Management Act 1997</i>
COC	Chain of Custody
COVID-19	Coronavirus disease
CoPC	Contaminates of Potential Concern
CRC Care	Cooperative Research Centre for Contamination Assessment and Remediation of the Environment
CSM	Conceptual Site Model
DOEE	Department of the Environment and Energy
ESLs	Ecological Screening Levels
HA	Hand auger
HEPA	Heads of EPAs
HILs	Health Investigation Levels
HSLs	Health Screening Levels
NATA	National Association of Testing Authorities
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NEMP	National Environmental Management Plan
NICE	Norfolk Island Consulting Engineers
NIHRACS	Norfolk Island Health and Residential Aged Care Service
NIRC	Norfolk Island Regional Council
LOR	Limit of Reporting
mbgl	Meters Below Ground Level
MPS	Multi Purpose Service
OC/OPPs	Organophosphorus and organochlorine pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PFAS	Per- and polyfluoroalkyl substances
PID	Photo Ionisation Detector
QA/QC	Quality Assurance / Quality Control
SAP	Sampling Analysis Plan
SPR	Source Pathway Receptor
TCE	Trichlorethylene/ Trichlorethylane
TP	Test Pit
TRH	Total Recoverable Hydrocarbons
VOC	Volatile Organic Compounds

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# Document Status

## *Document Restriction Level*

UNCLASSIFIED

## *Document Revision Status*

This document is in *Final Form*.

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# 1. Introduction

GHD Pty Ltd (GHD) has been engaged by The Department of Infrastructure, Transport, Regional Development and Communications to undertake a contaminated land assessment within the infrastructure footprint of a proposed Multi Purpose Service (MPS) health facility on Norfolk Island.

This report details the results and findings of the contaminated land assessment completed to date, including a site history assessment and initial intrusive investigation.

## 1.1 Project background

The objective of the Norfolk Island Health and Residential Aged Care Service (NIHRACS) Multi-Purpose Service (MPS) Facility Replacement Project is to replace, refurbish or demolish (where appropriate) ageing assets approaching the end of its useful life, or have capacity, condition, and compliance high risk issues.

The project is currently at the 30% Concept Design Phase and design drawings showing the proposed infrastructure layout of the Project are provided in Appendix A.

## 1.2 Objectives

The objectives of the contaminated land assessment were to:

- Assess the nature and extent of any existing or potential contamination within soils associated with the infrastructure footprint of the proposed MPS facility.
- Assess whether the soil in the infrastructure footprint area poses unacceptable risks to human health or the environment.

## 1.3 Scope of works

The scope of works for the contaminated land assessment comprised the following tasks:

- Review of desktop information pertaining to investigation area.
- Preparation of a site specific a Project Health, Safety, and Environment Management Plan.
- Completion of a site walkover and interviews with site personnel by a GHD Environmental Scientist.
- Undertaking a targeted soil sampling program consisting of:
  - Ten soil bores to a maximum of 3.0 meters below ground level (mbgl)
  - Six soil bores to 1.0 mbgl
  - Three test pits to a maximum depth of 0.6 mbgl.
- Logging of soil encountered and collection of soil samples from the boreholes and test pits.
- Submission of an Australian Customs Declaration with Australian Quarantine and Inspection Service (AQIS) permit issued to Australian Laboratory Services (ALS) for the import of samples from Norfolk Island to the Australian mainland.
- Submission of soil samples to an Australian National Association of Testing Authorities (NATA) accredited laboratory.
- Preparation of this report detailing the investigations undertaken, the results of sampling, the nature and extent of any existing contamination in addition to the provision of recommendations and further investigations (if required).

It is noted that no assessment of groundwater was undertaken as part of this assessment.

## 1.4 Regulatory framework

The works were completed in general accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as updated in 2013 (NEPM). The NEPM is the national guidance document for the assessment of site contamination in Australia; the purpose of this guidance is to establish a nationally consistent approach for the assessment of site contamination. The NEPM contains a number of schedules providing guidance on how to characterise site contamination, and assess the potential risks associated with this contamination.

Key guidance documents considered in the preparation of this Site Investigation Report include:

- Australian Standard AS 4482.1–2005. *Guide to the investigation and sampling of sites with potentially contaminated soil - Part 1: Non-volatile and semi-volatile compounds* (AS4482.1-2005)
- Australian Standard AS 4482.2–1999. *Guide to the sampling and investigation of potentially contaminated soil - Part 2: Volatile substances* (AS4482.2-1999)
- Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), 2011. *Health Screening Levels for petroleum hydrocarbons in soil and groundwater. Technical report series No. 10*. Cooperative Research Centre for Contamination Assessment and Remediation of the Environment
- CRC CARE, 2019. *National Remediation Framework*. Cooperative Research Centre for Contamination Assessment and Remediation of the Environment
- Heads of EPAs (HEPA) Australia and New Zealand and the Australian Government Department of the Environment and Energy (DoEE), *PFAS National Environmental Management Plan*, Version 2.0, January 2020 (NEMP, 2020)
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999, as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), National Environment Protection Council, May 2013
- Standards Australia, 2017. *Geotechnical Site Investigations*, AS 1726:2017, Sydney: Standards Australia
- WA Department of Health (2009), *Guidelines on the Assessment, Management and Remediation of Asbestos Contaminated Sites in Western Australia*, May 2009

## 2. Site information

### 2.1 Site details

The site is located to the north of Grassy Road in the hamlet of Burnt Pine, located in the central portion of Norfolk Island. The site is shown in Figure 1, Appendix B.

Further details regarding the site are summarised in Table 2-1.

**Table 2-1 Site location and details**

Item	Description
Site identification	Norfolk Island Health and Residential Aged Care Services
Site address	2 Grassy Road, Norfolk Island
Property details	<p>The site is comprised of the following allotments:</p> <ul style="list-style-type: none"> <li>• Lot 34 Portion 24K (4,048 m<sup>2</sup>)</li> <li>• Lot 33 Portion 24a3 (925 m<sup>2</sup>)</li> <li>• Lot 35 Portion 24b1 (2,279 m<sup>2</sup>)</li> <li>• Lot 36 Portion 24c (22,360 m<sup>2</sup>)</li> <li>• Lot 60 Portion 24b2 (9,874 m<sup>2</sup>)</li> </ul> <p>The Lot and Portion numbers are identified on the detailed survey plan provided in Appendix C.</p>
Land ownership	<ul style="list-style-type: none"> <li>• Norfolk Island Hospital Enterprise is the owner of: <ul style="list-style-type: none"> <li>- Lot 34 Portion 24K</li> <li>- Lot 33 Portion 24a3</li> <li>- Lot 35 Portion 24b1</li> </ul> </li> <li>• Administration of Norfolk Island is the owner of: <ul style="list-style-type: none"> <li>- Lot 36 Portion 24c</li> <li>- Lot 60 Portion 24b2</li> </ul> </li> </ul> <p>The current certificates of title for the site are provided in Appendix D.</p>
Land zoning	The site is zoned as Special Use Zone, under the Norfolk Island Plan 2002 (amended 21 <sup>st</sup> March 2016). The intent of the special use zone is to protect and preserve land for existing and future public, government, and Administration use or development.
Local government authority	Norfolk Island Regional Council (NIRC).
Current land use	<p>The site is currently used to provide health and aged care services to residents of Norfolk Island.</p> <p>Further details on the current land use and existing infrastructure are provided in Section 4.1.</p>

## 2.2 Surrounding land use

The surrounding land uses are summarised in Table 2-2 and presented in Figure 2, Appendix B. A detailed inspection of the surrounding properties was not undertaken as part of this assessment.

**Table 2-2 Summary of surrounding land uses**

Direction	Descriptions
North	Undeveloped bushland, Broken Bridge Creek
East	Residential properties, service station and mechanical workshop
South	Service station, mechanical workshop, Ferny Lane Theatre
West	Residential properties, commercial plumbing workshop

## 3. Environmental Setting

### 3.1 Topography

The elevation of the site ranges between 110 and 114 m above Australian Height Datum (AHD) (Albert and Macro, 2020). In general, the majority of the site is flat with a gradual downward slope to the south that extends from Burglars Lane to Grassy Road.

The north eastern boundary of the site has a steep downward slope to the north and north east toward a gully containing Broken Bridge Creek, within an area of undeveloped bushland.

### 3.2 Geology

Norfolk Island is situated on the Norfolk Ridge, which comprises deeply weathered erosional remnants of volcanoes consisting of olivine basalt lavas and tuff, which commonly have a weathering profile up to 45 m (GHD, 2017).

There are five main geological formations which comprise the geological units of Norfolk Island (Parsons Brinkerhoff, 2005):

- Ball Bay basalts
- Duncombe Bay basalt
- Cascade basalt
- Steele's Point basalt
- Calcarenite

The basalt formations constitute distinct volcanic layers formed between approximately 3 million and 2.3 million years ago, while the calcarenite was likely formed via deposition of sand, coral and shell fragments cemented with lime along the southern coastline.

### 3.3 Soils

#### 3.3.1 Regional

Norfolk Island is deeply weathered, owing to a humid subtropical climate, and prolonged weathering has produced predominantly clayey decomposed volcanic soils (GHD, 2017).

A geotechnical investigation by Parsons Brinkerhoff (2005), reviewed the Soil Map of Norfolk Island (Stephens and Hutton, 1954) which indicates that the majority of the ten soil groups present across the Norfolk Island are clayey soils developed over basalt flows.

Soil mapping for geotechnical zoning indicates that the area surrounding the site and the surrounding area is likely comprised of either the Middlegate gravelly clay or Rooty Hill clay (Parsons Brinkerhoff, 2005).

