

Audit Close Out Report

RAAF Base Point Cook (0932) - Former Fire Training Area

05-Sep-2022

RAAF Base Point Cook Former Fire Training Area Audit (17174)

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05-Sep-2022

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Quality Information

Document Audit Close Out Report

Ref 60657609

Date 05-Sep-2022

Prepared by [REDACTED]

Reviewed by [REDACTED]

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	21-Mar-2022	Draft	[REDACTED] Global Initiative Leader - PFAS Commercialization	
B	17-May-2022	Draft	[REDACTED] Global Initiative Leader - PFAS Commercialization	
C	12-Jul-2022	Draft	[REDACTED] Global Initiative Leader - PFAS Commercialization	
0	24-Aug-2022	Final	[REDACTED] Global Initiative Leader - PFAS Commercialization	
1	05-Sep-2022	Final	[REDACTED] Global Initiative Leader - PFAS Commercialization	

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List of Acronyms

Term	Description
1,1,2,2-TeCA	1,1,2,2-tetrachloroethane
1,1,2-TCA	1,1,2-trichloroethane
1,1-DCA	1,1-dichloroethane
1,2-DCA	1,2-dichloroethane
ADF	Australian Defence Force
ADS	Aeration Delivery System
AECOM	AECOM Australia Pty Ltd
ASC NEPM	<i>National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013</i>
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
cis-1,2-DCE	Cis-1,2-dichloroethene
CoPC	Chemicals of Potential Concern
CSR	Contaminated Site Record
CSM	Conceptual site model
CRAT	Contamination Risk Assessment Tool
DCARM	Directorate of Contamination Assessment, Remediation and Management
DCMM	Defence Contamination Management Manual
DEQMS	Defence Estate Quality Management System
DNAPL	Dense Non Aqueous Phase Liquid
DTD	Direct Thermal Desorption
EFR	Environmental Factor Record
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPS	EnviroPacific Services
ERIA	Ecological Risk Investigation Area
ERS	Environmental Reference Standard
EV	Environmental Value
FTA	Fire Training Area
GED	General Environmental Duty
GEMS	Garrison Estate Management System

Term	Description
GME	Groundwater monitoring event
ISCO	In-situ chemical oxidation
LNAPL	Light Non-Aqueous Phase Liquid
MAH	Monocyclic Aromatic Hydrocarbons
MNA	Monitored natural attenuation
NAPL	Non-Aqueous Phase Liquid
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHL	National Heritage List
PAH	Polycyclic Aromatic Hydrocarbons
PCI	Primary contaminants of interest
PCE	Tetrachloroethene
PCR	Primary Contact Recreation
PFAS	per- and poly-fluoroalkyl substances
PFHxS	perfluorohexane sulfonate
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PWC	Parliamentary Standing Committee on Public Works
RAAF	Royal Australian Air Force
RAP	Remediation Action Plan
RCIP	Regional Contamination Investigation Program
s.53V	Section 53V Audit
SEPP PMCL	<i>State Environment Protection Policy (Prevention and Management of Contamination of Land)</i>
SZA	Source Zone A
SZB	Source Zone B
TCE	Trichloroethene
TDS	Total dissolved solids
TFR	Technical Framework for Remediation
TPH	Total Petroleum Hydrocarbons
trans-1,2-DCE	Trans-1,2 dichloroethene

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Term	Description
TRH	Total Recoverable Hydrocarbons
VC	Vinyl Chloride
WDES	Water Dependant Ecosystems
WHS	Work Health and Safety
US EPA	United States Environmental Protection Agency
VOC	Volatile organic compounds

Groundwater Monitoring Well Conversion ID Table

Monitoring well IDs across the former fire training area (FTA) have been updated to be compliant with the Defence Contamination Management Manual (DCMM) and Defence's ESdat; the conversion table is detailed below.

Historical Groundwater Monitoring Well ID	Revised Groundwater Monitoring Well ID
F105MWA	MW037
F115MWA	MW038
F116MWA	MW039
F117MWA	MW040
F26MW	MW041
F27MWA	MW042
F27MWB	MW043
F27MWC	MW044
F28MW	MW045
ASD10	MW110
F03MW	MW111
F05MW	MW112
F12MW	MW113
F13MWR	MW114
F14MWR	MW115
F20MW	MW116
F21MW	MW117
F22MW	MW118
F24MW	MW119
F25MW	MW120
F30MWAR	MW121
F33MW	MW122
F34MW	MW123
F36MW	MW124
F37MW	MW125
F38MW	MW126
F45MW	MW127
F63MWR	MW128

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Historical Groundwater Monitoring Well ID	Revised Groundwater Monitoring Well ID
F71MW	MW129
F72MW	MW130
F73MW	MW131
F74MW	MW132
F75MW	MW133
F76MW	MW134
F77MW	MW135
F78MW	MW136
F79MW	MW137
F80MW	MW138
F81MW	MW139
F82MW	MW140
F83MW	MW141
F84MW	MW142
F85MW	MW143
F86MW	MW144
F87MW	MW145
F88MW	MW146
F89MW	MW147
F90MW	MW148
F91MW	MW149
F92MW	MW150
F93MW	MW151
F94MW	MW152
F106MWA	MW154
F107MWA	MW155
F108MWA	MW156
F109MWA	MW157
F110MWA	MW158
F111MWA	MW159
F112MWA	MW160

Historical Groundwater Monitoring Well ID	Revised Groundwater Monitoring Well ID
F113MWA	MW161
F114MWA	MW162
F118MWA	MW166
F119MWA	MW167
F120MW	MW168
F121MW	MW169
F31MWC	MW171
F32MWC	MW172
F46MWC	MW173
F95MWC	MW174
F96MWC	MW175
F97MWC	MW176
F98MWC	MW177
F103MWC	MW178
F104MWC	MW179
F122MWC	MW180
F123MWC	MW181
F124MWC	MW182
F125MWC	MW183
F126MWC	MW184
F127MWC	MW185
F128MWC	MW186
F30MWB	MW188
F35MWB	MW189
F48MWB	MW190
F49MWB	MW191
F50MWB	MW192
F99MWB	MW193
F100MWB	MW194
F101MWB	MW195
F102MWB	MW196

Executive Summary

AECOM Australia Pty Ltd (AECOM) was engaged by the Department of Defence (Defence) – Directorate of Contamination Assessment, Remediation and Management (DCARM) to complete this Audit close out report attributed to the Section 53V (s.53V) audit at the former Fire Training Area (FTA) [‘the site’] at RAAF Base Point Cook (0932) [‘the Property’].

The overarching aim of the former FTA Site remediation project was to provide Defence with a site that is suitable to enable Defence to undertake dry surface training activities with overnight camping, while mitigating Defence’s risks and long term liabilities by complying with Victorian legislation relating to the protection of the environment at and immediately adjacent to the former FTA.

The current Audit follows on from the original assessment Audit also undertaken by Mr. Katopodis, completed in January 2012, which considered the impacts to groundwater and Port Phillip Bay associated with historical activities at the FTA Site and the requirements for remediation. The completed s.53V Audit concluded that ‘beneficial uses of land and groundwater are precluded at the FTA Site’ (now ‘environmental values’ under the Victorian Environment Reference Standard). The completed Audit also made several recommendations for remediation, risk management and further assessment work to close out identified data gaps.

This second s.53V environmental audit report currently under preparation, will document the condition of the former FTA post remediation including impacts to protected beneficial uses onsite, and within the adjacent marine ecosystem and the Point Cook Coastal Park.

The purpose of this document is to provide a holistic interpretation of contamination at the former Fire Training Area (FTA) over time, summarising the works completed between 2013 to 2021, including remediation across the former FTA. In addition, this document includes a summary of relevant historical documents and interpretation of historic and current data pertaining to the FTA (including PFAS). Historical AECOM documents that are currently in draft were not requested to be finalised and have been retained as draft.

A summary of the post-remediation condition of the former FTA site is presented below.

Post-remediation sampling results of soil, groundwater, soil vapour, sediment, surface water and pore water indicated potential harm to a series of Environmental Values (EVs). In order to further investigate potential human health and ecological risks associated with these impacts, a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) were undertaken.

Soil

The post-remediation soil sampling results indicated there is potential harm to the *Human health (commercial onsite)* and *Land dependent ecosystems and species (highly modified ecosystems)* Environmental Values (EVs).

Potential risks associated with these impacts were assessed in the HHRA and ERA.

The HHRA concluded that there were potentially unacceptable risks to Defence workers who may spend 8 hours per day, 240 days a year in a future building at the FTA Site. The contaminants driving this risk are Primary Contaminants of Interest (PCIs) in soil vapour via indoor inhalation. Health risks associated with soil impacts for other assessed exposure scenarios were concluded to be low and acceptable.

The ERA concluded that there was low potential for terrestrial ecological receptors from exposure to PCIs and Chemicals of Potential Concern (CoPCs) in soil.

Groundwater

The post-remediation groundwater sampling results indicated there is potential harm to the *Water-based recreation (PCR)*, *Water dependent ecosystems and species (WDES)* and *Agriculture and irrigation (stock watering) (A&I)* EVs.

Potential risks associated with these impacts were assessed in the HHRA and ERA. The HHRA also assessed potential vapour inhalation risks associated with volatile CoPCs in the shallow and intermediate aquifers.

The HHRA concluded that there were potentially unacceptable risks to:

- Defence workers who may spend 8 hours per day, 240 days a year in a future building at the FTA Site; and
- Intrusive maintenance workers who undertake excavations to a maximum depth of 2 m bgl, where groundwater is encountered in the trench during the works.

Human Health risks associated with groundwater impacts for other assessed exposure scenarios were concluded to be low and acceptable.

The ERA did not identify a complete exposure pathway between receptors and groundwater and it was considered that sediment, porewater and surface water data were more appropriate media to assess potential ecological exposure.

Soil Vapour

Post-remediation soil vapour sampling results indicated there is potential harm to the *Human health (commercial onsite)* EV.

Potential risks associated with these impacts were assessed in the HHRA.

The HHRA concluded that there were potentially unacceptable risks to:

- Defence workers who may spend 8 hours per day, 240 days a year in a future building at the FTA Site; and
- Intrusive maintenance workers who undertake excavations to a maximum depth of 2 m bgl, where groundwater is encountered in the trench during the works.

Human Health risks associated with assessed soil vapour exposure scenarios were concluded to be low and acceptable.

Sediment

The post-remediation sediment sampling results indicated there is potential harm to the *Water dependent ecosystems and species* and *Water-based recreation (primary and secondary contact)* EVs.

Potential risks associated with these impacts were assessed in the HHRA and ERA.

The HHRA concluded that Human Health risks associated with assessed sediment exposure scenarios were low and acceptable.

The ERA concluded that if the reported sediment concentrations are representative of exposure conditions sediment dwelling invertebrates, it is unlikely that adverse impacts to higher order predators will result.

Surface Water and Pore Water

The post-remediation surface water and pore water sampling results indicated there is potential harm to the *Water dependent ecosystems and species* and *Water-based recreation (primary and secondary contact)* EVs.

Potential risks associated with these impacts were assessed in the HHRA and ERA.

The HHRA concluded that Human Health risks associated with assessed surface water and pore water exposure scenarios were low and acceptable.

The ERA concluded that:

- A PFOS detection in porewater at one location indicated a potential direct toxicity risk to aquatic ecology. However, direct toxicity is unlikely to be significant at this one location because the sediment-dwelling infauna will be sporadically present in response to tidal fluctuations. There is also some uncertainty whether the porewater concentration at this location is representative of sediment porewater or groundwater conditions; and
- There is a potential for adverse impacts to ecological receptors in RAAF Lake (and the salt marsh area) from direct and indirect exposure to PFOS in surface water.

Revised CRAT Risk Ranking

The information reviewed as part of this report and Defence's Contamination Risk Assessment Tool (CRAT) were used to assign risk rankings to the identified FTA Site contamination source areas, according to the Defence Security and Estate Group Risk Management Process. A summary of the updated risk rankings has been included in **Table A**.

Table A Revised CRAT Risk Rankings

CSR ID	CSR Description	Previous Risk Rating*	Updated CRAT Risk Ranking
CSR_VIC_000125	Old Fire Training Area - Source Zone A (Pit A)	Very High	High
CSR_VIC_000126	Old Fire Training Area - Source Zone C (Pit C)	Medium	High
CSR_VIC_000127	Old Fire Training Area - Source Zone D (Pit D)	Medium	High
CSR_VIC_000128	Old Fire Training Area - Source Zone E (Pit E)	Medium	High
CSR_VIC_000129	Old Fire Training Area - Source Zone B (Pit B)	Very High	High

Notes: (*) denotes risk ranking as per GEMS entry for the Property, no CRAT is accessible via objective for these CSRs therefore the risk ranking source is currently unknown.

Data Gaps and Recommendations

The follow data gaps and recommendations remain.

Onsite

- There are uncertainties regarding vinyl chloride concentrations in groundwater, including increasing concentrations in some wells, potential for ongoing dechlorination over time and LORs exceeding assessment criteria in a number of samples. These uncertainties warrant further monitoring of groundwater to monitor PCI concentrations, including vinyl chloride with an appropriate detection limit.
- Consideration should be given to the assessment of seasonal variability (i.e. reversal of hydraulic gradient) within the shallow aquifer at the site in relation to migration of dissolved phase contamination across the FTA;
- In the instance that a future building is to be constructed at the site, further soil vapour investigation is undertaken in the proposed area of the proposed building to refine the risk assessment to this receptor;
- Consideration should be given to refinement of PFAS source-pathway-receptor linkages in future site assessments, including further assessment of PFAS sources (on-site and off-site), transport and attenuation mechanisms.

In relation to Intrusive Maintenance Workers:

- Future risks may be addressed via management actions such as a Site Management Plan (SMP), including measure to minimise incidental exposure of intrusive workers to groundwater and inhalation of vapours.

Offsite

- Port Phillip Bay
The potential for PFAS bioaccumulation into biota and whether there is a potentially unacceptable risk to consumers is unknown.

As only one round of porewater sampling has occurred to date (AECOM, 2020 and AECOM, 2021), there is uncertainty regarding the reliability of the porewater concentrations to reflect PFAS exposure conditions to aquatic ecology along the Foreshore. Further assessment is required to provide additional lines of evidence to support a low potential for adverse ecological impacts, including:

- A desktop assessment to better understand the potential for PFAS direct ecotoxicity to aquatic biota along the foreshore which may include consideration of the porewater results (in particular the sum of PFOS + PFHxS) in the context of relevant published ecotoxicological data;
 - A site-specific assessment to further refine exposure assumptions for higher order predators that may consume inter-tidal sediment-dwelling aquatic biota along the Foreshore adjacent to the site, including additional porewater sampling; and
 - A desktop assessment to understand whether there is an ongoing PFAS source and migration pathway between the site and Foreshore. In particular, the extent to which the FTA remediation works removed the primary PFAS source and/or whether the sheet pile cut-off wall is effective in reducing PFAS migration to the Foreshore in the future.
- RAAF Lake
 - Collection of additional data should be considered as part of a possible Property-wide PFAS investigation, in order to refine the current understanding of adverse ecological impacts (direct and indirect toxicity) from PFAS exposure at RAAF Lake.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was engaged by the Department of Defence (Defence) – Directorate of Contamination Assessment, Remediation and Management (DCARM) to complete this Audit close out report attributed to the Section 53V (s.53V) audit at the former Fire Training Area (FTA) [‘the site’] at RAAF Base Point Cook (0932) [‘the Property’].

The former FTA is located within the southeast portion of the Property and has reported significant contamination impacts in historical investigation works sourced from a series of former firefighting pits. The former FTA is the subject of a voluntary statutory environmental audit process and Tasos Katopodis of GHD (‘the auditor’) has been appointed to complete an environmental audit pursuant to the *Environmental Protection Act 1970*. A s.53V environmental audit report was prepared in 2012 by the auditor titled *Former Fire Training Area, RAAF Base Williams, Point Cook, Victoria, s.53V Environmental Audit Report* (GHD, 2012). This report focussed on the impacts of contamination on beneficial uses and the requirement for remediation at the former FTA. Based on recommendations of the environmental audit, large scale soil and groundwater remediation works have been completed that has included the removal of the majority of dense non aqueous phase liquid (DNAPL) mass beneath the former FTA and construction of a sheet pile cut-off wall.

The overarching aim of the former FTA Site remediation project was to provide Defence with a site that is suitable to enable Defence to undertake dry surface training activities with overnight camping, while mitigating Defence’s risks and long term liabilities by complying with Victorian legislation relating to the protection of the environment at and immediately adjacent to the former FTA.

A second s.53V environmental audit report is currently under preparation that will document the condition of the former FTA post remediation including impacts to protected beneficial uses onsite, and within the adjacent marine ecosystem and the Point Cook Coastal Park.

This report will form the Audit close out report summarising the works completed between 2013 to 2021, including remediation across the former FTA.

1.1 Property Description

The Property is located approximately 30 kilometres (km) south west of the Melbourne’s central business district (CBD) and comprises approximately 338 hectares (ha) as shown in **Figure F1, Appendix A**. The former FTA is located in the south eastern portion of the Property and occupies an area of approximately 27 ha as shown in **Figure F2, Appendix A**.

The Property is the oldest continually operating military airfield in the world and listed on the National Heritage List (NHL). It is currently used by both civilians (general aviation) and RAAF. The Property is an active RAAF base and training school, with a range of land uses that are supplementary to the aerodrome and aircraft support areas.

The former FTA was historically used for fire training activities from the 1960’s to the 1980’s. Fuels, chlorinated solvents and other chemicals are understood to have been placed into pits across the site and over plane fuselages before being set alight. Once training activities ceased at this location the pits were filled with solid and possibly liquid wastes.

1.2 Background

1.2.1 Primary Sources of Contamination and Chemicals of Concern

Environmental investigations undertaken at the former FTA between 2003 and 2013 identified that historic fire training activities had contaminated soil and groundwater with a range of organic chemicals, resulting in contamination plumes, with an estimated volume of close to 1 million litres of DNAPL. These investigations also confirmed the presence of seven former pits and mounds that were likely used in fire training activities, as discussed in the AECOM document titled *Technical Framework for Remediation - RAAF Base Williams, Point Cook FTA Site, (Rev A)*, dated 1 May 2013 (AECOM, 2013a). The partial source removal remediation program, undertaken between 2014-2015, across the extent of the former FTA, excluding the area immediately to the north of the former FTA and within

Parks Victoria land to the east, identified and confirmed the presence of per- and poly-fluoroalkyl substances (PFAS) in soil and groundwater, as detailed in the AECOM document titled *Perfluorinated Compounds Investigation Former Fire Training Area, RAAF Williams, Point Cook (draft)*, dated 17 October 2014 (AECOM, 2014a).