#### 3.3.2 Local

Soils at the site encountered during a geotechnical investigation in 2020 (NICE, 2020), typically comprised brown low plasticity silty clay to depths ranging between 0.3 to 0.9 m below ground level (bgl), overlying orange, brown or red brown high plasticity clay extending to depths ranging between 3.0 – 4.5 mbgl.

The intrusive investigation undertaken as part of this site assessment provide a greater understanding of the identification, depth and extent of heterogeneous soil fill material identified across the site, as discussed in Section 8.1.

## 3.4 Hydrology

There are no natural surface water bodies or features at the site. Surface water at the site is expected to follow the local topography and flow south towards Grassy Road across the majority of the site and in a northerly direction along the northern site boundary.

The nearest surface water receptor is Broken Bridge Creek, located approximately 90 m north of the northern site boundary, at the base of a steep gully. Broken Bridge Creek extends in an approximate north east direction and confluences with Cascade Creek prior to discharging into the marine waters of Cascade Bay approximately 2.5 km north east of the site. At the time of the site inspection Broken Bridge Creek was observed to be dry.

The headwaters of Mission Creek are located approximately 500 m south west of the site and adjacent to the Norfolk Island Airport. Mission Creek extends in an approximate north west direction from the airport towards the western coastline of Norfolk Island.

However, given the distance between the site and the airport, it is considered unlikely that surface water runoff from the airport would impact the site.

## 3.5 Hydrogeology

### 3.5.1 Regional

In general, unconfined shallow groundwater within weathered volcanic rock and alluvium is typically intersected by groundwater wells and groundwater bores established across the island. Deeper, semi-confined groundwater is located within basalt fractures and interbedded tuff, which extends up to 35 m below sea level (Abell and Falkland, 1991).

### 3.5.2 Local

Mapped groundwater bore locations provided in Abell and Falkland (1991), indicate that one groundwater bore (bore number NI 300) was previously located in the approximate extent of the southern portion of the site and one groundwater well (bore number NI 73) was located in the approximate extent of the northern portion of the site.

Aquifer test data for bore number NI 300 indicates that the bore was established within weathered mantle rock, reported a standing water level of 38.0 mbgl and had a total bore depth of 84.0 mbgl. No data was provided for bore number NI 73.

During a geotechnical investigation at the site, groundwater was not encountered within the seven boreholes drilled to 4.5 mbgl in August 2020 (NICE, 2020).

## 3.6 Groundwater use

It is understood that the Norfolk Island planning laws generally do not support extraction and use of groundwater as a primary water source, as residents on the Island are responsible for the collection of rainwater in decentralised tanks.

### 3.6.1 Groundwater abstraction

#### *On site*

Groundwater is used on site for laundry purposes and extracted from a groundwater bore fitted with an extraction pump located approximately 80 m north of the site, at the base of the steep gully nearby to Broken Bridge Creek. It is understood that the bore is a secondary water supply and that groundwater is not used as a potable water source.

## **Off site**

Mapping within the Norfolk Island Environmental Strategy 2018-2023 (NIRC, 2018) indicates that up to 30 groundwater water bores are located within one kilometre of the site. No publicly accessible details of these groundwater bores were identified as part of this assessment.

### **3.7 Potentially sensitive receptors**

Potentially sensitive receptors in the vicinity of the site are summarised in Section 3.7.1 and Section 3.7.2.

Given the likely depth to groundwater (>15 mbgl) and that groundwater is unlikely to be encountered during excavations for the project onsite, groundwater beneath the site and users of groundwater in the surrounding area are not considered to be potential sensitive receptors.

It is important to note that any beneficial reuse of groundwater for potable purposes, or as a sensitive receptor to either human health or the environmental, has not been considered as it is beyond the scope of this assessment.

#### **3.7.1 Potential human health receptors**

- Current and future users of the site and surrounding properties (e.g. visitors, workers, patients, subcontractors and surrounding residents).
- Current and future intrusive construction and maintenance workers at the site (e.g. any person undertaking works at the site that may contact soil).

#### **3.7.2 Potential environmental receptors**

- Fauna and flora species likely to occur, either on the site, land located adjacent to the site or known to frequent either the site or adjacent land.
- Broken Bridge Creek, which is considered to be the closest receiving surface water body.

## 4. Site history

### 4.1 Site inspection

A GHD Environmental Scientist conducted a site inspection on 21 September 2020. The purpose of the inspection was to identify and observe existing infrastructure, discuss historical use and current activities with site personnel, identify and mark proposed sampling locations and supervise the clearance of sampling locations by a qualified underground service locator.

An inspection of the surrounding properties was not undertaken as part of the site inspection.

Selected photographs taken during the inspection are provided in Appendix E. Key site features are presented on Figure 2, Appendix B.

#### 4.1.1 Site inspection

Key observations during the inspection included:

- A sealed access road extended in a north easterly direction through the centre of the site from the entrance on Grassy Road. The access road contained formal car parking bays in the central portion of the site and an informal car parking on a grassed area.
- The main NIHRACS building was located in the central western portion of the site. The building was comprised of a number of smaller, interconnecting, single storey buildings, that provided the following services:
  - acute inpatient area
  - medical centre
  - waiting rooms and consult areas
  - residential aged care
  - medical imaging
  - physiotherapy
  - administration, staff rooms, kitchen, various storage areas
  - social worker personnel
  - maintenance workshop (Photo 2).
  - one adjoining above ground water storage tank
- A small garden area with outdoor seating was located adjacent to the physiotherapy and maintenance workshop areas of the main NIHRACS building.
- A laundry building with on site washing and drying facilities was located directly east of the small garden area / physiotherapy area.
- A doctor's residence building, current used as a specialist COVID-19 treatment unit, was located directly east of the laundry building.
- Two freestanding buildings, one used as a morgue and one used by the Red Cross, were located north of the laundry.
- A large underground water storage tank was located directly adjacent to the maintenance workshop in the northern portion of the site.
- Two above ground water storage tanks were located north east of the maintenance workshop. Both tanks were located within and / or adjacent to rectangular concrete foundations associated with the former sewerage treatment plant and discussed in Section 4.2.

- A very steep slope extended north beyond the two above ground water storage tanks and the doctor's residence building. The steep slope was mostly well vegetated and contained an unsealed access track that extended downslope to north and terminated on a flat area where a groundwater bore with in situ water pump and a decommissioned concrete groundwater well were located. Fragments of potential asbestos containing material (ACM) and varying amounts of inert construction and demolition waste, including concrete, brick and asphalt were observed on the surface of the unsealed access track.
- Three buildings were located in the central portion of the site between Burglars Lane and the access road that intersects the site. A rectangular building used to store archived hospital records was located adjacent to Burglar Lane along the eastern site boundary (Photo 9). A dental clinic with adjoining above ground water storage tank was located directly west of the archive store. An internet server room with associated information technology services was located west of the dental clinic.
- A large rectangular tent was located directly south of the archive store to enable drive thru COVID-19 testing for residents and visitors (if required).
- A rectangular building called Mawson House, located in south western portion of the site, was used as a meeting room and for medical storage. Scattered fragments of potential ACM were observed on the ground surface directly adjacent to the western side of the building.
- Two above ground water storage tanks were located in the south eastern corner of the site adjacent to the Grassy Road.
- An electrical transformer on a concrete slab was present adjacent to Grassy Road along the southern site boundary which appeared to be intact with no signs of cracking or weathering.
- An ambulance station and two above ground water storage tanks were located in the southern portion of the site.
- An unoccupied single storey residential property with adjacent rectangular garage was located in the southern eastern portion of the site. The vegetation surrounding the house and garage was overgrown. The house contained warning signs advising that ACM were present. The garage contained various old tins and plastic containers (mostly unlabelled or illegible), a waste oil container, one old fire extinguisher and minor staining / discoloured soils below two wooden crates (~1 m x ~1 m). Overgrown vegetation prevented access to the northern portion of the garage. Fragments of potential ACM were noted on the ground surface and within the vegetation directly adjacent to the garage.
- The eastern portion of the site adjacent to Burglars Lane was undeveloped land. A large twinned trunked Norfolk Island pine tree was located in the south eastern corner of the site.

Hazardous material assessments were not undertaken of any buildings, store material or equipment as part of this assessment.

#### **4.1.2 Off site observations**

Relevant off-site observations during the inspection included:

- A service station with adjoining mechanical workshop was located directly adjacent to the south western corner of the site. Tyres, dilapidated fuel bowsers, metal tanks inferred to be water heaters, and various inert waste materials including fragments of potential ACM, concrete and metal pipes on the ground surface directly adjacent to the site.

## 4.2 Site interviews

Informal site interviews were undertaken with site personnel and external contractors:

- Kathlene Bowman, NIHRACS Manager
- Lou Quintal, NIHRACS Maintenance Personnel
- Jim Travner, Norfolk Industries
- Andrew Barnett, Island Plumbing and Gas

Anecdotal information provided during the inspection and intrusive investigation included:

- A bakery was previously located where the archive store room was located onsite. The bakery burnt down during a fire in approximately 1970 – 1972. The bakery was rebuilt shortly after the fire and continued to operate until approximately 1980, after which it was used by NIHRACS. In approximately 2015/2016 the building was rebuilt as a shed constructed with sheet metal and aluminium framing after the previous structure which contained ACM was removed.
- The unoccupied single storey residential property located in the southern portion of the site was previously owned and occupied by a local resident known as Tinee Menzies. When Tinee resided in the house, horses grazed in the grassed area to the west of the house adjacent to Burglars Lane. Imported olive trees were also cultivated / maintained north of the property. It is understood that Tinee had worked at the Norfolk Island airport for many years. After his death approximately 30 years ago, the house was occupied by various rental tenants prior to being abandoned approximately 3 – 5 years ago.
- A diesel generator was located adjacent to the southern site boundary in the proximity of the current electrical transformer. The generator was a standby system used to maintain power to the site during power outages. The diesel above ground storage tank (AST) was approximately 200 L. The generator and AST were removed approximately 20 years ago and transported to the council works depot.
- A sewerage treatment plant which comprised one separator and one aerator system, was constructed in the northern portion of the site in the 1970s. The sewerage treatment plant was located where the two above ground water storage tanks are currently located (north east of the maintenance workshop). The sewerage treatment plant was decommissioned in 1989/1990 and mostly backfilled with soil after the concrete structures were broken up and left in situ below the ground surface.
- During the installation of the two above ground water storage tanks, located north east of the maintenance workshop (within the footprint of the former sewerage treatment plant), concrete was consistently encountered during excavation to establish 200 mm deep footings / foundations for the slabs where the tanks were mounted.
- Soil fill generated during excavation to establish the sewerage treatment plant in the 1970s, was likely to have been re-used on site in the vicinity of the morgue and the doctor's residence building to fill uneven ground.
- Before the sewerage treatment plant was constructed, 'soaking trenches' were used for disposal of waste water at the site. It is understood that the trenches were located in the northern portion of the site, in the vicinity of the grassed area located between the mortuary and the doctor's residence building.
- Septic tanks were also previously used onsite, with waste water removed via pump out to a truck that transported the waste water from the site.

- There is currently one groundwater bore located north of the site at the base of the steep gully, which is used to extract groundwater for laundry purposes only and is not used as a potable water source.
- A water supply connection from Norfolk Island Airport to the site was established in late 1980's / early 1990's. It was communicated that this supply of groundwater was historically used by the on site laundry only, and not for irrigation or other purposes onsite. It was noted that groundwater from the airport is no longer used on site.
- Fire trucks from the Norfolk Island Airport were previously stored directly west of the site, on the western side of Burglars Lane where Island Plumbing and Gas are currently located.
- Small herb gardens are located in raised gardens located in the fenced courtyard located directly adjacent to the physiotherapy building.
- Orange trees are located on the steep and well vegetated slope in the northern portion of the site but understood not to be consumed.
- The eastern portion of the site in the vicinity of the temporary COVID-19 testing tent and Burglars Lane, was burned in 2019 to control / remove old vegetation.

#### 4.2.1 Supplementary site interviews

In November 2020, a GHD Engineer visited the site and was told by a NIRC staff member that the groundwater connection between the Norfolk Island Airport and the site, was established to transport groundwater to a below ground tank located directly adjacent to the current maintenance workshop.

### 4.3 Historical aerial photographs

A review of available historical aerial photographs and imagery between 1942 and 2020 was completed to determine significant changes in land use and potential contaminating activity at the site and surrounding area. Historical aerial photographs are provided in Appendix F.

**Table 4-1 Summary of historical aerial photograph review**

Date	Photo details	Site observations	Surrounding land observations
1942	Source: Royal New Zealand Air Force, provided by NIRC  Resolution: Fair  Type: Black and white aerial photograph	The majority of the site was cleared and characterised by grassland.  In general, the ground surface was not uniform and appeared to undulate with portions of potential ground disturbance.  A circular structure was present in the south eastern corner of the site, directly adjacent to the Grass Road.	Grass Road was unsealed and present adjacent to the southern site boundary.  The area surrounding the site was mostly characterised by cleared land used for either rural resident land use or small scale stock grazing or agriculture.
1968	Source: Unknown, provided by NIRC	The northern and eastern portions of the site has been developed with NIHRACS buildings and infrastructure.	The Central Service Station and mechanical workshop was present directly south east of the site.

Date	Photo details	Site observations	Surrounding land observations
	<p>Resolution: Good</p> <p>Type: Black and white aerial photograph</p>	<p>Ground disturbance and / or exposed soils were present, surrounding the NIHRACS building and extended throughout the adjacent area to the north.</p> <p>An unsealed access road extended from Grassy Road to the NIHRACS building.</p> <p>The residential house with detached garage was located in the southern portion of the site was present.</p> <p>The ground surface in the western portion of the site was a pale brown colour, but it is unclear if this is due to possible ground disturbance or image resolution.</p>	<p>Selected portion of land adjacent and nearby to the site had been developed with residential properties.</p>
2005	<p>Source: Google Earth</p> <p>Resolution: Good</p> <p>Type: Colour aerial image</p>	<p>The general, current configuration of NIHRACS buildings was visible.</p> <p>The residential property in the southern portion of the site was surrounded by a fence.</p> <p>Exposed soil, associated with a driveway extending from the garage of the residential property to Grass Road, was present.</p> <p>Exposed soil was present directly adjacent to the NIHRACS maintenance workshop in the northern portion of the site in the vicinity of parked vehicles.</p>	<p>The area surrounding the site had been developed and contained building and properties similar to the present day configuration.</p>
2011	<p>Source: Google Earth</p> <p>Resolution: Good</p> <p>Type: Colour aerial image</p>	<p>The site appeared unchanged from the 2005 aerial image.</p>	<p>The surrounding area appeared relatively unchanged from the 2005 aerial image</p>

Date	Photo details	Site observations	Surrounding land observations
2015	Source: Google Earth Resolution: Good Type: Colour aerial image	The site appeared unchanged from the 2011 aerial image.	The surrounding area appeared relatively unchanged from the 2011 aerial image
2020	Source: Google Earth Resolution: Good Type: Colour aerial image	Vegetation clearance of trees had occurred in the central portion of the site. Ground disturbance and exposed soil was present in the central portion of the site. An access track had been cleared from the northern site boundary towards Broken Bridge Creek, which formed an approximate 'S-shape'. A number of circular rainwater tanks had been constructed in the south eastern and northern portions of the site.	The surrounding area appeared relatively unchanged from the 2020 aerial image

#### 4.4 Historical ownership review

Current titles for the site were provided by Norfolk Island Regional Council, however titles detailing previous owners of the allotments that comprise the site were not available for review.

#### 4.5 Previous investigation reports

A number of reports and documents were reviewed and summarised as part of the preliminary desktop assessment, provided in Appendix L.

- Geotechnical Investigation Report (Draft), NICE (2020)
- Tree assessment, Oberonia Botanical Services (2020)
- Asbestos building materials assessment, GHD (2016)
- Norfolk Island Report on Geotechnical Soils Investigations, Parsons Brinkerhoff (2005)

## **4.6 Potential sources of contamination**

A number of potential sources of contamination have been identified within the entire site based on the known site information, environmental setting and current and historical site use (i.e. the information presented in Section 2 – Section 4 of this report). However, it is noted that this assessment relates to the infrastructure footprint of the proposed MPS facility (rather than the entire site). Therefore, the following potential sources of contamination have been identified which could impact soils within the MPS facility footprint:

- Former diesel AST (associated with the former generator)
- Former sewerage treatment plant
- Former use of groundwater from the Norfolk Island Airport
- Historical and current operation of laundry facility
- Construction and demolition of buildings
- Use of soil fill materials
- Maintenance workshop
- Fuel storage at the service station and vehicle maintenance workshop (adjacent to the site)
- Historical storage of Norfolk Island Airport fire trucks (adjacent to the site)

These potential sources of contamination are further discussed in Section 5.

## **5. Preliminary conceptual site model**

A preliminary conceptual site model (CSM) identifying the potential source-pathway-receptor (SPR) linkages, was prepared based on the preliminary desktop assessment (Appendix L) and site history which identified contaminants of potential concern (CoPC) and key areas of interest associated with the infrastructure footprint of the proposed MPS facility.

The CSM considers the site in the context of the proposed infrastructure footprint and any current operational areas of the NIHRACS facility.

The preliminary desktop assessment (Appendix L) identified that the depth to groundwater at the site is likely to be >15 mbgl and unlikely to be encountered during excavations at the site during construction. Consequently, groundwater is considered unlikely to be pathway for the migration of potential contamination from the site during the construction phase of the project.

It is important to note that any beneficial reuse of groundwater for potable purposes, or as a sensitive receptor to either human health or the environmental, has not been considered as it is beyond the scope of this assessment.

A tabulated summary of the preliminary conceptual site model (CSM), based on the desktop assessment and site history is presented Table 5-1.

**Table 5-1 Summary of preliminary conceptual site model**

Potential source	Contaminants of potential concern	Pathway	Receptor
Former diesel AST (associated with generator)	Heavy metals, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAH)	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Surrounding land users and occupiers</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Former sewerage treatment plant	Heavy metals, TRH, BTEXN, PAH, organophosphorus and organochlorine pesticides (OC/OPPs), polychlorinated byphenyls (PCBs), per- and polyfluoroalkyl substances (PFAS), ACM	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Surrounding land users and occupiers</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Former use of groundwater from Norfolk Island Airport	PFAS	<ul style="list-style-type: none"> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Historical and current operation of laundry facility	Trichlorethylene/ Trichlorethylane (TCE), PFAS	<ul style="list-style-type: none"> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> </ul>

Potential source	Contaminants of potential concern	Pathway	Receptor
			<ul style="list-style-type: none"> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Construction and demolition of buildings	ACM	<ul style="list-style-type: none"> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Soil fill materials	Heavy metals, TRH, BTEXN, PAH, OCP, OPP, PFAS, ACM	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna)</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Maintenance workshop area	Heavy metals, TRH, BTEXN, PAH, OCP, OPP, ACM, PFAS	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Fuel storage at the service station and vehicle maintenance	Heavy metals, TRH, BTEXN, PAH	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> </ul>

Potential source	Contaminants of potential concern	Pathway	Receptor
workshop (adjacent to the site)		<ul style="list-style-type: none"> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Surrounding land users and occupiers</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>
Historical storage of Norfolk Island Airport fire trucks (adjacent to the site)	PFAS	Direct contact (oral / dermal)	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Surrounding land users and occupiers</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>

## **5.1 Initial data gaps and uncertainties**

Based on the information reviewed, a number of data gaps / uncertainties were considered to exist prior to the intrusive investigations. The intrusive investigations therefore aimed to close out or reduce the data gaps / uncertainties outlined below:

- The current contamination status of soils within the infrastructure footprint of the proposed MPS facility, including the presence and composition of soil fill materials (given that no previous investigations are understood to have occurred at the site).
- If off site land uses including the current service station and (former) storage of Norfolk Island Airport fire trucks adjacent to the site has resulted in potential migration of contamination to the proposed development area.