- Findings from these investigations identified Pit A and Pit B as being significant sources of on-going soil and groundwater contamination, which was present as DNAPL in both soil and groundwater, as well as dissolved phase contamination in groundwater. Investigation and the development of remediation strategies included limited sampling of the broader site, but typically focused on the areas of gross contamination. Three other historical pits (C, D and E) together with two mounds (F and G), containing miscellaneous fill have also been investigated. No visual evidence of fire training activities were observed at these locations with the exception of Pit E, which is reported to have contained firefighting equipment (HLA, 2004). The location of previously impacted pits at the former FTA is shown in Figure F2, Appendix A of the Post Remediation Groundwater Assessment Report (AECOM, 2022c) and are also presented in **Figure F6, Appendix A**. Further detail in relation to the historic uses of the former FTA and impacts from contamination are provided in AECOM, 2013a and the Soil, DNAPL and Soil Vapour Validation Assessment (AECOM, 2013b).
- The DNAPL is considered to be the primary source of dissolved phase groundwater contamination. The DNAPL comprises of numerous organic compounds (over 120 chemical compounds were identified) [(refer to Table 29 of the Stage 5 Interpretive Report: Groundwater and Soil Vapour (AECOM, 2021)] for further information on DNAPL composition). This DNAPL and dissolved phase contamination had migrated towards Port Phillip Bay and the Point Cook Coastal Park and had the potential to significantly impact off-site receptors.
- The remedial approach selected by Defence was ex-situ Direct Thermal Desorption (DTD) technology to treat the DNAPL impacted soils, which comprise the primary contamination source at the former FTA Site. This approach targets the bulk DNAPL mass and primary source of groundwater contamination and the associated dissolved phase impacts in the excavation areas, thereby reducing the potential dissolved phase contaminant concentrations in groundwater and potential impacts associated with subsequent off-Site migration. This component of the remediation was undertaken as part of a s.53V Audit. The scope of the remediation activities was developed through a series of historical environmental investigations and a range of remediation assessments and trials conducted at the site. The remediation works were completed in 2014 – 2015.
- The historic understanding of the site soil and groundwater contamination conditions in regard to PFAS was not understood at the time of selection of remediation technology. The ex-situ DTD technology was therefore not evaluated with regards to the treatment of PFAS contamination.

As detailed in AECOM, 2022c, based on the known sources, previous investigations and remediation undertaken, 12 primary contaminants of interest (PCI) were identified as compounds which presented the greatest risk of migrating and potentially impacting down gradient receptors, including Port Phillip Bay, these PCI are further detailed in **Section 4.1.3**. In addition, a number of other chemicals of potential concern (CoPC), including PFAS, were included in the analytical suite [(further detailed in AECOM, 2021)], to align with the Post Remediation Groundwater Management Plan, as detailed in the AECOM document titled *Post Remediation Groundwater Management Plan RAAF Williams, Point Cook - Former Fire Training Area*, dated 27 March 2015 (AECOM, 2015a).

The sources of contamination (existing and remediated) at the site are related to the historic pits previously used for fire training purposes and waste disposal. No off-site sources of PCI contamination have been identified during soil and groundwater investigation works. A range of PFAS contamination sources are known on-site outside the FTA boundary.

Table 1, below presents a summary of the known historical primary sources of contamination at the site and are further detailed in the AECOM document titled *Conceptual Site Model, RAAF Base Williams, Point Cook, former Fire Training Area*, dated 20 April 2010 (AECOM, 2010a) and adopted post remediation monitoring zones. Further detail including summaries of soil and groundwater investigation works undertaken regarding the nature and extent of soil contamination pre - and post the thermal remediation project is presented in AECOM document titled *Post Remediation Soil*

AECOM

RAAF Base Point Cook Former Fire Training Area Audit (17174)
Audit Close Out Report – RAAF Base Point Cook (0932) - Former Fire Training
Area

3

Assessment, Point Cook Remediation Project, RAAF Williams, Point Cook, dated 09 June 2017 (AECOM, 2017).

Table 1 Source areas and monitoring zones across the former FTA

Monitoring zone ¹		Description/Contamination Source ²	PCI targeted for clean-up	Remediation status	PCI and CoPC (post remediation)
1	Up-gradient Background	RAAF Lake, support activities for fire training. No source.	N/A	Not remediated	Chlorinated hydrocarbons, PFAS
2	General Site South West	Fire training and surface training, disposal pits for material. <u>Source</u> Former Fill Mounds F & G	N/A	Not remediated	Chlorinated hydrocarbons, PFAS
3	Source Zone A (CSR_VIC_000125)	Fire training and surface training, former fire training pit. <u>Source</u> <ul style="list-style-type: none"> Former Fire Training Pit A Secondary Source DNAPL migrated from Pit A: Approximate extent of DNAPL migration from Pit A and extending south east towards Port Phillip Bay. 	Chlorinated hydrocarbons (DNAPL)	Remediated by source removal and thermal treatment.	Chlorinated hydrocarbons, PFAS
4	Source Zone B (CSR_VIC_000129)	Fire training and surface training, former fire training pit. <u>Source</u> <ul style="list-style-type: none"> Former Fire Training Pit B Secondary Source light non aqueous phase liquid (LNAPL) / DNAPL migrated from Pit B: Approximate extent of non-aqueous phase liquid (NAPL) migration from Pit B and extending south towards a large acacia bush. 	Chlorinated hydrocarbons (DNAPL)		Chlorinated hydrocarbons, PFAS
5	General Site East (CSR_VIC_000126, CSR_VIC_000127, CSR_VIC_000128)	Fire training and surface training, disposal pits for material. <u>Source</u> Former Fire Training Pits C, D & E	N/A	Not remediated	Chlorinated hydrocarbons, PFAS
6	Discharge Zone	Beach shoreline No source	N/A		Chlorinated hydrocarbons, PFAS
7	Parks Victoria	Recreation area, with areas of high conservation significance and areas of historical and cultural significance. No source	N/A		Chlorinated hydrocarbons, PFAS

Note: ¹Refer to **Figure F4, Appendix A** for monitoring zones. ²Refer to **Figure F6, Appendix A** for location of former pits

The locations of Contaminated Site Records (CSR) correlating to the abovementioned sources in **Table 1** across the former FTA are further detailed in **Section 1.2.2**, and presented in **Figure F3, Appendix A**.

1.2.2 Contaminated Site Records

The Property was not initially assessed as part of the Regional Contamination Investigation Program's (RCIP) preliminary risk assessment in September 2017, which utilised the Defence Contamination Risk Assessment Tool (CRAT). Five Contaminated Site Records (CSR) exist on the Property associated to the former FTA as noted and summarised in **Table 2** below. All CSR locations across the former FTA are shown in **Figures F2 and F3 (Appendix A)**.

Table 2 RAAF Base Point Cook – former FTA CSRs

GEMS EFR ID	CSR Classification	CSR Name	Risk Ranking*
CSR_VIC_000125	Fire Training Area	Old Fire Training Area - Source Zone A (Pit A)	Very High
CSR_VIC_000126	Fire Training Area	Old Fire Training Area - Source Zone C (Pit C)	Medium
CSR_VIC_000127	Fire Training Area	Old Fire Training Area - Source Zone D (Pit D)	Medium
CSR_VIC_000128	Fire Training Area	Old Fire Training Area - Source Zone E (Pit E)	Medium
CSR_VIC_000129	Fire Training Area	Old Fire Training Area - Source Zone B (Pit B)	Very High

Notes: EFR – Environmental Factor Record; GEMS – Defence Garrison Estate Management System. () denotes risk ranking as per GEMS entry for the Property, no CRAT is accessible via objective for these CSRs therefore the risk ranking source is currently unknown.*

1.2.3 Environmental Reports

The following key reports have been referenced through this report, highlighting works completed by AECOM between 2010 and 2022 in relation to the current s.53V Audit Scope:

1. AECOM (2010a) Conceptual Site Model Report – RAAF Base Williams, Point Cook, former Fire Training Area, dated 20 April 2010;
2. AECOM (2010b), Ecological Risk Assessment – Phase 2, RAAF Williams, Fire Training Area, Point Cook, July 2010;
3. GHD (2011), Scope for Audit of Remediation of Former Fire Training Area, RAAF Base, Point Cook, Victoria, July 2011;
4. AECOM, (2012a), Intermediate Aquifer Investigation, RAAF Base Williams, Point Cook, Former Fire Training Area;
5. AECOM (2013a) Technical Framework for Remediation – RAAF Base Williams, Point Cook FTA Site (Rev A), dated 01 May 2013;
6. AECOM (2013b), Soil, DNAPL and Soil Vapour Validation Assessment, RAAF Base Williams, Point Cook, former Fire Training Area – Technical Advisory Services, dated 17 October 2013;
7. AECOM (2014a) Perfluorinated Compounds Investigation Former Fire Training Area, RAAF Williams, Point Cook, dated 17 October 2014 (draft);
8. AECOM (2014b), Assessment of potential DNAPL within the vicinity of the existing cut-off wall, 2014, dated 15 July 2014;
9. AECOM (2014c) Remediation Enclosure Air Monitoring and Sampling, Former Fire Training Area, RAAF Base Williams, Point Cook, dated 08 May 2014;
10. AECOM (2014d) Source Zone B Remediation Air Monitoring and Sampling, Former Fire Training Area, RAAF Base Williams, Point Cook, dated 12 December 2014 (draft);

11. AECOM (2014e) Point Cook Former Fire Training Area Remediation Project - Cell 1 Validation Inspection Report, dated 04 June 2014;
12. AECOM (2014f) Point Cook Former Fire Training Area Remediation Project Remediation Cell 2 Validation Inspection Report, dated 17 September 2014;
13. AECOM (2014g) Point Cook Former Fire Training Area Remediation Project Remediation Cell 3 Validation Inspection Report, dated 29 October 2014;
14. AECOM (2014h) Point Cook Former Fire Training Area Remediation Project Remediation Cell 4 Validation Inspection Report, dated 14 November 2014;
15. AECOM (2015a), Post Remediation Groundwater Management Plan RAAF Williams, Point Cook - Former Fire Training Area, dated 27 March 2015;
16. AECOM (2015b), Point Cook Former Fire Training Area Remediation Project Remediation Cell B1 Validation Inspection Report, dated 27 February 2015;
17. AECOM (2015c), Point Cook Former Fire Training Area Remediation Project Remediation Cell 5 Validation Inspection Report, 03 March 2015;
18. AECOM (2015d), Post Remediation Groundwater Management Plan, RAAF Williams, Point Cook – Former Fire Training Area, 27 March 2015;
19. AECOM (2015e), Human Health and Ecological Risk Assessment, RAAF Base Williams, Point Cook – Dry Surface Training Area, Rev A, dated 20 April 2015 (draft);
20. AECOM (2017), Post Remediation Soil Assessment, Point Cook Remediation Project, RAAF Williams, Point Cook, 9 June 2017;
21. AECOM (2020), Defence Regional Contamination Investigation Program: Stage 5 Monitoring, RAAF Base Point Cook (0932), 16 December 2020;
22. AECOM (2021), Stage 5 Interpretive Report: Groundwater and Soil Vapour, RAAF Base Point Cook (0932): Former FTA Training Area, 10 December 2021;
23. AECOM (2022a), Stage 3 Human Health Risk Assessment, RAAF Base Point Cook (0932): Former Fire Training Area, 24 March 2022;
24. AECOM (2022b), Stage 3 Ecological Risk Assessment, RAAF Base Point Cook (0932): Former Fire Training Area, 28 March 2022; and
25. AECOM (2022c), Post Remediation Groundwater Assessment Report, Point Cook Remediation Project, RAAF Williams, Point Cook, 13 May 2022;

1.2.4 Audit Scope and Consideration

Tasos Katopodis of GHD has been engaged by Defence as the Environmental Auditor to complete a Section 53V Environmental Audit of the remediation of the former FTA. Defence requires that an environmental audit report be prepared by an environmental auditor on:

- The risk of any possible harm or detriment to the environment caused by remediation activities to be undertaken in the former FTA at RAAF Williams Point Cook Base; and
- The risk of possible harm or detriment to the environment caused by residual contamination remaining at the completion of the remediation program.

The activity under audit is the remediation of soil and groundwater contamination at the former FTA caused by prior use of the site for fire training and buried hydrocarbon waste in the former burning pits. The audit will consider the potential risks to the environment of the remediation activity itself as well as the final condition of the site following remediation. Where remediation activities were found to have impacted areas outside the designated former FTA boundary, the audit segment was expanded to include the impacted areas.

The current Audit follows on from the original assessment Audit also undertaken by Mr. Katopodis, completed in January 2012, which considered the impacts to groundwater and Port Phillip Bay associated with historical activities at the FTA Site and the requirements for remediation. The completed s.53V Audit concluded that 'beneficial uses of land and groundwater are precluded at the

FTA Site' (now 'environmental values' under the Victorian Environment Reference Standard). The completed Audit also made several recommendations for remediation, risk management and further assessment work to close out identified data gaps.

The objectives of the current environmental Audit are to assess potential impacts associated with remediation of identified soil and groundwater contamination due to fire training activity at the site and to assess the condition of the site following completion of the proposed remediation program. This Audit further aims to close out the identified data gaps from the original Site s.53V Audit in 2012.

As per the Audit Scope document (GHD, 2011), the audit report will consist of:

1. Data available to assess the impacts of remediation activities undertaken at the site;
2. Data available to characterise the contamination status of the site following completion of the remediation program;
3. Risk assessment to identify potential risks to human health and the environment as a result of any residual contamination present on site following completion of the remediation program;
4. Development of a strategy for ongoing management and monitoring of the site; and
5. Opinion on risk posed to the environment by the remediated site, including consideration of whether Clean Up to the Extent Practicable has been achieved in principle.

1.2.5 Technical Framework for Remediation

The Technical Framework for Remediation (TFR) (AECOM, 2013a) provided an overarching framework to address key remediation issues at the former FTA which may affect Defence's desired end land-use scenario of dry surface training with overnight camping activities (with restrictions on activities that involve intrusive works, including digging). The TFR addressed the remediation project objectives, outlines the desired remediation and project outcomes, and presented identified key issues and data gaps that may impact the end land use and project outcomes. The TFR also identified and provided recommendations and approaches to close out these identified uncertainties to allow the former FTA to be assessed as suitable for Defence's dry surface training end land use objective (further detailed in **Section 1.2.6**).

The TFR:

- Clarified and articulated the objectives of the former FTA remediation project;
- Defined the preferred end land-use scenario for the former FTA;
- Clarified the Audit scope in relation to the physical Audit boundary, the relevant beneficial uses to be considered, chemical contaminants to be considered, as well as the areas of the former FTA that were to be considered within the Audit scope and provided justification why areas outside of these will be dealt with via an alternative mechanism/approach;
- Defined roles and responsibilities of the Defence Project Team and their part in delivering the project objectives and desired end land-use;
- Identified uncertainties associated with the Remediation Specifications that may have impacted the Contractor efficiently mobilising to the former FTA and provided recommendations to address these;
- Summarised the existing data for the former FTA in the context of 'whole of site' assessment, project objectives and end land use objectives. This summary included:
 - Non-Aqueous Phase Liquid (NAPL) impact (including both DNAPL and Light Non-Aqueous Phase Liquid (LNAPL));
 - Soil;
 - Groundwater (shallow, intermediate and deep aquifers);
 - Risk to human and ecological receptors;
 - Soil vapour; and

- Offsite mitigation and impacts.
- Identified data gaps and constraints associated with achieving the project objective (including those data gaps already identified by the Auditor);
- Provided a scope of work to resolve any of the identified data gaps or constraints; and
- Provided a scope of work for further environmental monitoring prior to, during and post remediation work.

1.2.6 End Land Use Definition

The end land use for the former FTA was defined as dry surface training, with overnight camping. This activity comprises:

- Dry surface training with restrictions on activities that involve intrusive works, including digging;
- Limited use of light vehicles on formed roads only;
- No semi-permanent or permanent structures to be erected on the former FTA, with the exception of temporary structures required for camping such as tents and canopy's; and
- Limited overnight camping for an individual duration to be determined based upon post remediation risks.

Defence had advised that the remediated former FTA was likely to only be used for the above purposes with the appropriate restrictions to members of the Australian Defence Force (ADF) and Army, Air Force and Navy cadets administered through Base Standing Orders and an Environmental Management Plan.

1.2.7 Audit Project Outcomes

The remediation and further validation assessment works were designed to meet the target objectives of the project to allow the former FTA Site to be used for Defence activities defined as, dry surface training with overnight camping (refer to **Section 1.2.6**).

The remedial approach of ex situ thermal desorption aimed to achieve the stated objectives and end land uses through the mass source removal of DNAPL. The risk associated with potential contamination from the remaining areas of the former FTA, including residual DNAPL and potential impact from previous fire training activities and Defence uses have been addressed through consideration of the potential risk that impacted surface soil and soil vapour within the former FTA may have on these ongoing Defence activities (Refer to various key environmental reports, as listed in **Section 1.2.3**)

In addition, residual (i.e. post remediation) groundwater risks are monitored and addressed through monitored natural attenuation (MNA) assessment through ongoing trend analysis and managed through appropriate groundwater monitoring (AECOM, 2022c and 2021).

2.0 Site Geology and Hydrogeology Characterisation

2.1 Regional Geology

Based on the 1:50,000 State Government of Victoria map sheet, the regional geology is characterised by Quaternary aged coastal dune systems and paludal silts and clays overlying Tertiary aged sands, silts and clays.

2.2 Local Geology

2.2.1 Fill Material

Fill is widespread throughout pits and mounds at the site, while the Intertidal Zone is relatively undisturbed by human activities. Across the majority of the former FTA, fill and/or sandy-silt generally occurs between the ground surface and approximately 1.75 metres below ground level (m bgl).

Numerous stockpiles of imported building and pavement waste, aircraft parts, drums, etc. have been noted towards the north of the former FTA. Concrete, bricks, wooden planks, engine parts, rope, and metal fragments were observed within material used to backfill. Bricks, tyres, wooden planks, 200 litre (L) drums, plastic, terracotta pipes and potential asbestos containing material were historically observed within material used to backfill former Pit B, also known as Source Zone B, monitoring zone 4, as presented in **Figure F4, Appendix A**.