## 6. Field investigation

### 6.1 Approach

A Sampling Analysis Plan (SAP) was produced to guide the intrusive investigations and is provided in Appendix M.

The intrusive investigations generally targeted the proposed design and areas where potential sources of contamination and / or potentially contaminating activities may have been undertaken and were considered to have the potential to impact soils within the infrastructure footprint of the proposed MPS facility (based on the findings of the site history review).

### 6.2 Deviations from SAP

During the initial intrusive investigations, a number of deviations from the SAP occurred. The deviations are summarised in Table 6-1.

**Table 6-1 Deviations from SAQP**

Deviation from SAQP	Variation from SAP justification / action taken
Additional sample locations	<p>Three additional hand augers were established during the intrusive investigation based on observation during the inspection and / or site interviews undertaken with site personnel, as detailed in Section 4.1 and Section 4.2:</p> <ul style="list-style-type: none"><li>• HA02 was established where minor staining / discoloured soils was identified below two wooden crates located within the rectangular garage in the south eastern portion of the site.</li><li>• HA05 was established directly adjacent and topographically downgradient of the former sewerage treatment plant in the northern portion of the site.</li><li>• HA06 was established topographically down gradient of the building formerly used for autopsy in the northern portion of the site.</li></ul>
Relocation of TP03	<p>TP03 was repositioned to the eastern side of the garage due to overgrown vegetation preventing access to the western side of the garage.</p>
Additional laboratory analysis	<p>Additional laboratory analysis was required for:</p> <ul style="list-style-type: none"><li>• the establishment of three additional sample locations</li><li>• delineation of concentrations of CoPC detected above either the adopted assessment criteria or laboratory limit of reporting (LOR) in selected samples</li></ul>

Deviation from SAQP	Variation from SAP justification / action taken
Additional laboratory analysis - Speciation of Chromium (III+VI)	Following receipt and initial review of results, concentrations of Chromium (III+VI) were detected above the adopted assessment criteria at selected samples. Speciation of the oxidation state of Chromium (III) or Chromium (IV) was scheduled for 16 of the 40 results (40% of primary samples detected above the adopted assessment criteria). A range of samples collected from different depths from across the site were selected for the speciation analysis.

## 6.1 Field work program

The fieldwork program undertaken is summarised in Table 6-2.

**Table 6-2 Summary of fieldwork program**

Date	Activity
21 September 2020	Underground service location and site walkover to establish the final position of investigation locations following interviews with site personnel.
22 September 2020	Advancement and sampling of boreholes (BH01 – BH04)
23 September 2020	Advancement and sampling of boreholes (BH05 – BH10) Advancement and sampling of test pits (TP01-TP03)
24 September 2020	Advancement and sampling of hand augers (HA01 – HA06)

## 6.2 Field methodology

Soil samples were collected with reference to Section 18 of the PFAS NEMP (version 2.0) and Schedule B2 of the NEPM. A summary of the field methodology is presented below.

### 6.2.1 Soil investigation

The soil sampling methodology is summarised in Table 6-3. Soil sampling locations are presented in Figure 3, Appendix B.

**Table 6-3 Soil sampling methodology**

Activity	Details
Underground services locating	An independent contractor was used to clear underground services using radio-detection prior to any sub-surface works being undertaken.
Sampling plan design	Soil sampling locations were distributed on an approximate grid within the proposed infrastructure layout of the Project. Whilst the layout of the Project is predominately located in the western portion of the site, a limited number of locations were also advanced in the south eastern corner and northern portion of the site where potential sources of contamination and / or potentially contaminating activities were identified from the site history assessment detailed in Section 4.
Borehole advancement	Ten soil bores were advanced across the site using a backhoe with an attached rear solid flight auger.

Activity	Details
Test pit advancement	Three test pits (TP01 – TP03) were using an eight tonne excavator with a 300 mm wide bucket. The intention was to advance each test pit to a maximum depth of 0.5 mbgl or a minimum of 0.2 m into natural material.
Hand auger advancement	Six manual hand auger soil boreholes (HA01 – HA06) were established to a maximum depth of 1.0 mbgl.
Soil logging	Soils encountered during excavation were described and logged by an Environmental Scientist. Records of the soil types encountered (including depths and related observations) are presented in the soil lithological logs in Appendix G.
Soil sampling	<p>Soil samples were collected at each sample location from the approximate depths of the surface/near surface (0.0 – 0.2 mbgl), 0.2 mbgl, 0.5 mbgl, 1 mbgl and then every 0.5 m within soil fill or every 1 m within natural soil, or when changes in lithology or visual / olfactory evidence of potential contamination were observed.</p> <p>All samples were collected using disposable nitrile gloves and transferred into laboratory prepared and supplied sampling containers appropriate for the analysis required.</p> <p>Samples collected from soil bore or hand auger locations were obtained directly from the solid flight auger or the hand auger.</p> <p>Samples collected from test pit investigation locations were obtained from the centre of the excavator bucket.</p> <p>Soil samples were field screened used a photo-ionisation detector (PID) and are included in the soil lithological logs in Appendix G. The calibration certificate of the PID is provided in Appendix H</p> <p>Samples were identified with a unique label, incorporating the sample location and depth. Records of the samples collected (including depths and related observations) are presented in the soil lithological logs.</p>
Sample preservation and transport	<p>Samples were chilled upon collection, stored on ice in an insulated cooler box while on site and in transit to the laboratory. Samples were transferred to the laboratory under Chain of Custody (COC) documentation.</p> <p>Samples were air freighted from Norfolk Island to Brisbane as soon as possible following collection. Ice was repacked in each insulated cooler box Norfolk Island prior to transport to Australian Laboratory Services (ALS) under an ALS AQIS permit and COC documentation.</p> <p>All COC documentation is presented with the laboratory analytical reports in Appendix I.</p>
Decontamination	Decontamination of the drill rig rods and hand auger was undertaken prior to the commencement of sampling each day and between sampling locations. The decontamination process included an initial rinse and scrub with tap water, a scrub of the equipment with a certified PFAS free, nutrient free and fluorine free detergent (Liquinox) with a known chemical composition and double rinsing of the equipment with deionised water. This process is consistent with the requirements of the PFAS NEMP (version 2.0).

Activity	Details
Reinstatement	Each sampling location (borehole, test pit and hand auger) was reinstated by returning excavated soils to the sampling location in the approximate order they were removed. No excess spoil was generated as part of the soil sampling.
Quality assurance and quality control (QA/QC)	<p>Four pairs of quality control samples were collected, with each pair consisting of an intra-laboratory ('blind') sample and an inter-laboratory ('split') sample.</p> <p>A pair of trip blanks to assess the potential for cross contamination during transport, were also sent within each of the insulated cooler boxes used to store and transport samples to the laboratory.</p> <p>Further detail regarding the quality assurance / quality control (QA/QC) is presented in Appendix J.</p>

## 6.1 Laboratory analytical program

### 6.1.1 Analytical laboratories

All primary soil, groundwater and intra-laboratory field duplicate (blind) samples were submitted to Australian Laboratory Services (ALS). The analysis of inter-laboratory duplicate (split) samples, for QC purposes, were sent to a secondary laboratory, Eurofins MGT.

Both primary and secondary laboratories are National Association of Testing Authorities (NATA) registered for the analytical program undertaken.

Certified laboratory documentation including COC, sample receipt notifications, certificates of analysis and laboratory QA/QC reports are provided in Appendix I.

### 6.1.2 Primary sample analysis

A summary of the adopted analytical schedule is provided in Table 6-4.

Samples collected from fill material or material in which visual or olfactory evidence of contamination were generally selected for analysis.

**Table 6-4 Laboratory analytical program**

Analysis	No of primary samples analysed	No of QA/QC samples analysed
Heavy metals <sup>[1]</sup> <sup>[2]</sup>	43	2
Lead	45	2
Chromium speciation <sup>[3]</sup>	16	n/a <sup>[7]</sup>
BTEXN, TRH	23	1
PAH	19	1
OP / OPPs, PCBs	16	1
Asbestos (presence / absence)	19	n/a
PFAS <sup>[4]</sup>	21	2
Volatile organic compounds (VOC) <sup>[5]</sup>	4	0
Nutrients <sup>[6]</sup>	4	0

**Notes:**

[1] Heavy metals: arsenic, cadmium, total chromium (III+IV), copper, lead, mercury, nickel, zinc

[2] A total of 45 primary samples were analysed for lead

[3] Speciated chromium analysis was undertaken on selected samples to determine the trivalent and hexavalent concentrations following receipt of initial results

[4] PFAS: A suite of 28 PFAS compounds was selected as this is in line with the standard national laboratory capabilities on PFAS analysis

[5] VOC analysis is undertaken for the identification of TCE

[6] Nutrients: Total nitrogen, total kjeldahl nitrogen, nitrate, nitrite, ammonia, total phosphorous, reactive phosphorous

[7] QA/QC for chromium speciation is not applicable and was undertaken as part of the heavy metals analysis

### **6.1.3 Quality assurance / quality control sample analysis**

A summary of the QA/QC samples collected and analysed as part of this assessment is provided in Appendix J.

## 7. Assessment criteria

For the purposes of this assessment, results were compared against Tier 1 investigation levels appropriate for residential land use with gardens and accessible soil. The adopted Tier 1 investigation levels for residential land use is the most land use setting for protection of human health and are considered appropriate as the proposed new MPS facility will cater for ongoing use of the site by sensitive users that include inpatients and residents of NIHRACS.

Soil results have been assessed against the most conservative Tier 1 guidelines available from the following published documents:

- CRC CARE 2011 *Health Screening Levels for petroleum hydrocarbons in soil and groundwater. Technical report series No. 10.*
- Heads of EPAs (HEPA) Australia and New Zealand and the Australian Government Department of the Environment and Energy (DoEE), *PFAS National Environmental Management Plan, Version 2.0*, January 2020.
- NEPC 2013 National Environmental Protection (Assessment of Site Contamination) Amendment Measure (NEPM) No. 1 – *Schedule B1, Guideline on Investigation Levels for Soil and Groundwater.*

### 7.1 Human health

The NEPM (and related CRC CARE documents referenced in the NEPM) and PFAS NEMP version 2.0) include the human health investigation levels (HILs) and health screening levels (HSLs).

The specific human health based guideline criteria for each analyte grouping is presented in Table 7-1.

**Table 7-1 Human health based guidance for soil**

Analytical suite	Guideline
Heavy metals, PAH, OC/OPPs	NEPM 2013 Table 1A(1) HIL-A Low Density Residential
TRH, BTEXN, VOC (for TCE analysis)	NEPM 2013 Table 1A(3) HSL-A Low density residential for Vapour Intrusion CRC Care 2011 Table A3 HSL-A for Vapour Intrusion CRC Care 2011 Table A4 Soil HSL-A direct contact CRC Care 2011 Table A4 Soil HSL-A Intrusive Maintenance Worker Direct Contact
PFAS	PFAS NEMP version 2.0 2020 Table 2 Human health investigation levels for soil - Residential land use with garden / accessible soil (HIL A)
Asbestos (presence/absence, identification in bulk solids)	Laboratory assessment for the identification of presence / absence of asbestos and the friability / bonded condition of asbestos

## 7.2 Ecological and ecosystem guidelines

Ecological screening levels (ESLs) and ecological investigation levels (EILs) were conservatively applied due to the presence of grassed and unsealed areas at the site. Ecological and ecosystem based guideline criteria for the assessment of soils samples are provided in Table 7-2.

**Table 7-2 Ecological guideline values**

Analytical suite	Guideline
Heavy metals, PAH, OC/OPPs	NEPM 2013 Table 1B(1) to 1B(5) EILs for Urban Residential and Public Open Space
TRH, BTEXN	NEPM 2013 Table 1B(6) ESL for Urban Residential and Public Open Space
PFAS	PFAS NEMP 2020 Table 3 Ecological guideline values for soil - Ecological indirect exposure

## 7.3 Aesthetic considerations

In addition to the above criteria, Section 3.6 of the NEPM (Schedule B1) provides some considerations for potential aesthetic issues which may affect sites that contain fill or refuse / foreign materials. There are no specific numerical guidelines and the assessment process for aesthetic issues requires balanced consideration of the quality, type and distribution of foreign material or odours in relation to the specific land use and sensitivity.

Aesthetic considerations include:

- Highly malodourous soils or groundwater
- Hydrocarbon sheens in surface water
- Discoloured chemical deposits or soil staining with chemical waste other than of a very minor nature
- Large monolithic deposits of otherwise low-risk material
- Presence of putrescible refuse including material that may generate hazardous levels of methane
- Soils containing residue from animal burial.

An assessment of soil aesthetics was made during the investigation with reference to Section 3.6, Schedule B1 of the NEPM.

## 8. Results

The following is a summary of soil results and field observations collected by GHD during the intrusive investigation undertaken in September 2020.

### 8.1 Field observations

The typical subsurface soil profile encountered during the intrusive investigation is summarised below. Detailed lithological logs with PID readings are presented in Appendix G.

#### Fill layer

- Generally comprised of brown, low plasticity gravelly clay or fine to coarse clayey gravel
- The depth of fill generally ranged from the ground surface to between 0.3 mbgl and 0.4 mbgl. The exception to this was the northern portion of the site where soil fill material was identified to a maximum depth of 1.3 mbgl at BH10 and extended to the termination depth of 1 mbgl at HA06. The deeper extent of fill in the northern portion of the site was consistent with site interviews where it was noted that historical filling and / or reinstatement of excavated material occurred following excavation to construct the former sewerage treatment plant.
- Fill soil generally appeared to be reworked natural material, not imported soil fill material.

#### Natural soil

- Fill material was generally underlain by two distinct layers of natural soil which were encountered sequentially.
- The first natural soil layer was typically encountered between 0.3 mbgl and 0.4 mbgl and extended to depths ranging between 1.2 mbgl in central portion of the site (BH05) to 3.0 mbgl along the southern site boundary (BH09). Soil in this layer generally comprised orange brown or red brown medium plasticity clay.
- The above soil layer was generally underlain by medium plasticity clay, typically grey brown or orange brown mottled with red, grey and yellow, with medium to coarse sub-angular to sub-rounded gravels inclusions, inferred to be highly weathered basalt inclusions. This material was encountered at the majority of sample locations to the maximum investigation depth of 3.0 mbgl.

#### PID field screening

In general, PID concentrations ranged between 0.0 parts per million (ppm) and 3.4 ppm in the majority of sampled locations. Higher readings were recorded at HA06\_0.0-0.2 (6.5 ppm) within soil fill material in the northern portion of the site and TP03\_0.0-0.2 (19.7 ppm) where minor discolouration / surface staining within the garage in the southern portion of the site. Laboratory analysis of the two samples within higher PID readings did not identify concentrations of TRH / BTEXN above the laboratory LOR.

#### Visual and olfactory observations of soil fill material

The following visual observations were identified during the assessment. Selected photographs are presented in Table 8-1:

- In general, minor amounts of inert waste materials including plastic, ceramic, glass and wire were identified within near surface soils and are considered likely to have originated from previous activities at the site and not the deposition of waste material that has originated from offsite.

- Deeper fill (with some construction and demolition waste) was identified in the northern portion of the site at BH10, where a concrete boulder was encountered at a depth of 1.1 mbgl.
- Potential ACM identified during the field work program at BH01, HA02 and TP02 within near surface soils (0.0 – 0.2 mbgl), was confirmed by laboratory analysis and is discussed below in Section 8.2.1.
- Potential ACM fragments were observed on the ground surface within overgrown vegetation in areas surrounding the residential house and garage (Photograph 1 and Photograph 2).
- Potential ACM fragments were observed on the ground surface east of Mawson House adjacent to the eastern property boundary / mechanical workshop (Photograph 3 and Photograph 4).
- Potential ACM fragments were observed on the ground surface along the steep unsealed track that extends north from the site towards Broken Bridge Creek.
- Minor discolouration / surface staining was observed within the residential garage, no other olfactory signs of contamination were present (Photograph 5).
- Fragments of charcoal were noted within soil fill layers at BH01 and BH10. The presence of charcoal at BH01 is consistent with site interviews which identified a former bakery was previously located in this area, prior to burning down in the early 1970's. The origin of the charcoal at BH10 is unknown, however the material was comingled within a soil layer that extended to 1.3 mbgl (Photograph 6).
- Roots and wooden fragments were observed within soil at BH03, which is consistent with the site history interviews, which identified that imported olive trees were previously cultivated in this portion of the site.

No other visual or olfactory evidence of contamination was observed during field investigations.

### **Aesthetic considerations**

With the exception of ACM identified, the remainder of the soil encountered as part of this assessment is not considered to have unacceptable aesthetics for the intended site use or reuse onsite.

**Table 8-1 Photographs of field observations**



**Photograph 1** – Overgrown vegetation surrounding residential house



**Photograph 2** – Potential ACM within overgrown vegetation surrounding residential house



**Photograph 3** – Potential ACM fragments between Mawson House and mechanical workshop



**Photograph 4** – General area where potential ACM fragments identified between Mawson House and mechanical workshop



**Photograph 5** – Minor discolouration / surface staining within the residential garage below crates (location od HA02)



**Photograph 6** – Charcoal recovered from BH01

## 8.2 Laboratory analytical results

### 8.2.1 Human health criteria exceedances

Reported concentrations of CoPC within soils were generally below the adopted assessment guideline value for human health and /or the LOR. Where guideline exceedances were reported, results are discussed below.

Tabulated soil results are provided in Table 1, Appendix K.

#### Asbestos

Twenty soil samples collected from soil fill material were initially submitted for asbestos (presence / absence) analysis.

The laboratory detected asbestos at three sample locations: BH01\_0.0-0.2, HA02\_0.0-0.2, TP02\_0.0-0.2. All samples where asbestos was detected were collected from soil fill material from a depth range between 0.0 – 0.2 mbgl. The material positively identified by the laboratory as asbestos comprised either asbestos sheeting, fibrous asbestos fragments or asbestos fibre bundles.

Asbestos was not detected in the remaining seventeen samples initially analysed.