As part of the 2014-2015 source removal remediation works (AECOM, 2014e to 2014h and AECOM, 2015b and 2015c) Monitoring Zone 3 and Monitoring Zone 4 as presented in **Figure F4, Appendix A** were excavated to the base of the shallow aquifer (that is, to the underlying marine clay). Excavated soils were treated by Direct Fired Thermal Desorption and treated soil backfilled and compacted to the source zones. The treated soil consisted of a generally homogenous silty sand material devoid of organic matter.

2.2.2 Natural Soils

A summary of the underlying geology at the site as sourced from the Geological Survey Melbourne Sheet SJ 55-1, from top to base (youngest to oldest), is presented in **Table 3** below.

Table 3 Site specific geology and aquifer unit of RAAF Lake and the former FTA

Geology	RAAF Lake ↔ FTA ↔ Port Phillip Bay	Approx. Elevation (mAHD)
Quaternary	Quaternary-aged (Pleistocene/Holocene) Aeolian deposits consisting of silty sand topsoil with organic matter.	+2 to -2
	Quaternary-aged (Pleistocene/Holocene) Aeolian deposits consisting of calcareous sands, clays and some silty swamp sediments forming coastal dune systems (shallow aquifer).	
	Quaternary-aged (predominantly Holocene) cemented gravelly sand and gravelly clay layer consisting of sands, gravel, trace silt/ clay, trace cobbles and coarse shell fragments (shallow aquifer).	
	Quaternary-aged (predominantly Holocene) paludal swamp and lagoonal deposits consisting of silts, clays and discontinuous sand lenses resulting from former and present inland and tidal swamps and lagoons. In areas the discontinuous sand lenses lie beneath the low permeability silts, clays.	
	Quaternary-aged Newer Volcanics. Silty clays and clayey sands. Basalt outcropping 500 m north west of Site; however, not encountered at former FTA.	-2 to -4
	Quaternary-aged blue/green clays containing glauconite of marine origin.	

Geology	RAAF Lake ↔ FTA ↔ Port Phillip Bay	Approx. Elevation (mAHD)
	Quaternary-aged clayey sands and sandy clays, brown/grey with occasional mottling, fine to medium grained sands often with traces of shell fragments and gravels. Found in the western area of Site, particularly in the area surrounding Pit A (intermediate aquifer).	-4 to -16
	Quaternary-aged coastal swamp deposits, fine sand, silt, silty clay, often with shell beds.	
Tertiary	Tertiary-aged Brighton Group sediments. Sediments of the Brighton Group intercepted at the Site are typically grey-brown, fine to coarse grained sand with variable amounts of silt and gravel and some clay (deep aquifer).	-16 to -29
	Tertiary-aged (Miocene/Oligocene) Fyansford (Newport Formation) Group consisting of glauconitic and carbonaceous sands, silts, clays and shelly sand. In the vicinity of former FTA, the lithology of the formation is predominantly clay and sandy clay.	> -29

2.3 Hydrogeology

Field investigations over the past 10+ years have observed significant erosion of the approximately 1 m high fore-dune bank denoting the high tide mark along the Intertidal Zone of the former FTA. The erosion has been noted to occur after storm events and has resulted in the high tide mark migrating approximately 10 m northwest towards RAAF Lake.

Based on bore logs and lithological interpretations, two principal aquifer systems and one intermediate aquifer system have been identified within the former FTA. These aquifers are:

- Shallow Sand Aquifer (including intertidal discharge zone) (principal aquifer), refer to as the shallow aquifer;
- Intermediate Clayey Sand Aquifer (intermittent aquifer), referred to as the intermediate aquifer; and
- Deep Brighton Group Sand Aquifer (principal aquifer) refer to as the deep aquifer.

The site hydrogeology has previously been described in the conceptual site model (CSM) report (AECOM, 2010a) and the post remediation groundwater assessment report (AECOM, 2022c). The following sections (**Sections 2.3.1 to 2.3.4**) provide a summary of those findings and an update of current conditions based on results from the May 2021 and July 2021 groundwater monitoring events (GMEs) (AECOM, 2020 and AECOM, 2021).

A conceptual cross section from northwest to southeast through Monitoring Zone 3, previously presented in AECOM, 2010a, is provided as **Figure F5, Appendix A**. Since this figure was produced, the Monitoring Well IDs for F50MWb, F83MW and F63MWR have been changed to MW192, MW141 and MW128 respectively. IDs for the other locations shown in **Figure F5** (soil bores and monitoring wells) have not been changed since it was produced.

2.3.1 Aquifer Characterisation – Shallow Aquifer

2.3.1.1 Geology and Groundwater Depth

The shallow aquifer consists of a sandy unit extending from ground level to approximately 3.0 – 3.5m bgl. This aquifer is underlain by a paludal and marine clay unit approximately 1.0 thick (principal aquifer). Remediated soils within Monitoring Zone 3 and Monitoring Zone 4 areas are a homogeneous mix of treated silty sand.

Depth to groundwater in the shallow aquifer has typically ranged between around 1 and 3 m btoc; or 0 to 1.5 mAHD.

2.3.1.2 Groundwater Flow Direction

The shallow aquifer's groundwater flow regime beneath the site has varied both spatially and over time due to several influences. These have included seasonal variability, tidal influence (locally), and remediation works including sheet piling (in 2008), dewatering of excavations within the remediation extents of Monitoring Zone 3 and Monitoring Zone 4 (in 2014/2015) and reinjection of treated groundwater to infiltration trenches in the southwest of the site (in 2014/2015).

Inferred groundwater contours are provided for April 2005, obtained from AECOM, 2010a (**Figure F6, Appendix A**), September 2012, obtained from AECOM, 2022c (**Figure F7, Appendix A**), September 2014, obtained from AECOM, 2022c (**Figure F8, Appendix A**), and May and July 2021 (**Figures F9a and F9b, respectively, Appendix A**). The groundwater monitoring well conversion ID table is presented in the front end of this report.

Groundwater flow in April 2005 and September 2012, prior to excavation and dewatering activities in Monitoring Zone 3 and Monitoring Zone 4 was inferred to be southeast towards Port Phillip Bay; with inferred groundwater contours parallel or subparallel to the coastline. However, flow reversal along the shoreline has been noted historically, with flow from Port Phillip Bay towards the site. This is thought to be influenced by rainfall patterns, with partial groundwater flow reversal between winter/spring and summer/autumn months (AECOM, 2010a).

Groundwater levels and flow in the shallow aquifer were affected by excavation and dewatering activities during remediation works undertaken between mid-2014 and mid-2015. This can clearly be seen in the inferred groundwater levels for September 2014; shown in **Figure F8, Appendix A**.

The inferred groundwater contours and flow regime for May 2021 (**Figure F9a, Appendix A**) and July 2021 (**Figure F9b, Appendix A**) show groundwater flow to the southeast and towards Port Phillip Bay, albeit with localised variations in groundwater levels across the site. A possible reversal of groundwater flow beneath the site adjacent to the bay is apparent in July 2021 contours and is consistent with previous CSM of partial reversal of flow between winter/spring and summer/autumn months (AECOM, 2010a).

Overall, the shallow aquifer groundwater flow regime for 2021 is similar to that observed pre-remediation efforts, and groundwater levels have substantially recovered to 'initial conditions', with the predominant groundwater flow direction southeast towards Port Phillip Bay.

Although groundwater flow from the coastal side of the former fire training pits within the former FTA has not been observed to flow towards RAAF Lake, in the northern portion of the site (beyond the former fire training pits) the groundwater flow direction in the shallow aquifer has occasionally been inferred to be northwards towards RAAF Lake, based on a low point at MW42 (formerly known as F27MWa) [AECOM, 2012a]. Typically, slightly lower groundwater elevations occur at monitoring well MW41, located to the east of MW42, and inferred contours have historically indicated a more easterly groundwater flow direction. Groundwater levels were also measured at monitoring well MW039 located north of MW042 towards RAAF Lake. The lower groundwater elevation measured at this well in 2015/2016 indicated a possible groundwater flow divide and a component of flow northwards from the northern portion of the site (beyond the former fire training pits). This gradient was reversed in the most recent GMEs conducted in May and July 2021 (refer to **Figures F9a and F9b, Appendix A**).

It is noted that the acacia trees onsite were considered to be a potential receptor as it was assumed groundwater flow was being affected by evapotranspiration from the trees and that this had potential to impact groundwater levels in isolated areas of the site, particularly during a decade long drought preceding remediation as their roots would have advanced deeper towards the groundwater. However, during non-drought periods, it was not considered that their roots would be in contact with the shallow groundwater aquifer. During remediation, it was observed that the thickest of the acacia trees were located in the north-east corner of the site and therefore there was potential for these trees to have influenced groundwater levels in isolated areas at the site, during periods of low rainfall.

It remains unclear whether the lower groundwater elevations observed in the northern part of the site are due to the influence of RAAF Lake to the north, occasionally acting as a discharge zone, or due to evapotranspiration effects of the acacia thicket at and just beyond the northern site boundary. It is however noted that the predominant groundwater flow direction has been southeast towards Port Phillip Bay.

Groundwater Recharge

Recharge of the sedimentary units of the shallow sand aquifer is expected to be predominantly by direct rain infiltration and potential throughflow from RAAF Lake. Correlation of rainfall and groundwater gauging undertaken during the source removal remediation program (refer to Appendix 18 of the Contractor's Remediation Contractor Report in AECOM, 2017), indicates that recharge of the shallow aquifer at the FTA occurs via rainfall (AECOM, 2017).

Hydraulic Conductivity

Assessment of hydraulic conductivities within the shallow aquifer was undertaken by HLA (2006) and are summarised in **Table 4** below.

The shallow aquifer was thought likely to be more transmissive in the vicinity of former Pit A, based on the testing results (AECOM, 2010a); however, the hydraulic conductivities of backfilled materials following remediation activities in 2014/2015 are not known.

Table 4 Range of calculated aquifer parameters, shallow aquifer (HLA, 2006)

Area	Hydraulic Conductivity (m/day)	Transmissivity (m ² /day)	Specific Yield (S _y)
Pit A	7 - 74	15 - 174	$9.3 \times 10^{-3} - 2.4 \times 10^{-1}$
Pit B	3 - 11	10 - 45	$9.9 \times 10^{-3} - 3.1 \times 10^{-1}$

2.3.2 Aquifer Characterisation – Intermediate Aquifer

2.3.2.1 Geology and Groundwater Depth

The intermediate aquifer is a clayey sand aquifer consisting of discontinuous semi-confined clayey sand/gravel and is underlain by a grey/orange-brown silty clay aquitard.

Typically, groundwater in the intermediate aquifer has ranged between around 1.3 and 3 m btoc, which is approximately 0 to 1.0 mAHD.

2.3.2.2 Groundwater Flow Direction

Groundwater flow in the intermediate aquifer has varied spatially and over time due to remediation activities at the site.

Inferred groundwater contours have been provided for September 2012, obtained from AECOM, 2022c (**Figure F10, Appendix A**), September 2014, obtained from AECOM, 2022c (**Figure F11, Appendix A**), and May and July 2021 (**Figures F12a and F12b, Appendix A**).

In September 2012, prior to the 2014/2015 excavation and dewatering activities, the groundwater flow direction was inferred to be southeast towards Port Phillip Bay (refer **Figure F10, Appendix A**).

Groundwater elevations in September 2014 are seen to have declined to below 0 mAHD in monitoring wells around the Monitoring Zone 3 due to remediation activities (refer to **Figure F11, Appendix A**).

The inferred groundwater contours and flow regime for May 2021 (**Figure F12a, Appendix A**) and July 2021 (**Figure F12b, Appendix A**) show a predominantly southeast flow direction towards Port Phillip Bay, generally consistent with pre-remediation conditions. A possible groundwater divide near the site's northern boundary is also apparent based on the lower groundwater elevation measured to the north of the site at MW044.

2.3.2.3 Groundwater Recharge

The intermediate aquifer is semi-confined by the overlying marine clay but is hydraulically connected with the shallow aquifer. This is seen in the groundwater level pressure responses to dewatering activities in the shallow aquifer within Monitoring Zone 3 (AECOM, 2010a).

Recharge of the intermediate aquifer is expected to be vertical leakage from the overlying shallow sand aquifer, upward vertical leakage from the deep aquifer and possibly via flow from RAAF Lake (AECOM, 2010a).

2.3.2.4 Hydraulic Conductivity

Aquifer testing of the intermediate aquifer was undertaken in 2012. Assessment was predominantly within the vicinity of Monitoring Zone 3. Refer to **Table 5** below, for results presented in AECOM, 2012a.

Table 5 Aquifer testing results (AECOM, 2012a)

Well ID	Hydraulic Conductivity	
	cm/s	m/day
MW174	1.47×10^{-4}	0.13
MW175	1.67×10^{-4}	0.14
MW176	3.28×10^{-4}	0.3
MW177	5.79×10^{-4}	0.5
Geomean	2.61×10^{-4}	0.228

2.3.3 Aquifer Characterisation – Deep Aquifer

2.3.3.1 Geology and Groundwater Depth

The deep aquifer consists of a thick sequence of gravelly sand, sands and silty sands identified as an upper unit of the Brighton Group underlying the former FTA. Typically, groundwater was encountered during drilling at depths of approximately 15 m bgl to 17 m bgl. The base of this aquifer is formed by clays of the upper part of the Fyansford (Newport Formation) Group at a depth of approximately 33 mbgl (AECOM, 2010a).

2.3.3.2 Groundwater Flow Direction

Groundwater elevation data and inferred groundwater contours are provided for November 2013, obtained from AECOM, 2022c (**Figure F13, Appendix A**), September 2014, obtained from AECOM, 2022c (**Figure F14, Appendix A**), and May and July 2021 (**Figures F15a and F15b, Appendix A**).

Inferred groundwater contours have previously indicated groundwater flow to be south to southwest beneath the western portion of the site, and east to southeast beneath the eastern portion. This appears to be due to higher groundwater elevations ('ridge') across the middle of the site [MW196 (F102MWB), MW194 (F100MWB), MW191 (F49MWB) and MW189 (F48MWB)] and lower groundwater elevations in the southwest of the site [MW195 (F101MWB)] and northeast of the site [MW193 (F99MWB)].

Groundwater elevations in May and July 2021 are generally consistent with historical results, except for a depressed groundwater elevation compared to historical values in the centre of the site at MW194 (F100MWB).

Groundwater levels, as presented in AECOM 2021, are seen to decline in 2012 and 2013 (prior to excavation and dewatering activities) and although fluctuations occur in 2014 and 2015 (during remediation works) the groundwater levels remain relatively stable over that period. There does not appear to be any clear evidence of groundwater levels in the deep aquifer being materially affected by remediation activities at the site.

Groundwater level fluctuations and potential interaction between the shallow, intermediate and deep aquifer are discussed further in **Section 2.3.4**.

2.3.3.3 Groundwater Recharge

This aquifer is confined to semi-confined at the site and recharge is most likely achieved through direct infiltration of rainwater where Brighton Group outcrops, or by vertical leakage from overlying sediments. Discharge of the deep aquifer (upper Brighton Group) is likely to be off-shore into Port Phillip Bay, with some vertical leakage to the overlying intermediate clayey sand aquifer may also occur.

2.3.3.4 Hydraulic Conductivity

Hydraulic conductivity testing was undertaken by AECOM in September 2013 to assess potential connectivity between the intermediate and deep aquifers. AECOM was unable to induce drawdown in the monitoring well to assess hydraulic conductivities. Given the geology of the aquifer and the lack of drawdown the hydraulic conductivity is qualitatively assessed to be high.

2.3.4 Aquifer Interconnection

Hydrographs for co-located ('nested') monitoring wells constructed in different aquifers allows potential effects and interactions to be considered. These have been provided in **Figure 1** to **Figure 4** to illustrate the spatial and temporal variations in vertical hydraulic gradients.

Typically, groundwater elevations in the shallow aquifer are similar to, or higher, than the underlying intermediate aquifer suggesting predominantly downward leakage, however this has reversed on occasion – for example during remediation activities in 2014/2015 when an upward gradient would have occurred beneath and adjacent to areas being dewatered.

The gradient between the deep and intermediate aquifer varies over time both across the site and at individual locations. At MW43, located up gradient of the former pits, there appears to be a predominantly upward gradient from the deep aquifer to the intermediate aquifer (refer to **Figure 1**), but the gradient is reversed further south at the northern site boundary (refer to **Figure 2**).

In the central portion of the site, downgradient of former Pit A and adjacent to Monitoring Zone 3, an upward gradient from deep to intermediate aquifer is apparent during remediation works (2014/2015); due to dewatering of the shallow aquifer and associated decreasing pressure response in the intermediate aquifer. Following rebound of shallow and intermediate aquifer groundwater levels after cessation of remediation activities, the gradient became downward towards the deep aquifer. This downward gradient and depressed groundwater level in the deep aquifer (MW194) are still apparent in the 2020/2021 data (refer to **Figure 3**). This appears anomalous compared to responses in other deep aquifer bores, and the reason is unknown.

Further downgradient and away from remediation activities, the groundwater levels in the shallow, intermediate and deep aquifers are similar, indicating small hydraulic gradients in this area (refer to **Figure 4**). Reversal of gradients between the intermediate and deep aquifer have occurred since 2015 (with no data available prior to 2015).

Overall, the current (2020/2021) groundwater levels and gradients are considered similar to those prior to remediations works at the site, with the exception of some anomalies such as the depressed deep aquifer groundwater levels at MW194 – the reason for which is unknown.