Following the detection of asbestos at BH01, HA02 and TP02, additional analysis was undertaken at each of these locations, with results summarised as follows:

- Delineation analysis did not identify asbestos within the underlying natural soils at BH01 (BH01\_0.3-0.5), HA02 (HA02\_0.5-0.7) and TP02 (TP02\_0.4-0.6) within the first round of additional analysis.
- Qualitative analysis identified that the asbestos detected at BH01, HA02, TP02 was friable, as defined under the WorkSafe Australia regulations, that specify friability is based on the ability to use finger pressure to crush a sample.

Visual evidence of the ACM is presented in Photograph 7 – 12, Table 8-2.

The description of asbestos provided by the laboratory and the soil lithology relative to exceedances and the underlying (delineation) samples is provided in Table 8-3.

Based on anecdotal information gathered during the site inspection (refer to Section 4.2), the identification of asbestos at BH01 (along with trace charcoal), is considered to be associated with the former bakery that is understood to have burnt down during a fire in the early 1970's. Following the fire, the building was rebuilt and is the location of the current archive store room.

HA02 and TP02 are located in the southern portion of the site, adjacent to the unoccupied residential property. Both the house (adjacent to TP02) and the garage (HA02) were noted to be constructed of ACM. It is likely that the asbestos material detected at these locations has resulted from comingling of building materials and the underlying soil fill material. During the field investigation the residential house was noted to be in a state of disrepair with a number of the building surfaces, inferred as potential ACM, containing cracks or broken sheets which may have contributed to the identification of ACM.

**Table 8-2 Photographs of ACM**



**Photograph 7** – ACM at BH01\_0.0-0.2



**Photograph 8** – Location of BH01, established adjacent to COVID-19 testing tent and archive store in the background



**Photograph 9** – ACM at TP02\_0.0-0.2



**Photograph 10** – Location of HA02, established inside residential garage



**Photograph 11** – ACM at TP02\_0.0-0.2



**Photograph 12** – Location of TP02, established adjacent to residential house

**Table 8-3 Summary of asbestos detections and underlying soils**

Location	Sample	Geological extent of material (mbgl)	Type of material	Lithology	Aesthetic considerations and other contaminant indicators	Asbestos detected	Type of asbestos	Friable asbestos
BH01	BH01_0.0-0.2	0.0-0.3	Fill	Gravelly clay	Trace charcoal fragments from 0.1 mbgl	Yes – multiple fibrous asbestos fragments approx. 25x16x4 mm and 3x2x1 mm	Chrysotile	Yes
	BH01_0.3-0.5	0.3 - >3.0	Natural	Clay	No	No	N/A	No
HA02	HA02_0.0-0.2	0.0-0.5	Fill	Clayey gravel	With glass fragments and marine shells	Yes - one asbestos fine approx. 35x15x5 mm.	Chrysotile and amosite	Yes
	HA02_0.5-0.7	0.5 - >1.0	Natural	Clay	No	No	N/A	No

Location	Sample	Geological extent of material (mbgl)	Type of material	Lithology	Aesthetic considerations and other contaminant indicators	Asbestos detected	Type of asbestos	Friable asbestos
TP02	TP02_0.0-0.2	0.0 – 0.4	Fill	Clayey gravel	No	Yes - multiple asbestos sheeting fragments approx. 30x16x3 mm, one fibrous asbestos fragment approx. 3x2x1 mm and multiple asbestos fibre bundles approx. 1x1x0.5 mm.	Chrysotile and amosite	Yes
	TP02_0.4-0.6	>0.6	Natural	Clay	No	No	N/A	No

## Heavy metals

### Chromium

Forty three samples were initially scheduled for chromium (trivalent + hexavalent) analysis. The reported concentration of chromium (trivalent + hexavalent) within forty of the analysed samples analysed ranged between 100 mg/kg and 430 mg/kg, exceeding the adopted human health assessment criteria of 100 mg/kg.

Further analysis was undertaken on sixteen of the samples that exceeded the assessment criteria to speciate the concentration of trivalent chromium and hexavalent chromium, as the adopted assessment criteria for chromium is applicable for hexavalent chromium only (not trivalent + hexavalent).

The samples chosen for speciation were selected to provide spatial coverage laterally and vertically across the site, from a range of different soil types.

The concentration of hexavalent chromium within all samples scheduled for speciation were reported either below the LOR or the adopted human health assessment criteria. In addition, the concentration of trivalent chromium in these samples was notably higher than hexavalent chromium. These results indicate the dominant form of chromium at the site is trivalent chromium. Based on these results, the detected concentrations of trivalent and hexavalent chromium are not considered to pose a risk to human health are likely the result of elevated natural variation of the local geology.

### Lead

The concentration of lead at HA01\_0.0-0.2 (1,050 mg/kg), HA02\_0.0-0.2 (630 mg/kg) and TP03\_0.0-0.2 (1,300 mg/kg), collected from near surface soils exceeded the adopted human health criteria of 300 mg/kg. All exceedances were reported within soil fill material.

Criteria exceedances were limited to the near surface soils, with laboratory analysis of underlying soil samples collected between 0.3 – 0.6 mbgl reporting results less than the adopted assessment criteria at all three locations (as summarised in Table 8-4).

Samples exceeding adopted human health criteria were located in two areas of the site:

- The south eastern corner of the site directly adjacent to the Service Station (HA01)
- Within or directly adjacent to the residential garage (HA02 and TP03)

Given the land use directly adjacent to the reported exceedances are associated with either current or former use of motor vehicles, the exceedances are considered likely attributed to the use or storage of fuel. Reported concentrations of BTEXN and TRH at HA01, HA02, TP03 were all below the LOR.

**Table 8-4 Summary of guideline exceedances for lead**

Location	Sample	Geological extent of material (mbgl)	Type of material	Lithology	Lead concentration (mg/kg)	Guideline exceedance of criteria (300 mg/kg)
HA01	HA01_0.0-0.2	0.0 – 0.3	Fill	Gravelly clay	1,050	Yes
	HA01_0.3-0.5	0.3 – 1.0*	Natural	Clay	23	No
HA02	HA02_0.0-0.2	0.0 – 0.5	Fill	Clayey gravel	630	Yes
	HA02_0.3-0.5	0.3 – 1.0*	Fill	Clayey gravel	19	No
TP03	TP03_0.0-0.2	0.0 – 0.4	Fill	Clayey gravel	1,300	Yes
	TP03_0.4-0.6	0.4 – 0.6 *	Natural	Clay	7	No

## PFAS

A total of twenty one samples were analysed for PFAS. One exceedance of the adopted human health criteria was reported for PFAS and an additional eight detections of PFAS were reported above the LOR but below adopted assessment criteria.

The sample exceeding the adopted assessment criteria was HA03\_0.0-0.2, collected from near surface soils directly adjacent to the current maintenance workshop. The reported concentration of Sum of PFHxS and PFOS (0.0223 mg/kg) and PFOS (0.0218 mg/kg) exceeded the criteria value of 0.01 mg/kg for both analytes. The reported concentration from the underlying sample from HA03\_0.8-1.0 were both one order of magnitude lower the adopted assessment criteria for Sum of PFHxS and PFOS (0.0054 mg/kg) and PFOS (0.005 mg/kg).

Given the underlying sample was one order of magnitude lower than the assessment criteria, the concentration of PFAS above the human health assessment criteria is delineated vertically to a maximum depth of 0.8 mbgl at HA03. Surrounding samples at BH04, BH06 and BH10 all reported detections of PFAS, but the concentrations were generally low and one order of magnitude lower than the LOR, indicating that the human health exceedance within soil at BH03 is laterally delineated to the nearest sample location at BH04, located approximately 15 m north.

The detections of PFAS in the northern portion of the site (HA03, HA04, BH06, BH10) may be attributed to the identified former use of groundwater originating from the Norfolk Island Airport, which was previously stored in a below ground tank located directly adjacent to HA03.

PFAS was also detected above the LOR but at least one order of magnitude lower below the adopted assessment criteria in the southern portion of the site at BH05, BH07 and BH09. Given the spatial distribution of these samples, the low concentrations may be representative of regional concentrations and possibly not a direct result of historical site activities.

The storage tank and maintenance workshop are presented in Photograph 13 – 14, Table 8-5.

**Table 8-5 Photographs of relevant to PFAS results**



**Photograph 13** – Below ground water storage tank formerly used to store groundwater from Norfolk Island Airport



**Photograph 14** – The maintenance workshop is located adjacent to water tank on an adjoining hardstand. HA03 was established on the grass next to workshop building.

## 8.2.2 Ecological criteria exceedances

### Heavy metals

A number of analysed samples exceeded the adopted ecological assessment criteria. These samples are summarised in Table 8-6.

**Table 8-6 Summary of guideline exceedances of adopted ecological criteria**

Analyte	Number of guideline exceedances	Guideline value (mg/kg)	Concentration range (mg/kg) Guideline value (mg/kg)
Zinc	11	70	155 – 873
Nickel	6	30	34 – 135
Chromium (III)	6	130	202 – 356
Copper	3	60	63 – 84
Lead	1	1,100	1,300

Exceedances of adopted ecological criteria were reported within samples collected from both fill material and natural soil. There does not appear to be a clear pattern in the vertical or lateral spatial distribution of the exceedances of ecological assessment criteria for heavy metals. It is considered that these results are likely attributed to natural variation within the local geology and are therefore not considered to pose a significant risk to the environment in the context of the Project. This is further supported by the fact that the EIL exceedances were distributed approximately evenly between natural soil and soil fill material.

### PFAS

One exceedance of the adopted ecological assessment criteria was reported for PFAS. The sample which exceeded the adopted assessment criteria was HA03\_0.0-0.2, collected from near surface soils directly adjacent to the current maintenance workshop and discussed above in Section 8.2.1.