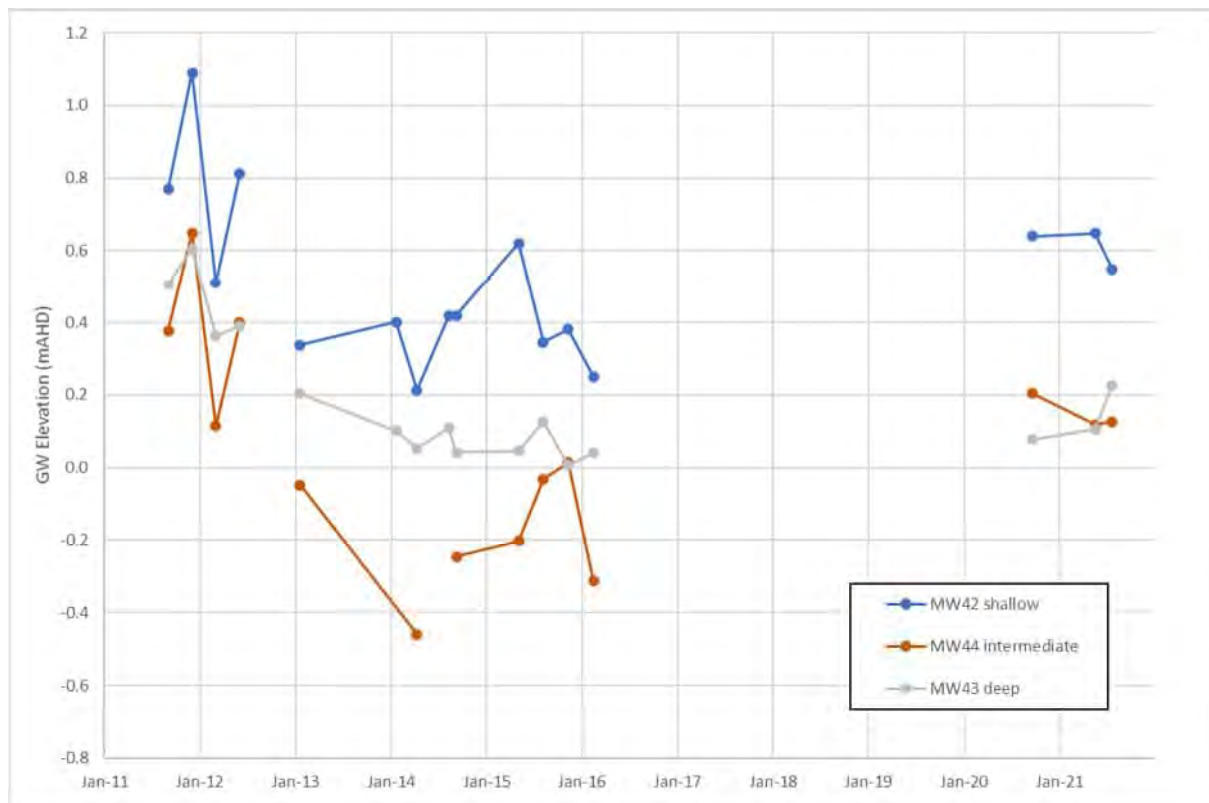


Figure 1 Upgradient 'nested set': MW042, MW044 and MW043

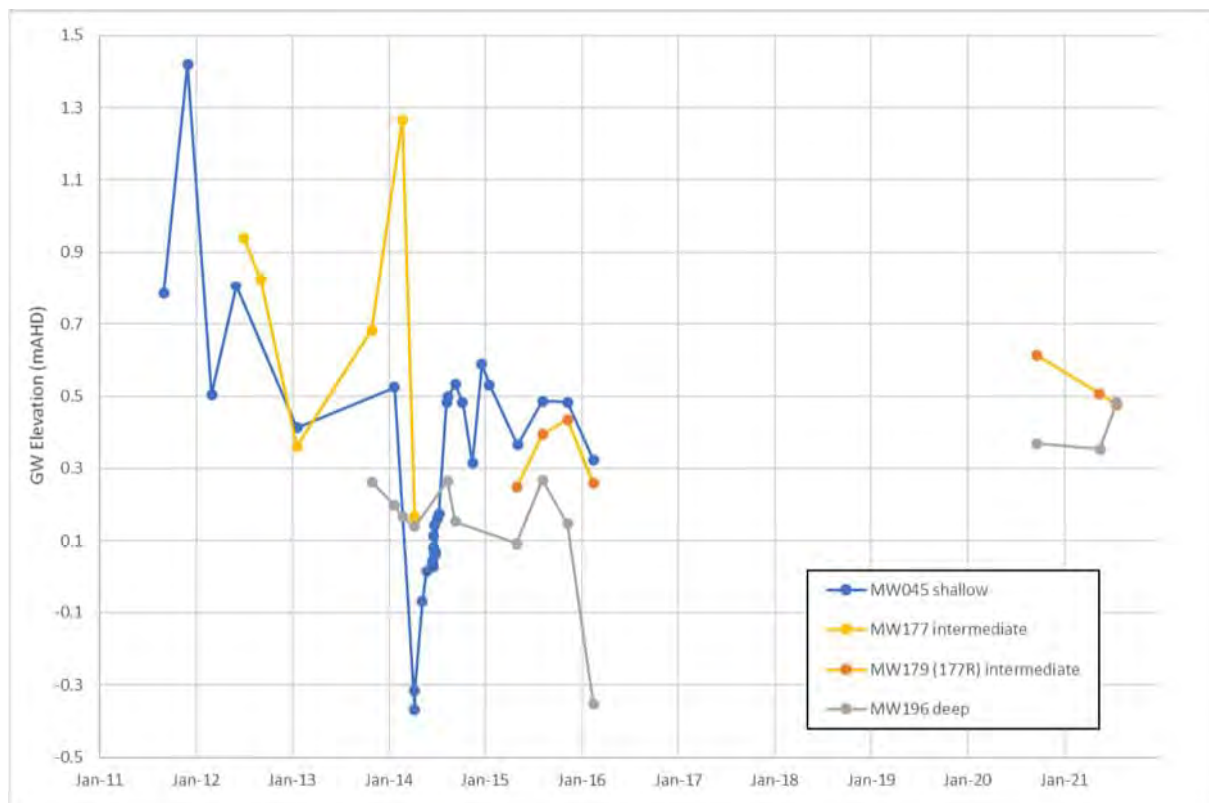


Figure 2 Upgradient 'nested set': MW045, MW177/179 and MW196

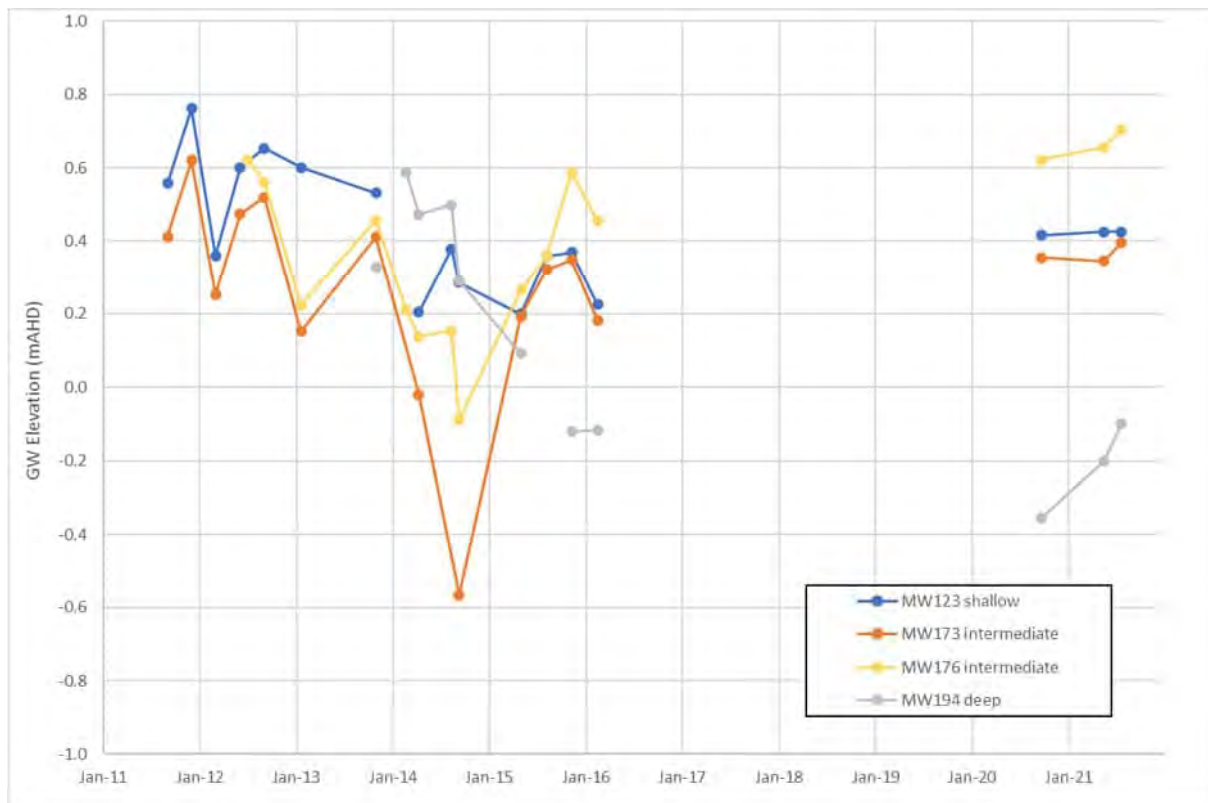


Figure 3 Central 'nested set': MW123, MW173, MW176 and MW194

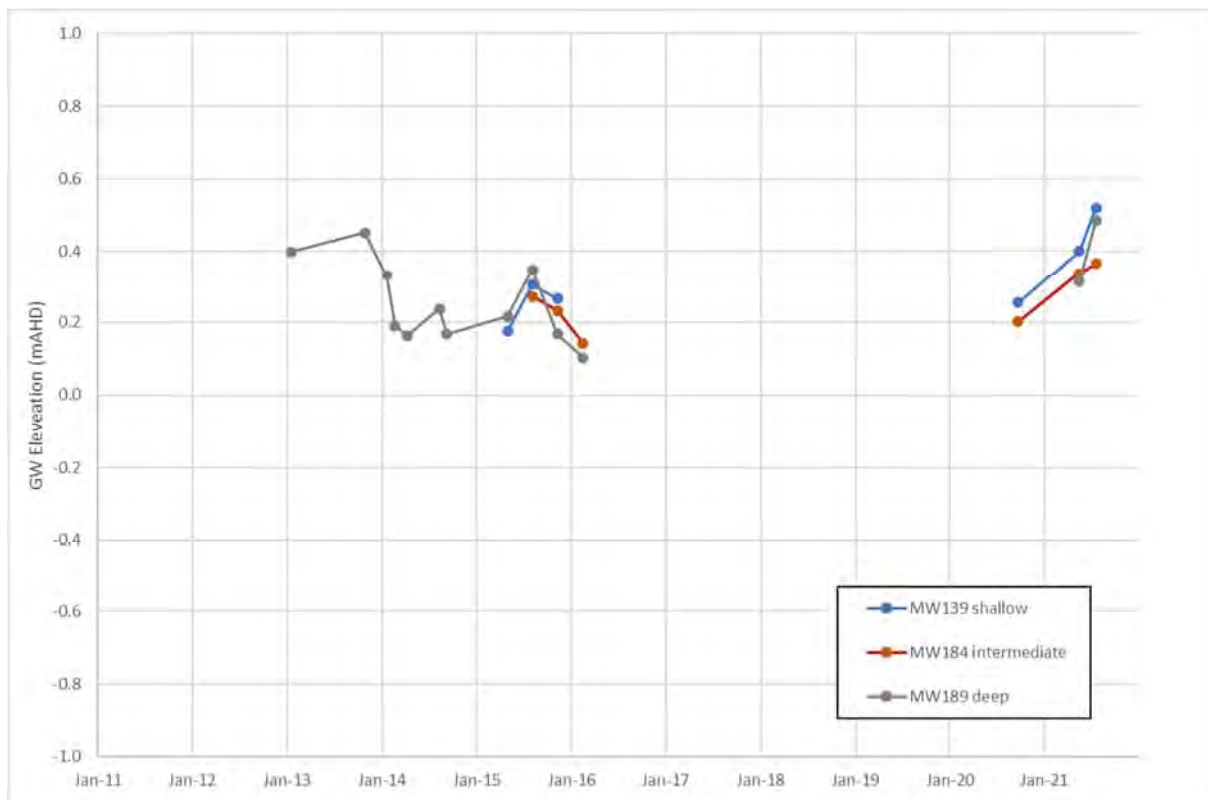


Figure 4 Downgradient 'nested set': MW139, MW184 and MW189

2.3.5 Salinity and Density Corrections

In groundwater environments where density variations can occur due to salinity differences (such as in coastal aquifers) it may be necessary to correct groundwater level data to estimate an equivalent 'freshwater head'. This allows variable density effects on groundwater levels (if any) to be taken into account when considering hydraulic gradients and groundwater flow; within and between aquifers.

Based on the limited depth of monitoring wells (and hence water columns) in the shallow and intermediate aquifers it is unlikely that density corrections would materially change equivalent 'freshwater heads'. In the deep aquifer, where monitoring well depths and water columns heights are greater, it is possible that density corrections could more notably effect 'freshwater heads' where total dissolved solids (TDS) values are high.

Density correction approximations, however, have not been attempted as part of this assessment due to the magnitude of spatial and temporal variations of TDS values reported for the site. The scale of variable density effects, if any, are therefore unknown.

3.0 Regulatory Framework and Environmental Values

Key guidelines and legislation applicable to the works undertaken have been defined below.

3.1 Defence Environmental Management Framework

3.1.1 Environmental Policy and Strategic Aims

The Defence Environmental Vision provided in the Environmental Policy (<http://www.defence.gov.au/estatemangement/Governance/Policy/Environment/Policy/EnvironmentalPolicy2016.PDF>) states: *Defence will be a leader in sustainable environmental management to support the ADF capability to defend Australia and its national interests*".

Defence's Vision is underpinned by five strategic aims, including Strategic Aim 3 which states that *"Defence will minimise future pollution risks and manage existing contamination risks"*. The strategic aims are detailed in the Environmental Strategy 2016 – 2036.

The priorities of Strategic Aim 3 are to:

1. *Minimise future pollution and contamination risks both in Australia and overseas operations;*
2. *Understand emerging contamination risks and advances in remediation and management approaches;*
3. *Apply a risk-based approach to managing contaminated properties, including unexploded ordnance, to reduce impacts on human health and the natural environment and maintain public access to key information about these risks; and*
4. *Manage contaminated properties and potential pollutants in accordance with relevant legislative obligations and standards.*

The actions, accountabilities and timeframes to achieve these priorities are provided in the Defence Environmental Plan.

3.1.2 Contamination Guidelines and Policy

Defence has developed numerous directives, guidelines and policies in relation to the management of contaminated land across the Estate.

The Defence Contamination Management Manual (DCMM 2019) provides the framework and technical guidance for the management of contamination related to Defence activities. The DCMM sets out mandatory requirements and is updated and/or amended as required.

Guidelines and policies are available on the Defence website:

<http://www.defence.gov.au/estatemangement/Governance/Policy/Environment/Contamination/default.asp>

3.2 Commonwealth Legislation, Policies and Guidelines

3.2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation.

Under the EPBC Act, any activity which is likely to have a significant impact on the environment, or on matters of national environmental significance, requires the approval of the Commonwealth Minister for the Environment and Energy. Under the EPBC Act, 'environment' is defined broadly and includes, but is not limited to, ecosystems and their constituent parts, people and communities, natural and physical resources and the heritage values of places. Non-compliance can result in penalties for both individuals and organisations.

3.2.2 National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended in 2013

The ASC NEPM, 2013 is developed by the National Environment Protection Council (NEPC) to protect or manage particular factors of the environment.

The ASC NEPM, 2013 establishes a nationally consistent approach to the assessment of Property contamination to ensure sound environmental management practices. The *National Environment Protection Measures (Implementation) Act 1998* (the Implementation Act) gives the Australian Government the power to implement NEPMs on its own land and for its own activities.

3.2.3 Workplace Health and Safety Act 2011

In 2011, Australia embarked on significant reformation of the National Work Health and Safety (WHS) Strategy. The process commenced in 2002 with the Workplace Relations Ministers' Council, the Australian Council of Trade Unions and the Australian Chamber of Commerce and Industry endorsing the current *Australian Work Health and Safety Strategy 2012-2022* (Safe Work Australia, 2011) to provide a framework of national activities to improve the health and safety of workers in Australia.

Defence operates within the Commonwealth WHS jurisdiction, however due to the nature of its business and operations there may be legislative touch points from time to time with State and Territory legislative requirements. The model WHS legislative framework consists of the WHS Act, WHS Regulation (both being statutory instruments), supported by advisory Codes of Practice. In addition to these National Codes of Practice, regulatory compliance may also be demonstrated by following technical or industry standards (such as the Australian Standards) where they provide a standard of work health and safety equivalent to, or higher than, the Code of Practice.

All controls required during works on the Property involving the handling of potentially contaminated materials will be implemented in accordance with the Defence WHS Manual.

3.3 Victoria Legislation and Policies

Defence and its contractors must operate to comply with all Commonwealth legislation, including the WHS Act, EPBC Act and the NEPM. Reference can be made to the Defence Legal Obligations Compliance Register found on Defence Estate Quality Management System (DEQMS). Defence may not be subject to State and Territory law in all situations. Whether or not Defence is bound by State and Territory law is a complex issue and legal advice must be obtained to confirm whether a particular State or Territory law is applicable to Defence. Defence contractors must comply with relevant State or Territory laws.

Section 3.3.1 provides an overview of the *Environment Protection Act 2017*, *Environment Protection Amendment Act 2018* (the EP Amendment Act 2018) and Environmental Reference Standard (ERS), which came into effect as of 1 July 2021. The EP Amendment Act 2018 repealed the Environment Protection Act (EP Act 1970) and amended the new *Environment Protection Act 2017* (the EP Act 2017).

The principal legislation this report adopts is the EP Amendment Act 2018 and the ERS, as the Victorian legislative reform occurred during the period of drafting this document and will be in effect at the time of issuance to the Victoria Environment Protection Authority (EPA).

3.3.1 Environment Protection Act (2017) and EP Amendment Act (2018)

The Victorian Government is committed to modernising the Victoria EPA, including its governance; and legislative and regulatory framework.

Legislative reforms include the EP Amendment Act 2018, which came into effect in July 2021 (after delay from July 2020), as noted in **Section 3.3**, above.

The new EP legislation focuses on preventing waste and pollution impacts, rather than managing the impacts after they have occurred. The legislation is intended to enhance the protection of Victoria's environment and human health through a more proportionate, risk-based environment protection framework.

The General Environmental Duty (GED) is central to the new laws. It requires all Victorian businesses and individuals to manage risks to human health and the environment from their activities; and take reasonable steps to prevent or minimise those risks.

In addition to the GED, the new legislation also sets out a range of duties, prescriptive elements and new instruments for managing contaminated land in Victoria. The duties for contaminated land include the new duty to manage contaminated land and duty to notify contaminated land.

3.3.2 Environmental Refence Standard

As part of the regulatory reform, new Environment Protection Regulations (the Regulations) and an ERS were released in draft in 2019, with public consultation between September and October 2019. The final Regulations and ERS were released in June 2021.