During the field investigation the immediate area surrounding HA03\_0.0-0.2 was noted to be a highly modified area with concrete hardstand located directly adjacent that frequently contained parked cars used by NIHRACS maintenance staff. It is considered that the ecological value of the sample location where the exceedance was identified is low.

### 8.3 Quality Assurance / Quality Control

A summary of the QA/QC used for this investigation is presented Table 8-7. Further details of the QA/QC assessment program are contained in Appendix J.

**Table 8-7 Summary of QA/QC compliance**

Item	Objective	Reference	Summary of Results	Compliance
Comparison of field and analytical data	Agreement between visual and olfactory evidence with laboratory results	-	Field observations correspond with the laboratory results.	Yes
Calibration of field instruments	Meet calibration specifications	AS4482.1-2005	Calibration certificates included Refer to Appendix H	Yes
Chain of Custody documentation	Completed	-	Completed in full Refer to Appendix I	Yes
Sample analysis and extraction holding times	Comply with holding times	AS4482.1-2005/NEPM (2013)	Refer Appendix I and Appendix J	Yes, with the exception of some minor exceedances.
Sample Preservation	Samples are collected in appropriately preserved containers	-	Refer to Appendix I	Yes
Analysis of intra-laboratory duplicate samples	1 for every 20 samples RPD 30% - 50%	AS4482.1-2005	Refer to Appendix J	Minor exceedance related to additional analysis of delineation samples
Analysis of inter-laboratory duplicate samples	1 for every 20 samples RPD 30% - 50%	AS4482.1-2005	Refer to Appendix J	Minor exceedance related to additional analysis of delineation samples
Analysis of laboratory method blanks	No contamination of blanks	NEPM (2013)	Refer to Appendix I and Appendix J	Yes.
Analysis of matrix and laboratory control spikes	Recoveries within the laboratory specified recovery limits	NEPM (2013)	Objective met. Refer Appendix I and Appendix J	Few outliers were reported. But overall laboratory QAQC results are within criteria.
Analysis of laboratory surrogates	No surrogate recovery outliers	NEPM (2013)	Objective met. Refer to Appendix I and Appendix J	Few outliers were reported. But overall laboratory QAQC results are within criteria.

Item	Objective	Reference	Summary of Results	Compliance
Analysis of laboratory duplicates	Frequencies and Relative Percent Differences (RPDs) within guideline and internal laboratory limits	NEPM (2013)	Objective met. Refer to Appendix I and Appendix J	Few outliers were reported. But overall laboratory QAQC results are within criteria.
Analysis of trip blanks	Frequencies within guideline limits, and reported concentrations less the laboratory LOR	NEPM (2013)	Objective met. Refer to Appendix J	Yes
Analysis of field rinsate samples	Concentrations less the laboratory LOR	NEPM (2013)	Objective met. Refer to Appendix J	Yes

Overall, the quality assurance and quality control indicates that the analytical results demonstrate reliability and repeatability of the data set and are sufficient on which to make an assessment of results.

## **9. Refined conceptual site model**

A preliminary conceptual site model was prepared in Section 5 based on the preliminary desktop assessment (Appendix L) and site history which identified CoPC and key areas of interest associated with the infrastructure footprint of the proposed MPS facility.

A refined CSM based on field observations and results from the intrusive works is presented in Table 9-1.

The refined CSM also includes an inferred risk ranking to human health and/or the environment based on the current understanding of the site conditions and development. It is noted that the level of risk is based on the limited assessment undertaken to date and primarily focusses on the risk associated with soil disturbance as a result of construction works for the Project.

**Table 9-1 Summary of refined conceptual site model**

Source	Pathway	Receptor	SPR linkage	Potential risk to human health or environment (associated with the Project)
Location of former diesel AST (associated with the generator)	<ul style="list-style-type: none"> <li>• Volatilisation and vapour inhalation (hydrocarbons)</li> <li>• Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>• Site users, workers, patients and visitors</li> <li>• Surrounding land users and occupiers</li> <li>• Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>• Intrusive maintenance and future construction workers (on site).</li> </ul>	Unlikely	<b>Low</b> – Concentrations of CoPC in soil sampled in the vicinity of this area were below the LOR and / or the adopted assessment criteria and are not considered to pose a significant risk to human health or the environment.
Former sewerage treatment plant	<ul style="list-style-type: none"> <li>• Volatilisation and vapour inhalation (hydrocarbons)</li> <li>• Inhalation (asbestos)</li> <li>• Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>• Site users, workers, patients and visitors</li> <li>• Surrounding land users and occupiers</li> <li>• Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>• Intrusive maintenance and future construction workers (on site).</li> </ul>	Unknown	<b>Moderate</b> – Whilst concentrations of CoPC were generally reported below the adopted assessment criteria, the contamination status of soils in the vicinity of the former sewerage treatment plant is largely unknown, as shallow refusal was encountered at the sample location that was established directly adjacent to the former sewerage treatment plant.

Source	Pathway	Receptor	SPR linkage	Potential risk to human health or environment (associated with the Project)
Former use of groundwater from Norfolk Island Airport	<ul style="list-style-type: none"> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>	Possible	<p><b>High</b> –PFAS was detected exceeding the adopted human health and ecological criteria in near surface soils at one location adjacent to the storage tanks formerly used to store groundwater from Norfolk Island Airport, indicating localised contamination in this area, which may be encountered during construction.</p> <p>PFAS detections above the LOR were also reported at a number of locations in the northern portion of the site, in the general vicinity of the either the storage tank or the laundry facility.</p>
Historical and current operation of laundry facility	<ul style="list-style-type: none"> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>	Unknown	<p><b>Moderate</b> –Concentrations of TCE were less than the LOR and / or the adopted assessment criteria.</p> <p>However, PFAS was detected in nearby soils and based on the former use of groundwater from the Norfolk Island Airport, the extent of any potential residual impact to below ground infrastructure or services associated with either the laundry or the water storage tank used to supply the laundry is unknown.</p>

Source	Pathway	Receptor	SPR linkage	Potential risk to human health or environment (associated with the Project)
Construction and demolition of buildings	<ul style="list-style-type: none"> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>	Possible	<p><b>High</b> – ACM was detected within near surface soils in a number of locations and identified as friable. The concentration of ACM within soil is currently unknown, however may present a risk to human health where encountered as part of the construction phase of the Project.</p> <p>Fragments of potential ACM were also observed on the ground surface in areas of the site outside of assessment area for this investigation.</p>
Soil fill materials	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>	Possible	<p><b>High</b> – concentrations of CoPC including lead and asbestos were reported above the human health criteria. These may present a risk to human health (primarily during construction).</p>
Maintenance workshop area	<ul style="list-style-type: none"> <li>Volatilisation and vapour inhalation (hydrocarbons)</li> <li>Inhalation (asbestos)</li> <li>Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>Site users, workers, patients and visitors</li> <li>Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>Intrusive maintenance and future construction workers (on site).</li> </ul>	Possible	<p><b>High</b> –PFAS was detected exceeding the adopted human health and ecological criteria in near surface soils directly adjacent to the maintenance workshop. It is noted that the impacts appear to be localised. The PFAS contamination may be encountered during construction.</p>

Source	Pathway	Receptor	SPR linkage	Potential risk to human health or environment (associated with the Project)
Fuel storage at the service station and vehicle maintenance workshop (adjacent to the site)	<ul style="list-style-type: none"> <li>• Volatilisation and vapour inhalation (hydrocarbons)</li> <li>• Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>• Site users, workers, patients and visitors</li> <li>• Surrounding land users and occupiers</li> <li>• Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>• Intrusive maintenance and future construction workers (on site).</li> </ul>	Possible	<b>Medium</b> – Concentrations of CoPC were less than the LOR and / or the adopted assessment criteria for hydrocarbons, however lead was reported above the human health and ecological criteria in one near surface sample.
Historical storage of Norfolk Island Airport fire trucks (adjacent to the site)	<ul style="list-style-type: none"> <li>• Direct contact (oral / dermal)</li> </ul>	<ul style="list-style-type: none"> <li>• Site users, workers, patients and visitors</li> <li>• Surrounding land users and occupiers</li> <li>• Ecological receptors (flora and fauna) and Broken Bridge Creek</li> <li>• Intrusive maintenance and future construction workers (on site).</li> </ul>	No	<b>Low</b> – PFAS was not detected above the LOR at the nearest sample location.

## 9.1 Refined data gaps and uncertainties

Based on this assessment, the following data gaps / uncertainties are considered to exist.

- The lateral extent of ACM within the soil fill layer in the vicinity of the archive store room / COVID-19 tent and the residential house.
- The concentration of asbestos in soil and the risk the presence of asbestos within soil presents to human health.
- The contamination status of the tank formerly used to store groundwater from the Norfolk Island Airport.
- The contamination status of soils surrounding the tank formerly used to store groundwater from the Norfolk Island Airport.
- The contamination status of infrastructure and services associated with the delivery of groundwater from Norfolk Island Airport to the site and the laundry facility.
- The contamination status of the soils within the extent of the former sewerage treatment plant.
- The lateral and vertical extent of soil fill identified in the northern portion of the site in the vicinity of the sewerage treatment plant and if ACM is present within this material.

# 10. Discussion

## 10.1 Soil fill

The intrusive investigation identified the presence of a soil fill layer that generally extended to a maximum depth of 0.4 mbgl across the site, excluding the northern portion of the site, where deeper soil fill was encountered to a depth of 1.3 mbgl with some minor construction and demolition waste.

The identification of the deeper extent of soil fill in the northern portion of the site was consistent with site interviews, which indicated historical filling of the steep slope had occurred using soils and other materials used during the construction of the former sewerage treatment plant. While the vertical extent of soil fill was identified to 1.3 mbgl, it is possible that deeper areas of fill may be present and are considered likely within the extent of the former sewerage treatment plant. The lateral extent of soil fill in this area is unknown.

Given the nature of the waste identified in portions of the site (i.e. construction and demolition waste), it is possible that asbestos may be distributed within soil fill in this portion of the site. This is further supported by the visual identification of potential ACM on the ground surface on the nearby unsealed access track that extends north from the site..

## 10.2 Asbestos

Three soil samples collected at the site positively identified asbestos sheeting, fibrous asbestos fragments and / or asbestos fibre bundles by laboratory analysis. Further analysis determined that the asbestos identified was friable. The detections of asbestos occurred within near surface soil fill material in two areas of the site:

- Adjacent to the archive store room / COVID-19 testing tent (nearby to Burglars Lane)
- Adjacent to the residential house / garage in the southern portion of the site.

The asbestos detected adjacent to the archive store room / COVID-19 testing tent is located within the footprint of where excavation for 'cut and fill' purposes is proposed for the MPS facility. The lateral extent of asbestos identified within near surface soils in this area remains unknown. The concentration of asbestos within soil also remains unknown. Based on the site history it is possible that asbestos is distributed within soil fill in this portion of the site, given the former bakery was demolished after a fire in the early 1970's. Given the current design includes excavation to 2.0 mbgl in this portion of the site, the potential to encounter ACM requires further quantitative assessment to determine the risk to human health prior to any intrusive works at the site. Consideration should also be given to ensuring that NIHRACS have an unexpected find protocol to safely manage any potential ACM encountered when removing the COVID-19 tent.

Asbestos was detected below the ground surface adjacent to the house and inside the garage of the residential property. Fragments of potential ACM were also observed on the ground surface nearby to the house and / or the garage where over-grown vegetation limited visual assessment of the ground surface. The identification of asbestos in this area may be associated with the current state of disrepair of the existing structure, where ACM that comprise the buildings structure have become broken or damaged. The lateral extent of the asbestos identified within near surface soils in the fenced area that surrounds the house is unknown, further assessment is recommend to delineate the identified asbestos prior to any intrusive works which could potentially disturb or mobilise asbestos within surface soils. This may also present human health risks to future users / workers on the site.

Potential ACM fragments were also identified along the site boundary between Mawson House and the mechanical workshop, and on the unsealed access track that extends north from the site down the steep slope. It is recommended these ACM fragments are hand picked (“emu picked”) and disposed appropriately off site in consultation with NIRC.

### **10.3 PFAS**

PFAS was detected above the human health assessment criteria in one sample collected from near surface soils adjacent to the maintenance workshop in the northern portion of the site. Vertical delineation of PFAS concentrations identified no exceedance of adopted criteria in underlying soils below a depth of 0.8 mbgl. Lateral delineation of PFAS concentrations identified no exceedance of adopted criteria approximately 15 m north.

While the vertical and lateral delineation samples did not exceed the adopted human health criteria, PFAS was reported in both samples above the LOR. Additionally, a number of surrounding samples also reported concentrations of PFAS above the LOR but below the adopted criteria in the northern portion of the site.

The detections of PFAS in the northern portion of the site may be attributed to the identified former use of groundwater originating from the Norfolk Island Airport, which was previously stored in a below ground tank located adjacent to the maintenance workshop. Staging plans for the proposed MPS facility indicate the below ground (water) tank and nearby laundry facility will require demolition. It is recommended that the contamination status of the tank, any adjoining infrastructure and the surrounding soils at depth are identified prior demolition to inform appropriate management and disposal of potentially contaminated materials. Additionally, based on the detection of PFAS, the depth to groundwater at the site may require future assessment.

Minor detections of PFAS were also reported in the southern portion of the site, however given the spatial distribution and the relatively low concentrations, it is considered these detections may be representative of regional concentrations and possibly not a direct result of historical activities at the site.

### **10.4 Lead**

The concentrations of lead within three near surface samples collected from soil fill material exceeded the adopted the human health assessment criteria. Vertical delineation of lead concentrations identified no exceedance of adopted criteria in underlying soils below a depth ranging between 0.3-0.4 mbgl.

Lead concentrations greater than the adopted human health screening criteria are not widespread, but localised within selected samples collected nearby where the operation, storage or re-fuelling of motor vehicles has occurred. The reported concentrations are not considered to currently present an unacceptable risk to site visitors, given the limited opportunity for directly contact with soil, but require management during construction works

Given the relative bioavailability of lead, it is recommended that planting edible fruit trees in the vicinity of either the residential garage or the Service Station located south east of the site is avoided. If planting edible fruit trees is planned in the either of these areas, a suitable volume of verified clean fill soils would be required to provide suitable protection to the root zone of any edible fruit trees.

# 11. Conclusions and recommendations

## 11.1 Conclusions

Based on the site history assessment and field investigations, some contamination is present within the infrastructure footprint of the proposed development, which may pose a risk to human health or the environment. The following conclusions are made:

- Asbestos identified in some areas of the site may present a risk to human health during any intrusive works or ground disturbance activities at the site. The extent of asbestos and the concentration of asbestos within soil is currently unknown.
- The former storage and use of groundwater from Norfolk Island Airport may have resulted in some localised PFAS contamination of soils.
- Elevated lead concentrations are not widespread, but localised to certain areas and material types. The identified concentrations of lead within selected samples may present a risk to human health.
- The depth of soil fill generally extended to a depth of 0.4 mbgl at the site, but was encountered to depth of at least 1.3 mbgl in the northern portion of the site.
- Further investigation and assessment will be required to assess the risk of soil impacts within the infrastructure footprint of the proposed MPS facility.

## 11.2 Recommendations

There are a number of potential remediation and management pathways available to manage the potential risks associated with the soil contamination identified at the site.

Based on the findings of the assessment, the following initial recommendations are made:

- Undertake a supplementary investigation with the aim to close out identified data gaps by:
  - Delineation of the lateral extent asbestos detected within the soil fill and assessing the concentration of ACM in soil and the risk this presents to human health.
  - Identifying the contamination status of the tank formerly used to store groundwater from the Norfolk Island Airport, in addition to analysis of adjoining infrastructure and deeper surrounding soils the tank.
  - Determine the lateral and vertical extent of soil fill in the northern portion of the site.
- Prepare a Remediation Options Assessment and Management Strategy. This assessment would be based on the identified contamination to date and the findings of the supplementary contamination investigation with the infrastructure footprint of the proposed MPS facility.

Options may include:

- Excavations to the lateral and vertical extent of identified contamination and placement within an engineered containment cell. This would require consideration during the 50% design phase.
- On site remediation.
- Design alterations, to consider leaving contaminated pipes or other structures in-situ.
- Notification to NHIRACS that:
  - Asbestos is present in near surface soils adjacent to the COVID-19 tent. The purpose of this is to ensure that an unexpected find protocol is in place to safely manage any potential ACM (if) encountered when removing the COVID-19 tent.

- Potential ACM fragments were identified along the site boundary between Mawson House and the mechanical workshop. The purpose of this is to ensure that human health risks are managed according by hand picking the fragments and disposal off site in consultation with NIRC.

## 12. References

- Abbott and Macro (2020). Planning showing detailed survey over part of NI Hospital. Survey plan reference: N20008-3A. July 2020.
- Abell R.S. and Falkland A.C. (1991). The hydrogeology of Norfolk Island South Pacific Ocean. Bulletin 234. Australian Government Publishing Services, Canberra. Retrieved online 19 August 2020 at [https://d28rz98at9flks.cloudfront.net/31/Bull\\_234.pdf](https://d28rz98at9flks.cloudfront.net/31/Bull_234.pdf)
- GHD (2016). Asbestos Building materials Assessment Norfolk Island Hospital. Final report prepared for the Administration of Norfolk Island, January 2016.
- GHD (2017). Norfolk Island Airfield Landslide Initial Geotechnical Assessment and Recommendation. January 2017. Unpublished report prepared for Norfolk Island Regional Council
- GHD (2020a). Preliminary Desktop Assessment, Norfolk Island MPS DSC. September 2020.
- GHD (2020b). Sampling Analysis Plan, Norfolk Island MPS DSC. September 2020.
- Oberonia Botanical Services (2020). Tree assessment, Norfolk Island Multipurpose health Services and Regional Ages Care Facility Project. 24 August 2020. Unpublished technical memorandum prepared for GHD
- Parsons Brinkerhoff (2005). Norfolk Island Report on Geotechnical Soils Investigations. Prepared for the Norfolk Island Administration. June 2015.
- Norfolk Island Consulting Engineers (2020). Draft Geotechnical Investigation Report. Norfolk Island Health and Residential Aged Care Services (NIHRACS) Replacement Project. Unpublished report prepared for GHD. 21 August 2020
- Norfolk Island Regional Council (NIRC 2018). Norfolk Island Environmental Strategy 2018-2023. 21 November 2018. Retrieved online 21 August 2020 at <http://www.norfolkisland.gov.nf/sites/default/files/docs/Norfolk%20Island%20Environment%20Strategy%202018%E2%80%932023.pdf>
- Norfolk Island Plan (2016). Last amendment approved 21<sup>st</sup> March 2016 (effective 21<sup>st</sup> March 2016). Retrieved online 8 September 2020 at <http://www.norfolkisland.gov.nf/sites/default/files/docs/planandbuild/NIPlan/Norfolk%20Island%20Plan%20Current.pdf>
- Stephens and Hutton, (1954). A Soil and Land use Study of the Australian Territory of Norfolk Island, South Pacific Ocean, Division of Soils, Commonwealth Scientific and Industrial Research Organisation, Australia, Melbourne.