As outlined in the Publication 1752: Guide to the proposed Environmental Reference Standard (EPA, 2019), the purpose of an ERS is to set out the environmental values (i.e. uses, attributes and functions of the environment that Victorians value) that are sought to be achieved or maintained in Victoria. The ERS for the environmental values includes objectives for supporting different uses of the environment and measurable indicators that can be used to determine whether those objectives are being met. The standard contains environmental values, objectives and indicators for four elements of the environment: air, noise, land and water (surface water and groundwater). These are not mandatory compliance requirements but provide a benchmark for assessing actual and potential risks to environmental value. The ERS is taken into account by regulators in decision making processes (such as issuing operating licenses).

The ERS replaces State Environment Protection Policy (SEPP) [Prevention and Management of Contaminated Land (PMCL)] and SEPP (Waters) and incorporates most aspects of these including environmental values, with some minor changes. Some clauses of SEPP (Waters) remaining in force for two years under the Environment Protection (Transitional) Regulations. The retained clauses mostly relate to sewage and council wastewater management and are not relevant to this investigation.

3.3.2.1 ERS Part 4: Land

The Part 4 of the ERS sets out a framework for the protection of land environmental values (EVs) in Victoria. The ERS identifies:

- Six land use categories, as follows:
 - *Parks and Reserves;*
 - *Agricultural;*
 - *Sensitive use;*
 - *High density; and*
 - *Other (lower density);*
 - *Recreational / Open Space;*
 - *Commercial; and*
 - *Industrial.*
- Environmental values of land to be protected within each land use category;
- Land indicators and objectives by which to measure the protection of these environmental values.

The land use categories and applicable environmental values as shown in **Table 6** below.

Table 6 Land Use Categories and Environmental Values (as per ERS, 2021)

		Parks and reserves	Agricultural	Sensitive Use		Recreation / Open Space	Commercial	Industrial
				High Density	Other (lower density)			
Land dependant ecosystems and species	Natural ecosystems	✓						
	Modified ecosystems	✓	✓		✓	✓		
	Highly modified ecosystems		✓	✓	✓	✓	✓	✓
Human health		✓	✓	✓	✓	✓	✓	✓
Buildings and structures		✓	✓	✓	✓	✓	✓	✓
Aesthetics		✓	✓	✓	✓	✓	✓	
Production of food, flora and fibre		✓	✓		✓			

It is understood that Defence intends to retain ownership of the former FTA for continued use as a training area. As detailed in **Section 1.2.6**, it is anticipated that the former FTA will be utilised for training purposes (with no subsurface access) and possibly overnight camping. Based on this information, commercial land use scenarios are currently considered appropriate for future land use. As such, consistent with AECOM, 2017, it is considered that commercial use is the most appropriate land use in accordance with the ERS. **Table 6** provides the environmental values of land to be protected as per the requirements of the ERS.

As access and exposure by human receptors will be limited to Defence personnel and it is understood that the former FTA will not be re-developed with structures, the protection of buildings and structures and the aesthetic EV's are considered unlikely to be realised.

Therefore based on the above approach (Commercial), the EV's of most relevance at the former FTA are as follows:

- Land dependant ecosystems and species (Highly modified ecosystems); and
- Human Health.

For the offsite Parks Victoria (recreation / open space), the EV's of most relevance are as follows:

- Land dependant ecosystems and species (Modified and Highly modified ecosystems); and
- Human Health; and
- Aesthetics.

3.3.2.2 ERS Part 5: Water

3.3.2.2.1 Groundwater

The Part 5 (Division 2) of the ERS sets out a framework for the protection of groundwater environmental values in Victoria. The ERS identifies:

- Seven segments of the groundwater environment based on background water quality levels of TDS;
- Environmental values of groundwater to be protected within each segment of the groundwater environment; and

- Groundwater indicators and objectives by which to measure the protection of these environmental values.

The groundwater segments and applicable environmental values as shown in **Table 7** below.

Table 7 Groundwater segments and Environmental Values (as per ERS, 2021)

Environmental Value	Segment (TDS mg/L)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,001)
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

3.3.2.2.2 ERS Part 5: Water, Division 3 Surface waters

Subject to the inferred groundwater and stormwater flow directions identified at the Property, potential surface water receptors include RAAF Lake, north of the former FTA as presented in **Figure F1** and **F2, Appendix A**, and Port Phillip Bay. The protected beneficial uses identified have been determined subject to the segment to which the receiving waters belong and are further discussed below. Surface water throughout the former FTA is likely to discharge to the south to south-east towards Port Phillip Bay, it has been identified as the main receptor in relation to the former FTA.

Port Phillip Bay forms the southern boundary of the Property and the former FTA. The bay falls within the ERS Geelong Arm subsegment, which includes *'the surface waters of the Werribee coastal zone extending 5 km offshore from Point Cook and south to Point Richards and encompassing the Geelong Arm'*. The ERS describes the Geelong Arm subsegment as a slightly to moderately modified ecosystem, therefore the 95% protection levels set out in Australian & New Zealand Guidelines for Fresh and Marine Water Quality [ANZG (2018)] apply in accordance with ERS Section 19 Clause 4(6)(ii). The protected environmental values of the Port Phillip Bay ecosystem within the Geelong Arm subsegment, and a summary of the relevant water quality guidelines are provided in **Table 8**, below.

Table 8 Surface water segments and Environmental Values

Environmental value	Segment	Aquatic reserves	Marine and Estuarine															
		Aquatic Reserves	Estuaries	Port Phillip Bay				Western Port		Corner Inlet	Gippsland Lakes					Open Coast		
	Sub - segment			Hobsons Bay	Central -East	Geelong Arm	Exchange	Entrances and North Arm	East Arm		Lake Wellington	Lake Victoria	Lake King	Lake Reeve	Exchange	Otway	Central Bass Strait	Gippsland (Two-Fold)
Water dependent ecosystems and species that are:	Largely unmodified	✓			✓		✓	✓								✓	✓	✓
	Slightly to moderately modified		✓	✓		✓			✓	✓	✓	✓	✓	✓				
	Highly modified																	
Human consumption after appropriate treatment																	✓	
Agriculture and irrigation																		
Human consumption of aquatic foods		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aquaculture		✓ if the environmental quality is suitable and an aquaculture licence has been issued under the Fisheries Act 1995																
Industrial and commercial			✓	✓	✓	✓	✓	✓	✓	✓						✓		✓
Water-based recreation (primary contact)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water-based recreation (secondary contact)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water-based recreation (aesthetic enjoyment)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Navigation and shipping		✓	✓	✓	✓	✓	✓	✓		✓				✓	✓	✓	✓	✓

3.4 PFAS Regulatory Framework

Prior to January 2018, there had been no nationally agreed approach for the management of PFAS contaminated groundwater, contaminated soils or wastes.

The PFAS National Environmental Management Plan (PFAS NEMP, 2018) was published in January 2018 and provides the overarching framework for the assessment and management of PFAS contamination in Australia. The PFAS NEMP was intended to be an adaptive plan, to be updated to reflect the evolving knowledge surrounding PFAS. Following the release of the draft Version 2.0 on 28 February 2019 and subsequent public consultation, the PFAS NEMP Version 2.0 was published in January 2020. The PFAS NEMP 2.0 was endorsed by the Heads of EPA (HEPA) in October 2019 and is being implemented in all states and territories of Australia, except Victoria.

While the PFAS NEMP 2.0 is not strictly endorsed within Victorian, it is widely adapted and therefore the guidance relating to PFAS in soil, surface water and groundwater for this report is based on advice from the January 2020 PFAS NEMP 2.0, and the 2019 National Health and Medical Research Council (2019 NHMRC) guidance which presents:

- Health-based guidance values for groundwater for perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS) and perfluorooctanoic acid (PFOA), for drinking water and recreational water (primary contact); and
- Guideline values for the protection of freshwater aquatic ecosystems, for PFOS and PFOA, also conservatively adopted as interim screening values for marine waters.

3.5 Other Guidance Documents

Australian Standards

The following Australian Standards were referenced during sampling and investigation to ensure sufficient and reliable information for the assessment of sites with potentially contaminated non-volatile and semi-volatile compounds was obtained:

- Standards Australia (AS4482.1-2005) Guide to the investigation and sampling of sites with potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds; and
- Standards Australia (AS 4482.2-1999) Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile Substances.

4.0 Conceptual Site Model and Conditions Prior to Remediation

4.1 Nature and Extent of Contamination - Prior to Remediation

4.1.1 Sources of Contamination

The sources of contamination at the former FTA are related to the historic pits previously used for fire training purposes and waste disposal. No off-site sources of contamination of the identified CoPC have been identified during soil and groundwater investigation works.

Contamination sources at the former FTA as identified during pre-remediation investigations (AECOM, 2010a) are summarised in **Table 1, Section 1.2.1**, and illustrated in **Figure F6, Appendix A**. There are two separate identified point sources of DNAPL: Former Fire Training Pit A (Source Zone A) and Former Fire Training Pit B (Source Zone B). DNAPL originating from each pit had migrated beyond the extents of the pits towards the south-east.

Figure F16, Appendix A, obtained from AECOM (2017), presents the extent of NAPL impacts prior to the remediation program.

4.1.2 Soil and Groundwater Conditions Prior to Remediation

The conceptual model of the horizontal and vertical distribution of the DNAPL across the inferred source zones, is based predominantly upon information gathered during the extensive push tub coring and test pit program, refer to GHD document titled *Department of Defence Former Fire Training Area, RAAF Base Williams, Point Cook, Victoria s.53V Environmental Audit Report, GHD, January 2012* (GHD, 2012). Significant DNAPL saturation was present in the immediate vicinity of Pit A [Secondary Source Zone A (SZA)] and extended discontinuously from the water table to the base of the Shallow Sand Aquifer over a vertical interval of approximately 2 m. DNAPL in this zone appeared to exist as multiple pools perched on capillary barriers (clay and other low permeability units). Approximately 20 m down-gradient of the pit, DNAPL largely resided as a pool or multiple pools, at the base of the aquifer, and was perched on the lower paludal clay, marine clay, or both. Further down-gradient (>40 m) the DNAPL appeared to largely reside as a pool on the marine and paludal clay and varied in thickness from less than 0.1 m to approximately 0.4 m. Visual observations during push tube sampling suggested full saturation of DNAPL in the pore space.

In the vicinity of Pit A (Secondary SZA) the DNAPL ranged in thickness from approximately 0.05 m to 1.25 m. Based on this range, the estimated volume of DNAPL for Secondary SZA, assuming a porosity of 0.3 and 100% saturation, was calculated to range between 310,000 L and 800,000 L. These volumes were primarily based on the measured saturated thickness of DNAPL observed in push tube soil cores obtained from soil bores drilled across the site, rather than measured in groundwater wells.

In the vicinity of Pit B [Secondary Source Zone B (SZB)] the thickness of DNAPL ranged from 0.02 m up to 0.55 m. Based on this, the estimated volume of DNAPL for Secondary Source Zone B, assuming a porosity of 0.3 (AECOM, 2013b) and 100% saturation, was calculated as 150,000 L.

LNAPL was also present in the vicinity of Pit B (Secondary SZB) and test pitting identified LNAPL surrounding Pit B and Mounds F and G. In the vicinity of Pit A, LNAPL was previously only identified to extend a short distance to the north west. The LNAPL encountered was recorded to have a notable solvent odour. Chemical analysis of the LNAPL at the Site was not undertaken. Fire-fighting activities across the FTA used a mixture of chemicals, which generated both LNAPL and DNAPL. LNAPL was unable to be sampled and analysed at the site in later post-remediation works, and the exact chemical composition is unknown.

The chemical composition of the DNAPL is discussed below in **Section 4.1.3**.

4.1.3 Primary Chemicals of Interest

DNAPL and Source Zone validation works are discussed in AECOM 2013a. The DNAPL is considered to be the primary source of dissolved phase groundwater contamination. The Conceptual Site Model (AECOM, 2010a) identified twelve primary chemicals of interest (PCI) which presented the greatest risk of migrating and potentially impacting down gradient receptors, including Port Phillip Bay.

Over 120 chemical compounds were identified in the DNAPL samples collected at the FTA Site. 1,1,2-TCA was the highest compound concentration detected in the DNAPL (16.2%w/w) followed by 1,2-DCA (7.2%w/w) and bis(p-tol) ethane (5.8% w/w), (AECOM 2013a). Approximately 21% of the DNAPL mass could not be chemically identified with the analytical methods employed. Other major classes of compounds present in the DNAPL included: ether; lesser chlorinated ethenes and ethanes; monocyclic aromatic hydrocarbons; and polycyclic aromatic hydrocarbons (AECOM 2013a).

The following PCI were identified as representing the greatest potential risk to offsite receptors.

- Tetrachloroethene (PCE);
- Trichloroethene (TCE);
- 1,1,2-trichloroethane (1,1,2-TCA);
- 1,2-dichloroethane (1,2-DCA);
- 1,1,2,2 tetrachloroethane (1,1,2,2 TeCA);
- 1,1-dichloroethane (1,1-DCA);
- Vinyl chloride (VC);
- Benzene;
- Chlorobenzene;
- Chloroform;
- Cis-1,2-dichloroethene (cis-1,2-DCE); and
- Trans-1,2dichloroethene (trans-1,2-DCE) (AECOM, 2013a)

4.1.3.1 Per- and poly-fluoroalkyl substances

The presence of per- and poly-fluoroalkyl substances (PFAS) at the former FTA is likely associated with the use of firefight foams during fire training activities at the Site.

PFAS were initially investigated in 2009 within the sediment of the intertidal zone by the collection of five samples to support the Phase 2 Ecological Risk Assessment (AECOM, 2010b). All samples were reported as non-detects. At the time, analysis was undertaken by Leeder, for which NATA accreditation was not held

Prior to the source removal remediation program, PFAS had not been validated across all environmental media to a level that would allow a conclusion to be formed regarding the distribution PFAS in soil and groundwater at the former FTA or whether the Site is suitable for Defence's proposed end land use (AECOM, 2014a).

4.2 Potential Transport Mechanisms – Pre-Remediation

4.2.1 Soil Contamination

The NAPL present in Primary SZA and SZB represented the major contaminants to the soil at the site (pre-remediation). Due to the relatively high porosity of the shallow soils, contaminant flux and dispersion of NAPL in the unsaturated zone is likely to have been relatively unhindered, however laboratory derived values of kinematic viscosity and density (AECOM, 2010a) indicated that the NAPL had a relatively low mobility and low tendency to penetrate a porous media. Heterogeneities in the soil may have caused local pooling of NAPL in the unsaturated zone. Volatilisation of certain components of NAPL to the atmosphere is likely to have occurred (to a minor extent). This likely occurred where NAPL was exposed to the air in the pore space of the soil, and some of the residual NAPL mass attached to soil particles through sorption processes, effectively removing a portion of the contaminant mass from the flow system. Transport through the unsaturated zone within source areas can also occur when rainwater infiltrates into the ground and dissolves some of the contaminants in the NAPL mass. As this rainwater continues to infiltrate further into the subsurface, the NAPL-derived contaminants can migrate to reach groundwater.

The following sections discuss the occurrence and migration of LNAPL and DNAPL separately in more detail.

4.2.1.1 LNAPL

The LNAPL identified at the Site migrated on top of the water table in the direction of the horizontal hydraulic gradient. Due to the low hydraulic gradient of the shallow aquifer, relatively little migration of LNAPL associated with Source Zones A and B, Mound F and Mound G were observed (compared to DNAPL and dissolved phase migration).

4.2.1.2 DNAPL

The DNAPL migrated from Pit A and Pit B represented Secondary Source Zones and appeared to exist predominantly as multiple pools perched on capillary barriers (clay and low permeability units). Residual phase DNAPL was also present sorbed to the soil matrix. Pooled DNAPL was thought to migrate under the effects of gravity predominantly along the base of the paludal and/or marine clays at the base of the shallow aquifer. DNAPL has the capacity to provide a long term continuing source of groundwater (dissolved phase) contamination.

The surface of the marine clay is considered relatively flat underlying the source zones. The height of the marine clay and the interpreted top of clay elevations are presented in Figure F16 of AECOM (2013a). However, from pre-remediation monitoring as well as observations made during remediation, DNAPL was migrating downgradient of the source zones along the marine clay layer towards Port Phillip Bay.

4.2.2 Groundwater Contamination

The following sections describe the groundwater contaminant transport mechanisms, as described in AECOM, 2010, which were identified at the former FTA. Note that these mechanisms are still applicable to the Site post-remediation, however the concentrations and chemical forms of contaminants (as discussed in **Section 6.2**) will differ.

4.2.2.1 Advective Transport

Advective transport results in the migration of contaminants in certain directions with the groundwater flow but does not affect concentrations. Advective transport is determined by evaluation of hydraulic gradients and groundwater flow directions.

Dissolved contaminants at the Site are transported with groundwater flow predominantly as a result of advective transport due to the relatively high transmissivity of the Shallow Aquifer. The direction of migration is primarily towards the Bay; however, the hydraulic gradient is seasonally reversed.

The influence of both seasonal variability and tidal activity in the intertidal zone also play an important part in the migration of dissolved phase contamination at the former FTA. The groundwater flow regime at the Site showed a partial reversal as a result of wetter conditions during the Winter months and dryer conditions in the summer months. This phenomenon is further influenced in the intertidal zone, by tidal dynamics where groundwater during low tide discharges into the Bay and more saline sea water infiltrates the underlying aquifer during high tide.

4.2.2.2 Dispersion

Hydrodynamic dispersion is the process whereby groundwater containing dissolved contaminants must move around individual sand grains or other heterogeneities (variations) in the aquifer during groundwater flow. As a result of this, the specific path and velocity of any particle is highly variable. This results in effective dilution and spreading over space of constituent concentrations in groundwater plumes, as groundwater moves along these variable paths and mixes with other groundwater. The concentrations within the plume will decrease, while the area covered by the plume will increase as it migrates away from the source area.

Hydrodynamic dispersion, both longitudinal and transverse, was considered likely to be affecting the migration of dissolved phase contamination at the Site. However, due to the relatively small transport distance between the DNAPL sources and the Bay, dispersion was not considered likely to affect any significant attenuation. Both advective transport and dispersion are affected by heterogeneities in the soil, such as silt and clay lenses, which subsequently affect localised hydraulic conductivity.

4.2.2.3 Retardation / Soil Partitioning

Based on their chemical characteristics, many contaminants will partition between the soil and water phases. There is an equilibrium level at which some percentage of the constituent will be dissolved in groundwater and some portion will sorb onto the surface of the solid materials in the aquifer. In general, organic contaminants will prefer to sorb onto organic material in the aquifer. The partitioning of metals can be affected by pH and other chemical conditions in the system. This is measured through the soil-water partitioning coefficient (K_d) under equilibrium conditions.

The effect of partitioning is to reduce the overall velocity of contaminants dissolved in the groundwater relative to the groundwater itself, known as retardation.

Partitioning from NAPL present in Primary Source Zones A and B to groundwater has the capacity to provide a long term source of dissolved-phase contamination. Sorption of dissolved phase contaminants onto the surrounding aquifer matrix was also thought to be retarding the migration of contaminants towards potential receptors. The Shallow Aquifer is thought to have relatively low organic carbon content, and as such, adsorption was thought to be a relatively minor process affecting contaminant transport at the Site.

4.2.2.4 Degradation and Redox Effects

Within groundwater systems, there are microbes capable of breaking down many contaminants, however, the effectiveness of these microbes is often dependant on specific environmental conditions. Contaminants are broken down more efficiently based on their chemical properties and the groundwater system properties.

Redox is most directly related to inorganic parameters where their mobility in groundwater systems is a function of their valence state, determined by the redox conditions. The fate and transport of organic contaminants at the Site is affected by local redox conditions. When microbes degrade organic contaminants, oxygen is consumed, therefore oxygen levels in groundwater become depleted. The release of organic chemicals to the subsurface across the Site has caused oxygen in groundwater to be consumed, based on chemical analysis of groundwater samples. Geochemical conditions in the Shallow Aquifer at the Site are typically anaerobic; depleted of oxygen. The groundwater in the deeper confined aquifer was also considered likely to be under reducing conditions due to its age and separation from the atmosphere.

The anaerobic conditions within the Shallow Aquifer are less favourable for degradation of some dissolved constituents (e.g. benzene) and more favourable to others (e.g. PCE). Installation and operation of the Aeration Delivery System (ADS) produced locally restricted zones or aerobic oxidising conditions in order to encourage further degradation of contaminants.

4.2.3 Intertidal Pore Water

As the groundwater interacts with sediment and surface water in the intertidal zone of Port Phillip Bay, the chemistry changes significantly. Certain contaminants were shown to partition into the sediments and not reach surface water, whilst other contaminants may have reached surface water, either diluted and/or chemically transformed due to the mixing of groundwater and surface water. Contaminant plumes were highly attenuated within the intertidal sediments due to mixing of saline and terrestrial groundwater. The relatively high TDS values reported in the intertidal zone at the Site were noted as evidence of this.

An appreciable reduction in contaminant concentrations was recorded in the intertidal zone, however variable concentrations were recorded at certain locations. It was thought possible that the paludal and marine clays were acting as a diffuse source of contamination in the intertidal mixing zone. Diffusion driven transport of contaminants was thought likely to occur vertically and horizontally through the pore spaces present in the paludal and marine clays and through more permeable zones within the dunal deposits. Diffusion of organic contamination from the more permeable Shallow Aquifer into the underlying clay matrix is governed by Fick's First Law. Numerous studies have been undertaken which have assessed the importance of diffusive loss of dissolved phase chemical mass into low permeability (clayey) layers (Sudicky and Frind, 1982, Mackey et al., 1993, Parker et al., 1996, Reynolds and Kueper, 2004). The presence of clay acting as a diffuse source, along with transitional mixing-zone encouraging diffusive driven transport of contaminants, was thought to help explain the short-term contaminant concentrations recorded at the Site.

4.2.4 Contaminant Mass Flux

Estimates for contaminant mass flux were calculated to assess the relative amount of dissolved phase contaminants at the former FTA. Mass flux values were calculated based on site derived information during groundwater discharges to the Bay, to understand the degree of contamination to each aquifer at the former FTA. Data was collected in the pre-2010 Site investigations. In the absence of hydraulic conductivity data for the Intermediate and Deep Aquifers, conservative estimates were made based on lithology for the aquifers and published data for the Brighton Group (Deeper Aquifer). Mass flux estimates were calculated for six PCIs, shown in Table 9 below.

Table 9 Pre-remediation Contaminant Mass Flux Estimates

Aquifer	Analyte	Concentration (mg/L)	Cross-sectional Area (m ²)	Hydraulic Gradient (i)	Hydraulic Conductivity (m/day)	Groundwater Discharge	Mass Flux to Bay (kg/day)
Shallow	PCE	2.7	290	0.001	20	5.8	0.01566
	TCE	15.3	320	0.001	20	6.4	0.09792
	1, 1, 2-TCA	126	320	0.001	20	6.4	0.8064
	1, 2-DCA	545	320	0.001	20	6.4	3.488
	VC	59.6	200	0.001	20	4	0.2384
	Benzene	18.9	165	0.001	20	3.3	0.06237
Intermediate	PCE	0.06	80	0.002	10	1.6	0.000096
	TCE	4.2	80	0.002	10	1.6	0.00672
	1, 1, 2-TCA	12.4	80	0.002	10	1.6	0.01984
	1, 2-DCA	121	80	0.002	10	1.6	0.1936
	VC	27.4	80	0.002	10	1.6	0.04384
	Benzene	1.6	80	0.002	10	1.6	0.00256
Deep	PCE	0.006	163	0.003	2	0.978	5.87E ⁻⁰⁶
	TCE	0.01	163	0.003	2	0.978	9.78E ⁻⁰⁶
	1, 1, 2-TCA	0.14	163	0.003	2	0.978	0.000137
	1, 2-DCA	0.1	163	0.003	2	0.978	9.78E ⁻⁰⁶
	VC	ND	163	0.003	2	0.978	NA
	Benzene	ND	163	0.003	2	0.978	NA

Notes: PCE = tetrachloroethene; TCE = trichloroethene; 1,1,2-TCA = 1,1,2-trichloroethane; 1,2-DCA = 1,2-dichloroethane; VC = vinyl chloride; ND = Non detect, NA = Not available.

Average aquifer thickness: Shallow 2 m, Intermediate 2 m, Deep 13 m.

Hydraulic conductivity for the shallow aquifer assumed to be 20 m/day.

Hydraulic conductivity for the intermediate aquifer conservatively estimated to be 10 m/day based on lithological information.

Hydraulic conductivity for the deep aquifer assumed to be 2 m/day using an upper estimate for Brighton Group Aquifer (Leonard, 1992).

It can be seen that the estimated total mass flux (kg/day) to the Bay for the six PCIs is greatest from the Shallow Aquifer. The flux of contaminants from the Intermediate and Deep Aquifers was calculated at two to six orders of magnitude lower than the Shallow Aquifer.

In both the Shallow and Intermediate Aquifers, the parameter with the greatest estimated mass discharging to the Bay was the 1,2-dichloroethane. In the Deep Aquifer it was 1,1,2-trichloroethane. Attenuation with depth was predominantly thought due to the presence of the marine and paludal clay layers acting as a barrier for contaminant migration between the Shallow Aquifer and underlying aquifers. Therefore, the level of contamination in the Intermediate and Deep Aquifers is significantly lower than the Shallow Aquifer, as a result, the mass fluxes from the Intermediate and Deep Aquifers were correspondingly expected to be lower.

4.3 Potential Receptors and Exposure Pathways – Pre-Remediation

The principal receptors which may be exposed to contaminated groundwater were expected to be users or inhabitants of the intertidal zone of Port Phillip Bay. Sampling of the intertidal zone down-gradient of Secondary SZA indicated that concentrations of the PCI were being recorded in pore water samples up to a distance of 30 m into the intertidal zone. Environmental, health and perception risks posed by contamination present at the former FTA were considered as follows (AECOM, 2010a):

- Impact to the marine ecosystem, given its proximity to the groundwater discharge area and that the ecosystem criteria were exceeded within groundwater wells at the foreshore;
- Impacts to swimmers from dermal contact and incidental ingestion of contaminated groundwater discharging to the Bay, given the primary contact recreation criteria were exceeded within groundwater wells at the foreshore;
- Impact to recreational fisherman who regularly use the area immediately offshore of the former FTA. Criteria for fish tainting were exceeded within groundwater wells at the foreshore;
- Potential aesthetic issues associated with odour and possible discolouration of groundwater, should the public expose the groundwater table while using the beach;
- Potential aesthetic issues associated with odour and possible groundwater discolouration and dermal contact should wet conditions cause groundwater to emerge within depressions between dunes;
- Potential health risks from loose pieces of surface asbestos associated with the stockpiles at the Site; and
- Public perceptions of Defence's environmental management practices, given the nature and size of contamination identified and the close proximity to highly valued Point Cook Coastal Park, Cheetham Wetland (a RAMSAR site), significant Shorebird habitat, Point Cook Marine Reserve and the frequent use of the offshore area by recreational fishermen.

A 2007 Human Health Risk Assessment (HHRA) (HLA ENSR, 2007) found that exposure to chemicals of potential concern detected in the groundwater, surface water and marine biota within the intertidal zone were not considered to pose an unacceptable risk to human health. The HHRA assessed that no unacceptable risk was posed to adults and children who play in the sand and who ingest the maximum volume of 0.5 mL of affected groundwater per event. Ingestion greater than this was considered unlikely, however may potentially result in an unacceptable risk, which was mitigated by restricted access to the site.

A Phase 1 Ecological Risk Assessment (ERA) found that general ecological receptors exposed to impacted groundwater derived from the former FTA were not likely to be significantly affected by PCI derived from the Site. Epifaunal and infaunal benthic invertebrates, bottom feeding fish, plants and microorganisms were considered to be the ecological receptors with the highest potential for exposure and impacts from the PCI derived at the Site.

A further Phase 2 Ecological Risk Assessment (AECOM, 2010b) was undertaken in 2009 to assess the higher risks associated with the intertidal zone of Port Phillip Bay. The Phase 2 ERA found that whilst Site derived contaminants were present in pore waters within the intertidal zone and shallow subtidal zone of Port Phillip Bay down-gradient of the former FTA, the presence of these contaminants did not appear to have significantly impacted ecological receptors within the study area. Further,

contaminant concentrations present in pore water down-gradient of the former FTA did not appear to be associated with toxic effects to marine invertebrate test species considered representative of ecological receptors likely to be found in the intertidal and subtidal zones of Port Phillip Bay.

The thicket of Acacia trees in the north east corner of the Site were also considered potential receptors due to the assumption that groundwater flow was affected by evapotranspiration from the trees. An investigation of the potential impacts to these trees was not undertaken, however visual inspections of the area reported good vegetation conditions.

The post-remediation CSM outlining current conditions is detailed in **Section 7.0** onwards.

5.0 Summary of Remediation Works Completed to Date (2013 – 2021)

5.1 Remediation scope

In order to achieve the remediation project objectives, the following scope of work was undertaken:

- Assessment of the condition of soil within the former FTA outside of the two primary Source Zone areas, including consideration of surface soils, solid inert waste and existing stockpiles;
- Assessment of the condition of the treated soil within the former FTA backfilled to the two primary Source Zone areas;
- Assessment of the condition of marine clays with the contract remediation extent; and
- Assessment of the mass source removal of the two primary Source Zones of DNAPL impacted areas to the extent practicable.

The above assessment works were undertaken to support Defence's voluntary audit of the former FTA. Further to the above, the following scope items were presented separately to be used to form and support Defence's a voluntary audit of the former FTA:

- Assessment of the likely risk posed by residual NAPL and other detected remaining contamination following the remediation in relation to Defence's desired end use scenario (AECOM, 2015e); and;
- Assessment of groundwater contamination status and the risk posed to both onsite and offsite receptors (AECOM, 2015e)

5.1.1 Remediation Planning and Approvals

The former FTA remediation program underwent an extensive remediation planning and approvals process incorporating a Remediation Feasibility Study, development of a Remediation Action Plan (RAP), Parliamentary Standing Committee on Public Works and Facility Review (shadow works approval process).

The RAP was prepared to present a detailed assessment of remediation technologies previously assessed and to recommend a preferred practicable strategy to remediate soil and groundwater contamination at the former FTA. The RAP was developed as a framework to satisfy Stakeholder and project requirements within the context of mitigating Defence's longer term risks and liabilities (to the extent practicable) and to comply with the intent of Victorian legislation with regard to the protection of the environment at, and immediately adjacent to, the former FTA.

The outcome of the RAP included a detailed technology assessment and a recommendation that the preferred remediation technology to remove DNAPL to the extent practicable was considered to be excavation and ex situ thermal desorption.

On 26 July 2011, a public hearing of the Parliamentary Standing Committee on Public Works (PWC) inquiry into the proposed contamination remediation works at the former FTA was held. The purpose of the PWC was to seek funding approval to remediate the former FTA. The PWC were advised in *Contamination Remediation Works Former Fire Training Area, RAAF Base Williams, Point Cook, Victoria-The Statement of Evidence to the Parliamentary Standing Committee on Public Works*. Australian Government (Department of Defence, 2011) that the proposed remedial works at the former FTA comprise: 'the remediation involves the excavation of contaminated soil and removal of approximately 950,000 litres of DNAPL and subsequent thermal treatment at a temporary built facility, utilising heat to break down the contaminants to acceptable levels. Once treated, the validated soil will be returned to the ground and the area rehabilitated. The work will include:

- a. Dewatering to allow excavation of contaminated soil and DNAPL;
- b. Treatment of groundwater extracted during the dewatering process;
- c. Removal (excavation and stockpiling of contaminated soil and DNAPL within and extending from Pits A & B;

- d. Preconditioning of contaminated soil and DNAPL prior to treatment;
- e. Ex situ onsite treatment of the contaminated soil and DNAPL using thermal desorption technology;
- f. Testing and validation of the treated material;
- g. Backfilling of excavations using the treated and validated material;
- h. Importation of clean validated soil (if required); and
- i. Rehabilitation and revegetation of the areas of the site affected by the works.

Following the PWC hearing the following motion was moved in the House of Representatives in relation to the proposed remedial works at the former FTA. On 13 October 2011, the House of Representatives passed the motion and gave approval for the remediation works at the former FTA to proceed in accordance with the detail presented at the PWC.

Early remediation works began at the site in 2013, as reported in *Soil, DNAPL, Soil Vapour Validation Assessment Report* (AECOM, 2013b). The scope of works associated with this report included the excavation and sampling of 53 test pits across the FTA Site; DNAPL delineation to identify source mass areas; installation and sampling of 11 soil vapour bores within the site boundary and three soil vapour bores located in the Point Cook Coastal Park; a semi-quantitative HHRA based on the soil vapour data for the dry surface training receptors; ambient air monitoring for the purpose of assessing risk to Site workers during remediation; and a qualitative assessment of potential risks associated with using areas of the former FTA for overnight camping.

Additional investigation into PFAS (AECOM, 2014a) was undertaken during the DNAPL remediation program and was designed to identify the potential extent of PFAS contamination of soil and groundwater in the former FTA. The investigation included test-pitting distributed across the former FTA, groundwater sampling distributed across the former FTA and Parks Victoria and preliminary assessment of the efficacy PFAS treatment in the DTD unit and wastewater treatment plant.

Validation sampling was also carried out as part of the remediation scope of works, reported in AECOM, 2015a, which details the post-remediation soil conditions. Post remediation groundwater monitoring was also undertaken (AECOM, 2015b) for the shallow, intermediate, and deep aquifers to assess remediation effectiveness and residual groundwater contamination.

5.1.2 Remediation Approach – Direct Fired Thermal Desorption

Following the outcome of the PWC hearing to address the gross DNAPL contamination within the former FTA, Defence engaged EnviroPacific Services (EPS) (the Contractor) to remediate the gross DNAPL impacted areas associated with Source Zones A and B using ex-situ DTD technology. This technology was selected by the Contractor to treat the DNAPL impacted soils, which comprise the primary contamination source at the former FTA. This approach targets the bulk DNAPL mass and primary source of groundwater contamination and the associated dissolved phase impacts in the excavation areas, thereby reducing the potential dissolved phase contaminant concentrations in groundwater and potential impacts associated with subsequent off-Site migration.

The scope of the Remediation Activities was developed through a series of historical environmental investigations and a range of remediation assessments and trials conducted at the former FTA. These previous investigations typically targeted the impacts associated with the former fire training activities, which were historically undertaken in localised excavations and pits within the former FTA. More recent assessments have been undertaken to resolve some of the remaining data gaps and uncertainties associated with soil, NAPL and soil vapour conditions at the former FTA. This included impacts associated with residual DNAPL and LNAPL likely to be present following the completion of the source removal remediation works specified within the Remediation Contract Technical Specification (Department of Defence, 2011), as well validation assessment of existing soil conditions outside of the excavation areas, but within the former FTA. This was designed to allow conclusions to be formed in relation to the former FTA suitability for Defence's proposed end land use, which includes overnight camping.

5.2 Soil Remediation

The overarching objective of the remediation process was to treat the DNAPL contaminated soil to a standard which would allow the soil to be backfilled to the source zone excavations and compacted.

The adopted remediation approach removed the primary source of the soil and groundwater contamination at the site via the excavation of the source zone. Excavation was undertaken within temporary excavation enclosures consisting of an aluminium support structure covered by polyvinylchloride woven panelling.

Excavation of SZA and SZB was undertaken in smaller designated remediation cells, compartmentalised by sheet piling. SZA consisted of five individual remediation cells and SZB consists of two remediation cells. Sheet piles were keyed into the marine clay but not through the vertical extent of the marine clay. Sheet piling was set back for the remediation extent by at least 3m.

To facilitate excavation of the remediation cells, dewatering was undertaken prior to and during excavation works. Extracted groundwater was combined with neutralised DTD Unit scrubber wastewater. Groundwater extracted from the remediation cells was treated by sedimentation (silt buster), air-stripping of volatiles and filtration through granular activated carbon. Treated water was sampled for PCI and reinjected to the Shallow Aquifer to the south west of the former FTA.

Excavated soils were pre-treated in a designated enclosure prior to treatment in the DTD Unit. Pre-treatment was undertaken to facilitate a matrix of soil that was as homogenous as practicable given the nature of the excavation process in terms of lithological composition and moisture content of soils.

Pre-treated soil was stockpiled in the pre-treatment enclosure prior to processing in the DTD Unit. The DTD unit when optimised was operated at between 15 – 30 tonnes per hour for 6 days per week.

Treated soils were segregated in batches of 100 tonnes and stockpiled for validation by the Contractor and Technical Advisor. Treated soils assessed by the Technical Advisor as meeting the requirements of the Remediation Technical Specification were approved by the PMCA for use as backfill to the remediation excavation extent.

At completion of the excavation and backfilling with treated soil to sufficient depth the remediation enclosure was relocated to the next designated remediation cell. As completion of work the sheet pile were removed from the excavation extent.

The final surface was reformed to the satisfaction of the PMCA and where required to cover the extent of the remediation areas virgin excavated quarry sands were imported to provide surface cover to the remediation source zones. At completion of reforming of the final surface revegetation works were undertaken.

5.2.1 Treated Soil Tracking and Mass Balance

Treated soil stockpile tracking was undertaken by the contractor throughout the remediation program. Assessment of the mass balance of soil going into the treatment plant and coming out of the treatment plant in terms of loss of contaminant was not assessed due to the inherent error relating to the moisture content of pre-treated soil and post-treated and water conditioned soil that will misrepresent the mass of soil. AECOM did not undertake an assessment of this mass balance as there was insufficient data to accurately calculate this change. AECOM noted (AECOM, 2017) that no untreated or treated soil from the source zone was disposed of off-site. Inspection of the site showed that the surface level appeared to have reduced marginally. AECOM noted that the PCMA approved the final surface profile as per the requirements of the RTS AZ5054 (AECOM, 2017).

5.2.2 Additional Material Requiring DTD Unit Treatment

The *Remediation Technical Specification* (AECOM, 2013a) allowed for a total volume of DNAPL estimated to be up to 950,000 litres with an in-situ volume of contaminated soil within the contract remediation extent of 25,500m³. Based on further DNAPL delineation works undertaken in 2013 (AECOM, 2013b) an additional volume of 1,707m³ of DNAPL impacted soil was identified, resulting in a contract in-situ soil volume requiring excavation and treatment of 27,207m³.

During the remediation program works the depth of excavation to marine clay was identified as deeper than the contract remediation depth. Further analysis by the Contractor, PMCA and TA estimated the total additional in-situ volume of material requiring treatment to be approximately between 4,700 m³

and 7,360 m³. The final in-situ volume of material treated in the DTD Unit had a surveyed volume of 31,721.33 m³, refer to EVR3035, 2014a.

5.2.2.1 Soil Subsidence During Sheet Piling (December 2013)

On 17 December 2013, soil samples were collected relating to an area of soil subsidence that occurred during installation of the sheet piles related to the remediation program. The subsidence occurred at the northern extent of the SZA, outside the contract remediation extent. Soil samples were collected by AECOM to identify if the material located around the sheet pile should be removed and either treated in the DTD unit or sent off-site. Soil results indicate that the material could remain in its current position and that no further action was required.

Buried drums were identified as the cause of subsidence. Drums were removed and stockpiled, DNAPL was not identified. It was noted at the time the future excavations were expected to uncover further material. EPS indicated that as drums are uncovered within the excavation area, they were to be transported to the pre-treatment enclosure, set aside and classified/disposed of as required. This process was noted to occur throughout the remediation program.

5.2.2.2 Cut-Off Wall DNAPL Delineation Test Pitting

AECOM undertook assessment of the potential presence of DNAPL within the vicinity of the existing sheet pile located at the southern end of SZ A on 9 July 2014. Works included the excavation of seven (7) test pits to the depth to the marine clay and visual observation of excavated material (no soil samples were collected) to identify potential DNAPL.

The lithology was observed to be consistent with historic assessment and reporting and no visual evidence of DNAPL was observed at all test pits located (test pits were located to the north, south, east and west of the sheet pile. Photo-ionisation detector readings were measured at between 14.0 ppm (2.5 m bgl) and 397 ppm (3.0 m bgl) on the north of the sheet pile and between 19.1 ppm (3.5 m bgl) and 570 ppm (3.2m bgl) on the southern side of the sheet pile.

Based on the observations of the test pitting investigation AECOM recommend maintaining the current remediation excavation extent, noting that no gross DNAPL contamination was observed between the current remediation extent and the existing cut-off wall.

5.2.2.3 DTD Unit White Residue

Operation of the DTD unit during November 2014 was observed to result in the production and emission of a white residue from the DTD unit scrubber. The residue was observed to be produced intermittently and resulted in accumulation of a residue at the remediation site within the vicinity of the remediation infrastructure, across the DTD Unit process area and immediate surrounds.

EPS was requested to provide formal explanation of the origin and composition of the white residue. AECOM reviewed EPS's assessment of the white residue and are satisfied of the following:

- The white residue consists predominantly of metal salts of sulphate and chloride with some unconsumed caustic soda and is a result of carryover from the DTD unit scrubber;
- That the salts are not considered to represent a risk to human health and/or the environment;
- That EPS managed the production and emission to atmosphere by continuing to divert scrubber liquor to the wastewater treatment plant at greater frequencies; and
- That the Proof of Performance Test 4 preliminary results are below emission limit criteria.

5.2.2.4 Blue Pigment Soil

At the initiation of the remediation program during preparatory ground clearing works (November 2013) for the DTD Unit area EPS identified an isolated area of near surface soils between 0.0-0.4m bgl that contained blue pigments. These soils were located outside the contract remediation extent.

Two soil samples were collected by AECOM from the soil stockpile on 2 March 2015 and chemical analysis in accordance with the requirements for DTD unit treated soils [PCI, metals, total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAHs), etc] with the exception of SPOCAS analysis.

No detects were reported for volatile or hydrocarbon based substances. One soil sample reported cadmium concentrations above adopted guideline values. Based on the reported results it was

recommended the stockpiled material remain on-site, included and managed via the Defence Contaminate Site Register (CRS), relocated to within the eastern area of the site currently used for stockpile management.

5.2.2.5 Tar Seepage Source Zone B (April 2015)

Seepage of tar was noted at two locations outside the remediation contract extent immediately to the west and north of SZB. The tar seepage was first observed in May 2015 during surface soil sampling works post remediation.

The identified tar seepage was observed and photographed (AECOM, 2017). The western tar seepage was noted to be approximately 50 cm x 30 cm and up to 2 cm thick. The northern tar seepage was noted to be bulbous in nature and approximately 5 cm in diameter when first observed.

The presence of the tar was identified as a human health risk for direct contact and as such management of the tar seepage was initiated. The tar seepage to the west of SZB was investigated in August 2015 to assess the immediate surficial extent. This involved removal of the surface tar and probing hand tools. The assessment concluded that the tar was likely associated with at least one drum at the surface. The location was marked and subsequently observed to assess the re-emergence of tar to the surface. The northern tar seepage was not investigated or removed due to the smaller size.

5.3 Groundwater Remediation

Remediation of the former FTA relating to soil and groundwater involved a number of trials and pilot studies to 2013 when source removal remediation was undertaken. A summary of the remediation works undertaken to date is presented below. Refer to AECOM, 2017 for a detailed description of works relating to the source removal remediation program. AECOM, 2017 also presents an assessment of the estimated initial contaminant mass of free-phase and dissolved phase contamination include mass removal and assessment of residual material.

5.3.1 Historic Remedial Works

The following remedial actions were undertaken by Defence to address the observed contamination prior to source removal and treatment works undertaken between March 2014 – March 2015:

- ISCO Bench Scale Treatability Study;
- ISCO Field Scale Treatability Study;
- Aeration Delivery System;
- Sheet Pile Cut- Off Wall and DNAPL Extraction Wells; and
- Shoreline Regression Protection Works.

In addition to these measures, Defence also finalised an agreed remediation strategy to treat observed DNAPL contamination at the Site. An ex-situ thermal desorption remediation program commenced at the FTA Site in late 2013.

5.3.2 In Situ Chemical Oxidation Bench and Field Scale Treatability Study 2007 - 2010

A bench-scale in-situ chemical oxidation (ISCO) treatability study was conducted in June 2007 by Aquifer Solutions Inc. and East Tennessee State University, to evaluate whether the technology was feasible for treatment of DNAPL at the Site (HLA, 2007).

Based on the findings from the bench-scale study, ISCO Field Trials were completed at the Site and have been summarised in the Field Trials Implementation Report (Aquifer Solutions / HLA 2007).

The bench to scale trials were relatively successful and it was recommended that design for a field scale application be undertaken with a view to conducting pilot scale trials. As field scale pilot trial was undertaken in December 2008 by Aquifer Solutions and AECOM and included a three step injection of persulfate within the western area of the SZA plume. Results of the field scale trial are presented in HLA, 2007.

The injection and post treatment results indicated a favourable response to ISCO with sufficient radius of influence across the trial area, general reduction in DNAPL thickness in soil samples and reductions in groundwater VOC concentrations.

The data collected suggested that the DNAPL treatment was highly heterogeneity-controlled with the greatest treatment in higher permeability zone. Identification of lithological changes over small distances and managing these effects was identified a challenge to broader implementation of ISCO. Results of the ISCO trials are presented in report *Field Trials Implementation Report for In-Situ Chemical Oxidation for DNAPL Treatment*, (AECOM, 2010b).

5.3.3 Aeration Delivery System 2007 - 2010

From July 2007 to July 2010, an Air Delivery System (ADS) was commissioned to enable aeration and enhancement of intrinsic bioremediation capacity of groundwater that would have otherwise discharged directly into Port Phillip Bay under the standard groundwater flow regime (AECOM, 2007).

The ADS operated by injecting air into the sub surface to assist in aerobic degradation of targeted dissolved phase organic compounds. The main objective of the ADS was to intercept and treat certain dissolved phase contaminants that were amenable to biodegradation processes prior to groundwater migrating beyond the Site boundary.

It is noted that at the time of preparing this document the ADS was not operational. However, reference to the ADS is still made within the report and considered relevant with respect to discussing data relative to historical GMEs and trends based on concentrations of PCI across the FTA Site. ADS installation details and groundwater monitoring results are presented in AECOM report *Aeration Delivery System – Pilot Trial, Former Fire Training Area, RAAF Williams, November 2007*, (AECOM, 2007).

5.3.4 Sheet Pile Cut Off Wall and DNAPL Extraction Wells 2008

A sheet pile Cut-Off Wall was installed down-gradient of SZA in August 2008 through the Shallow Aquifer to limit further migration of DNAPL towards Port Phillip Bay (within the Shallow Aquifer). Four 100 mm diameter wells were constructed immediately north (up-gradient) of the Cut-Off Wall to allow potential future extraction of DNAPL should it be identified during future monitoring events to have migrated and pooled behind the wall. The Cut-Off Wall is currently still in place. AECOM undertook a soil investigation of the area immediately surrounding the cut-off wall during July 2014 to assess potential migration of DNAPL up to and around the cut-off wall. No DNAPL was observed during test pitting activities (AECOM, 2015e).

5.3.5 Shoreline Regression Protection Works

In August 2011, Defence instigated measures to limit future shoreline regression and impact on existing infrastructure at the FTA. The design was proposed by Defence's consultants (Aurecon / DMM) and included construction of a revetment armouring rock wall extending along the southern boundary of the Site in a south west – north east direction. A small portion of the south eastern boundary was not included in the regression protection works. At the time of the December 2012 GME and September 2012 gauging event, monitoring wells F36MW and F87MW respectively, were noted as damaged and lost due to shoreline erosion. These wells are located on the south eastern boundary of the Site. In addition, the ADS lines currently located in the south eastern portion of the Site has been undermined due to ongoing erosion. Soil vapour and groundwater monitoring wells within Parks Victoria, in particular F91MW and SV13 are likely to be undermined in the near future (2 years).

5.3.6 Source Removal Remediation Ex-Situ Thermal Desorption 2014 - 2015

Following the outcome of the PWC hearing to address the gross DNAPL contamination within the FTA Defence engaged EnviroPacific Services to remediate the gross DNAPL impacted areas associated with Source Zones A and B using ex-situ Direct Thermal Desorption (DTD) technology. This technology was selected by EPS to treat the DNAPL impacted soils, which comprise the primary contamination source at the former FTA. This approach targeted the bulk DNAPL mass and primary source of groundwater contamination and the associated dissolved phase impacts in the excavation areas, thereby reducing the potential dissolved phase contaminant concentrations in groundwater and potential impacts associated with subsequent off-Site migration. Further detail is provided above in **Section 5.2**.

5.3.7 Free Phase Hydrocarbon Removal

The objective of the remediation program was the removal of free phase hydrocarbon source contamination. The combined volume of DNAPL in soil prior to the remediation program was

estimated to be between 460,000L and 950,000L within the primary and secondary source zones (AECOM, 2010c).

DNAPL was largely observed to reside as multiple pools of DNAPL in the silty sand at between 1.0 - 1.5 m bgl to 3.0 m bgl (typically resin like DNAPL) and at the base of the Shallow Aquifer perched on the lower paludal clay or where the paludal clay was not present on the marine clay (typically dark brown/black DNAPL).

An estimated 403,750 – 807,500 L / 367,412 kg – 936,700 kg of free-phase DNAPL was assessed to have been removed during the source removal remediation program, refer to AECOM, (2017) for further detail.

5.3.8 Dissolved Phase Hydrocarbon Removal

Dissolved phase contamination removal was undertaken incidentally during the remediation programs as a result of dewatering activities undertaken by the remediation contractor. Groundwater was extracted from the sheet piled remediation extent to facilitate excavation works. Extracted groundwater was treated by an on-site wastewater treatment plant consisting of a silt buster for removal of gross sediments and hydrocarbon, a bank of reverse flow air strippers to removal volatiles and parallel activated carbon filters followed by a polishing activated carbon bank prior to discharge to infiltration trenches.

An estimated 156 kg of dissolved phase PCI were removed from groundwater from within the vicinity of SZA and SZB, refer to AECOM (2017) for further detail.

6.0 Extent and Nature of Contamination Post-Remediation

6.1 Soil

As detailed in the Post Remediation Soil Assessment (AECOM, 2017), assessment of the condition of soil within the remediation contract extent, including validation of the marine clay, treated soil and removal of DNAPL was assessed against the requirements of the Remediation Technical Specification ([RTS AZ5054] (2010)). Based on the soil analytical results and field observations the following conclusions were noted in respect to the condition of soil:

- Gross DNAPL within the contract remediation extent has been removed and treated within the DTD Unit;
- The objectives of the remediation program were met with regards to treated soil and validation of the marine clay;
- Residual DNAPL was removed from the contract remediation extent and areas immediately at the boundary of the remediation contract extent to the extent practicable;
- Based on findings of the Soil, DNAPL and Soil Vapour Validation Assessment (AECOM, 2013b), soils outside of the contractor remediation extent generally indicated no evidence of gross contamination at most locations for the CoPC and that the results further indicated that the proposed land use should not be constrained by identified impacts to soil and groundwater; and
- The PFAS assessments (AECOM, 2014a) reported concentrations in soil below the adopted human health guidelines for PFOS and PFOA.

6.1.1 Extent of Residual Soil Contamination within the Contract Remediation Extent

Assessment of impacts to soil within the contract remediation extent was limited to residual contaminant likely associated with historic fire training activities. As consistent with previous assessments; the contract remediation extent was considered to extend vertically no deeper than the marine clay and extend laterally to the contracted remediation area including any additional areas excavated under PMCA Site Instructions.

The soil within this assessment was considered to include marine clay at the base of the remediation contract extent, treated soil backfilled to the remediation extent and quarried material imported for use as top soil. This assessment of residual contamination considered contamination identified pre-remediation, as detailed in **Section 4.1** and supporting data from the following sources:

- AECOM treated soil validation sampling;
- EPS treated soil validation sampling;
- AECOM marine clay validation sampling;
- AECOM visual assessment observable DNAPL contamination noted at different locations in the walls of the final remediation extent and determined to be residual based on the definition of the Technical Specification for Remediation AZ5054;
- AECOM 2014a Perfluorinated Compounds Investigation, Former Fire Training Area, RAAF Williams, Point Cook; and
- AECOM 2014c Assessment of field pH of pre-treated and DTD treated soils, Former Fire Training Area, RAAF Williams, Point Cook, 21 August 2014.

A review and assessment of residual contamination status within the contract remediation extent was undertaken as per the source zone areas SZA and SZB.

6.1.1.1 Remaining Identified DNAPL

As detailed in AECOM, 2017, the assessment of residual DNAPL within and or on the extents of the contract remediation extent is based on identified DNAPL assessed to be residual during the remediation program and presented in the remediation cell validation reports.

Areas of residual DNAPL are identified in Figure 14 of AECOM, 2017, with assessment of the identified DNAPL type, extent and remedial management measures provided in the tables 20-33 of

AECOM, 2017 for individual areas. Assessment of extent of remaining DNAPL has been undertaken where appropriate against historic soil validation works (AECOM, 2013a and AECOM, 2013b) to delineate the extent from the contract remediation boundary.

Based on the review of observed DNAPL presented below AECOM is generally satisfied that gross DNAPL was removed from Source Zone A and Source Zone B from the contract remediation extent and minor additional areas outside the contract remediation extent during the source removal remediation program. AECOM notes that hydrocarbon impacts outside the remediation extent associated with other historic fire training pits C, D, E, F and G may be present. Further assessment of DNAPL identified at the contract remediation extent is presented in the Remediation Cell Validation Reports (AECOM, 2014-2015).

The post remediation residual DNAPL assessment is summarised and presented in **Figure F17¹, Appendix A**.

6.1.2 Final Land Surface – TopSoil

The post remediation surface validation sample grid is presented in **Figure F18, Appendix A**, and is further summarised in the sections below.

6.1.2.1 Remediation Extent – Imported Fill

Topsoil material was imported from Batesford Quarry, Geelong after approval by the PMCA regarding compliance with Technical Specifications (AECOM, 2013a). Imported backfill material was classified as natural excavated material, evidenced by a certificate from the material supplier, however, no chemical analysis of imported material was undertaken. Material imported was identified as natural occurring virgin quarry material screened sand.

6.1.2.2 Surface Soil Post Remediation Validation – DTD Unit Soil Processing Areas

As part of the Contractor's demobilisation program and post demobilisation the following activities were undertaken:

- Trimming of remediation haul roads from the excavation cells and treatment of trimmed soil in the DTD (undertaken by the Contractor with visual and soil sample validation by the AECOM);
- Replacement of surface material stockpiled to the south of the DTD unit processing area (Contractor) to the DTD Unit processing area; and
- Surface soil validation sampling (AECOM) of the DTD Unit processing area and applicable areas of haul roads post the contractors demobilisation.

AECOM undertook a review of the data quality related to the surface validation sampling and was satisfied that the results were suitable for the proposed assessment and interpretation of treated soil.

6.1.2.2.1 Top Soil Validation Sample Analysis and Results

Samples were analysed for PAH/phenols, benzene, toluene, ethylbenzene, xylene (BTEX), chlorinated hydrocarbons, halogenated benzenes, halogenated hydrocarbons, halogenated phenols, inorganics, monocyclic aromatic hydrocarbons (MAH), solvents, total petroleum hydrocarbons (TPH) and volatile organic compounds (VOCs) and compared against US EPA RSL (2015), NEPM 2013 Table 1B(7) Management Limits in Res / Parkland - Coarse Soil and NEPM 2013 Table 1B(7) Management Limits Comm / Ind - Coarse Soil criteria.

A summary of surface validation sample findings included (detailed in AECOM, 2017):

- All results were reported below adopted criteria;
- All PCI were below non-detect with the exception of tetrachloroethene (1 detection, 1.1 mg/kg) and chlorobenzene (1 detection, 0.8 mg/kg);
- Styrene, 1 detection, 0.7 mg/kg; and
- TPH (C₁₀ - C₄₀ (Sum of total)), 9 detects, 110 - 1690 mg/kg.

¹ This figure (from AECOM (2017)) incorrectly indicates observation of DNAPL at Test Pit TP36VA within the remediation extent. DNAPL was not observed at this location.

The following reported non-detects for all samples solvents, VOCs, chlorinated hydrocarbons (with exception of tetrachloroethene, halogenated benzenes with exception of chlorobenzene, halogenated phenols, MAHs with exception of styrene.

6.1.3 Final Land Surface – Treated Soil

As detailed in AECOM, 2017, an assessment relating to the treated soil backfill to the final remediation extent, was undertaken and detailed in the sections below.

6.1.3.1 Treated Soil Results – Source Zone A and Source Zone B

Summary results for treated soil validation for samples collected by the contractor and AECOM are presented in and AECOM, 2017 for SZA and SZB.

6.1.3.1.1 PCI Assessment

The following is of note in relation to the PCI Assessment of treated soils for SZA and SZB:

- Majority of samples reported results below the laboratory limits of reporting (LORs) for all PCI;
- All treated soil backfilled to the SZA and SZB remediation extents met the adopted criteria, with the approved variation regarding stockpile TS-98 – TS-99;
- Detection of PCI was generally limited to tetrachloroethene, trichloroethene, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,1,2,2-tetrachloroethane, cis-1,2-dichloroethene in both SZA and SZB, with the majority of detections associated with 1,2-dichloroethane (SZA: ~29%, SZB: ~29%);
- Maximum PCI concentration in SZA was reported for trichloroethene (1.9 mg/kg);
- Maximum PCI concentration in SZB was reported for 1,2 dichloroethane (0.9 mg/kg); and
- Remediation Cells Backfilled Treated Soil – Source Zone B.

6.1.3.1.2 Other Contaminants of Concern

The following is of note in relation to the Other Contaminants of Concern assessment of treated soils for SZA and SZB:

- All analytes were below the adopted criteria with the exception of sulfate, refer to AECOM 2014d for assessment of sulfate levels;
- Detected concentration of other contaminants of concern were generally limited to metals or metalloids; and
- Generally comparable results for detected other contaminants of concern were observed between SZA and SZB with the exception of cadmium.

6.1.3.1.3 ASLP

Review of analytical results treated soil for ASLP testing for all analytes show the majority of PCI and other contaminants of concern are reported below LOR. The observed analytes reporting detectable concentration that are of note include:

- TPH 60-440µg/L: speciation of TPH is not known, however there is the potential that this is due to residual chlorinated hydrocarbons present below the limit of reporting for treated soils;
- 1,1,2-trichloroethane and 1,2-dichloroethane: observed to represent the highest proportion of DNAPL pre-remediation; and
- Benzene: likely breakdown product of the desorption process.

No criteria were adopted for the remediation programs for leachable concentrations.

6.1.3.1.4 PFAS Assessment

The assessment of PFAS at the former FTA was undertaken as a preliminary and secondary assessment during the remediation program. The findings of these assessments are combined in AECOM 2014a *Perfluorinated Compounds Investigation, Former Fire Training Area, RAAF Williams, Point Cook*. AECOM notes that assessment of PFAS was not included in the Technical Specification Contractor or Technical Advisor treated soil validation sampling requirement.

The objective of the Preliminary Investigation was to determine potential concentrations in soil and groundwater at the Site and provide understand of the potential effectiveness of the DTD Unit thermal treatment with regards to PFOS/PFOA. The information gained from the Preliminary Investigation was used to support the potential need for the Secondary Investigation and provide direction as to the requirements of the Secondary Investigation. The objective of the Secondary Investigation was to gain understanding of the spatial distribution in soils within the Shallow Aquifer and in groundwater in the Shallow, Intermediate and Deep aquifers.

Assessment of treated soils for PFAS impacts was undertaken as part of the scope of work relating to AECOM 2014a PFAS assessment, this assessment included:

- 10 treated soil samples taken from SZA Remediation Cell 2 (location of Fire Pit A);
- Sample analysis PFOS, PFOA, 6:2 FtS, 8:2 FtS only; and
- Assessment of treated soil was only undertaken on soils sourced from Source Zone A Remediation Cell 2 and possibly Cell 3 treated soils.

Sampling of treated soil for PFAS was not included in the approved RTS AZ5054 due to the emerging nature of these contaminants at the time of writing of the RTS AZ5054 (2010).

The approach adopted at the time was the use of published generic assessment criteria relevant to the land use being assessed to screen out chemicals that present a negligible risk and thereby identify CoPC (chemicals that require quantitative assessment in the HHRA) i.e. a “Tier 1” assessment.

The use of “Tier 1” assessment criteria was not considered appropriate as PFAS have the potential to bioaccumulate within the food chain and no published guideline value (at the time) had been developed that is protective of the potential for bioaccumulation via all potential pathways.

PFOS was reported in all treated soil samples with a concentration range of 0.004 mg/kg – 0.0191 mg/kg. PFOA, 6:2 FtS and 8:2 FtS were below the limit of reporting in all sampled treated soils samples (LOR <5 µg/kg, <5 µg/kg, <1 µg/kg respectively).

6.1.3.1.5 Soil pH Assessment

pH levels in treated soils were observed to be elevated during the initial stages of the remediation program and assessment and on-going monitoring requirements were developed (AECOM, 2017). As part of on-going assessment works pH in treated soils were required to be analysed on-site prior to approval to backfill. Treated soils were required to be within a pH of 0.5 of the neutral range (6.5 - 8.5) prior to backfill.

Following remediation, a review of treated soil pH results showed that pH was within the neutral range, noting that as the treated soil pH logarithmic average is generally within the neutral range the soil presents minimal risk to the environment with regards due to potentially mobilising metals as a result of higher pH levels.

6.1.4 Marine Clay Residual PCI Impact

As detailed in AECOM (2017), the condition of validated marine clay surface was observed to be trimmed to non-visually impacted marine clay by the contractor. Minor isolated residual globules of DNAPL were observed on the marine clay associated either with historic push-tubing/ groundwater monitoring wells investigation locations and natural cracks within the marine clay.

Residual PCI impacts observed in the marine clay related to non-free phase DNAPL contamination appear to be associated with the southern areas of SZA and SZB. PCI were detected at varying concentrations in most validation samples with only non-detects of all PCI observed in the northern extent of SZA and SZB.

Highest concentrations of PCI in SZA marine clay were reported for 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane and tetrachloroethene. Highest concentrations of PCI in SZB marine clay were reported for 1,2-dichloroethane, 1,1-dichloroethane, trichloroethene and 1,1,2-trichloroethane.

The above observed concentrations are consistent with analysis of PCI proportions presented in the 2011 CSM (AECOM, 2010a).

6.1.5 Post Remediation Revegetation

At completion of the soil remediation program areas of the site disturbed by the remediation program were required to be revegetated as per the requirements of the Remediation Technical Specification (AECOM, 2013a).

Revegetation works were undertaken in general accordance with the Remediation Technical Specification. Variation to the specification was required based on availability of specification state plants. Proposed variations to the specified plant species were provided by the EPS horticulturalist and assessed for suitability by AECOM ecologists. AECOM was satisfied that the intent of the Remediation Technical Specification revegetation requirements was achieved with regards to replanting of appropriate species. The condition of plant in revegetated areas was inspected on a 3 month basis by the Contractor, PMCA and Technical Advisor.

6.1.6 Environmental Values - Soil

Part 4 of the Environmental Reference Standard (ERS) provides a statutory framework for protecting people and the environment from the effects of contamination. Based on the current land use, the applicable environmental values (EV) associated with the site are:

- Land dependent ecosystems and species (highly modified ecosystems);
- Human health (commercial onsite and recreational use offsite);
- Buildings and structures; and
- Aesthetics.

Based on the Tier 1 screening assessment presented in AECOM, 2022a and AECOM, 2022b, the CoC that were identified based on the analysed soil samples analysed from the site are presented in **Table 10** along with the exceeded Tier 1 assessment criteria applicable to each EV. A summary of the PCI identified post remediation are also presented in **Table 10**.

Table 10 Exceedances of Tier 1 Assessment Criteria for Soil and CoC (post-remediation)

CoC	Soil	
	0-1 m	1-2 m
1,1,2-trichloroethane	✓ ^{a, b, c, d}	✓ ^{b, c, d}
1,2-dichloroethane	-	✓ ^{b, c, d}
Benzene	-	✓ ^c
Toluene	✓ ^{c, e}	✓ ^{c, e}
TPH C ₆ -C ₁₀	✓ ^{c, e}	✓ ^{c, e}
TPH C ₁₀ -C ₁₆	✓ ^{c, e}	✓ ^{c, e}
TPH C ₁₆ -C ₃₄	✓ ^e	✓ ^e
PFOS	✓ ^f	✓ ^f
Copper	✓ ^e	-
Nickel	✓ ^e	-
Zinc	✓ ^e	-

Notes:

^a – Exceeds Defence worker direct contact pathway

^b – Exceeds intrusive maintenance worker direct contact pathway

^c – Exceeds Defence worker vapour inhalation pathway

^d – Exceeds intrusive worker vapour inhalation pathway

^e – Exceeds ecological criteria for urban residential and public open space

^f – Exceeds ecological criteria for direct and indirect toxicity

- No exceedance of available criteria

These results indicate there is potential harm to the *Human health (commercial onsite)* and the *Land dependent ecosystems and species (highly modified ecosystems)* EVs.

An HHRA (AECOM, 2022a) and an ERA (AECOM, 2022b) were undertaken to further investigate potential human health and ecological risks associated with the identified soil impacts. The findings of these risk assessments are presented in **Section 8.0**.

6.2 Groundwater

A post-remediation groundwater assessment was undertaken (AECOM, 2022c) to understand groundwater conditions and changes to the aquifer network as a result of remedial activities at the FTA Site. The assessment of the groundwater conditions within the assessment area was based on historic groundwater data collected during groundwater monitoring events conducted as per the Auditor approved Technical Framework for Remediation and the Post Remediation Groundwater Monitoring Plan (AECOM, 2015a).

Frequency of groundwater monitoring was conducted on a biannual basis prior to the source zone removal program and on a quarterly basis for the 12-month period post remediation. This frequency of monitoring encompassed seasonal changes. AECOM undertook a review of tidal conditions at the site as part of the post remediation monitoring program (AECOM, 2015a). The findings of the assessment indicated that tidal influence was predominately confined to the near shore with limited observed influence in the Shallow Aquifer with more pronounced influence in the Intermediate Aquifer due to its confined nature.

Assessment of groundwater conditions prior to clean-up was based on monitoring data collected prior to and up to November 2013, assessment of condition post clean-up is based on monitoring data collected from May 2015 to 2021. Monitoring data is also presented for the remediation period March 2014 to March 2015. AECOM notes that there are spatial gaps in groundwater data relating to the Shallow, Intermediate and Deep aquifers. These spatial data gaps are identified below by aquifer with justification of the acceptability of the data gap.

No LNAPL was detected in any of the shallow or intermediate aquifer wells gauged during all gauging events in 2020 and 2021 (AECOM, 2021). DNAPL was also not noted during the 2020 and 2021 post-remediation groundwater monitoring events.

6.2.1 Shallow Aquifer

6.2.1.1 Groundwater Contaminants of Concern Concentrations Pre, During, Post Remediation Summary

AECOM, 2022c presented the concentration of contaminants of concern (PFAS, PCI) pre, during and post remediation for the various Shallow Aquifer monitoring zones. The report provides a summary of groundwater contamination at these points in time for November 2013 (pre-remediation), August 2014 (during remediation) and May 2015 and February 2016 (post-remediation) including average concentration, detected concentrations ranges and number of samples collected and number of samples where a contaminant of concern was detected. Assessment of the distribution of contaminants is limited with regards to available data within the source zones and with regards to PFAS prior to remediation as samples were not collected within these zone or samples analysed for these analytes. As requirement of the TFR sampling within the source zones was not undertaken in November 2013 as this sampling round did not include monitoring wells within the source zone areas.

The collection and assessment of samples within the source zone commenced for PFAS during 2014 when these compounds were identified as a potential issue, refer to AECOM 2014a and AECOM 2015a. Sampling and analysis of groundwater from the Source Zone Areas for PCI was recommenced post remediation.

Additional post remediation monitoring of the shallow aquifer was undertaken between 2020-2021 and is further detailed in the sections below.

6.2.1.2 Assessment of Presence of Non-Aqueous Phase Liquid

Assessment of residual LNAPL and DNAPL was undertaken during gauging works completed as part of post remediation groundwater monitoring between April 2015 and February 2016. No LNAPL or DNAPL was observed during gauging works within gauged monitoring wells.

A review of the solubility limits of selected PCI was undertaken against groundwater monitoring results reported for the February 2016 (and where applicable November 2015) monitoring results² to assess whether DNAPL was likely present within the vicinity of monitoring wells reporting higher PCI concentrations. The review of solubility did not take into account the difference in temperature, as groundwater temperature was typically ~20°C and reported solubility reference temperatures are 20-25°C, which was considered a conservative comparison. Assessed PCI were selected based on the composition of DNAPL observed at the site as assessed as part of the Aquifer Solutions / HLA 2007 ISCO trials and are generally primary contaminants not daughter products.

Review of PCI solubility limits and reported concentrations at selected monitoring wells reporting high concentrations indicated that groundwater concentrations did not reach solubility limits in groundwater, indicating that DNAPL was likely not present at saturation conditions in the immediate vicinity of these monitoring wells. This was also indicated by the relative stable concentrations of PCI (AECOM, 2022c).

No DNAPL or LNAPL was noted in Shallow Aquifer in 2020 and 2021 (AECOM, 2021)

6.2.1.3 Contaminant Distribution Summary

Post remediation the plume decreased significantly compared to pre-remediation conditions with a marginal increase in extent towards Parks Victoria. While the post-remediation plume remained generally constant in terms of extent, there was a general increase in concentration of contaminants at selected monitoring well locations likely associated with residual contamination.

However observed concentrations at elevated post remediation concentrations were noted to be less than pre-remediation concentrations.

As detailed in AECOM, 2022c, a review of contaminant distribution and concentrations showed that groundwater contamination and inferred plume extents were strongly influenced by the reported results and likely residual DNAPL impacts to soil in the vicinity of monitoring wells MW117 (F21MWA) (south east of SZA), MW158 (F110MWA) (central SZA), MW119 (F24MWA) (south east SZB), MW121 (F30MWAR) (south east SZB), MW127 (F45MWA) (south east SZB) and MW161 (F113MWA) (Southern central SZB).

Review of PFAS contaminant distribution showed significant variability of contaminant distribution across monitoring events and the site, with impacts focused on the eastern area of the site relating to SZB. PFOS was reported at higher concentrations than PFOA at most detected locations, however, no sampling and analysis was undertaken for the extended suite of PFAS during monitoring as this was not standard practice at the time. Concentrations of PFAS were noted to extend off-site to the east into Parks Victoria, not delineated to the east, and likely to Port Phillip Bay to the south east. The inferred PFAS plume extent was found to be strongly influenced by the results for PFOS from MW123 (F34MWA) (south of SZB), MW127 (F45MWA) (south of SZB), MW137 (F79MW) (east of SZB) and MW142 (F84MWA) (Port Phillip Bay shoreline, south of SZB, east of SZA).

Concentrations of metals in groundwater were sampled and analysed as part of the post remediation sampling program as they had not been previously assessed. Concentration plots of analysed metals were not developed as concentrations were generally observed to be at or below guidelines with only minor exceedances. Refer to AECOM, 2022c for further detail regarding individual contaminants and associated plumes.

AECOM completed a Stage 5 Monitoring of Groundwater, Surface Water, Sediment and Soil Vapour at the FTA Site from 2020-2021. The results of this investigation are reported in AECOM, 2020 and AECOM, 2021 which included groundwater monitoring of shallow aquifer wells within the FTA Site boundary, upgradient wells and offsite wells within the Parks Victoria site in compliance with AECOM, 2015a, noting the following:

- VCH and benzene impacts in the shallow aquifer were observed to be highest in Monitoring Zone 3 and Monitoring Zone 4 where numerous wells in these zones exceeded the adopted health criteria. VCH and benzene concentrations were also identified albeit at lower concentrations in areas to the south and south west of Monitoring Zone 3 and to the south and east of Monitoring Zone 4 in Monitoring Zone 2, Monitoring Zone 5 and Monitoring Zone 6. These impacts have

² A value of 1% of the solubility limit was used to assess the likely presence of NAPL (AECOM, 2022c)

been delineated to the north, east and west where PCI concentrations were below the laboratory LOR and/ or adopted criteria;

- TRH C₆-C₁₀ and TRH C₁₀-C₄₀ concentrations above the laboratory LOR were detected in groundwater from wells in all monitoring zones. The highest TRH C₆-C₁₀ concentrations were detected in groundwater from Monitoring Zone 3, Monitoring Zone 4 and Monitoring Zone 5 which correlates with the presence of high PCI concentrations in these areas;
- PFOS concentrations were detected in groundwater from all wells sampled across the site. The highest PFOS concentrations were observed in wells located downgradient of Monitoring Zone 4 at the south-eastern boundary of Monitoring Zone 5 and adjacent to Monitoring Zone 6 and Monitoring Zone 7. PFOS impacts in groundwater have not been delineated in any direction;
- PFOA concentrations were detected in groundwater from 34 out of the 35 wells sampled. PFOA concentrations were detected in Monitoring Zone 4, Monitoring Zone 5, Monitoring Zone 6 and Monitoring Zone 7. PFOA concentrations were also observed to be highest in Monitoring Zones 5, 6 and 7; and
- Concentrations of metals were below the laboratory LOR or adopted assessment criteria, except for a concentration of molybdenum in groundwater at MW158 in Monitoring Zone 3 which was marginally above the adopted assessment criteria during the July 2021 monitoring event.

A summary of the analytical results for the 12 PCI and PFAS across the shallow aquifer from the four most recent post remediation groundwater monitoring events are presented in **Figures F19a – F19g, Appendix A, and Figure F22, Appendix A**, respectively.

A detailed trend analysis is provided in AECOM, 2021.

6.2.1.4 Assessment of Plume Stability

An assessment of plume stability was undertaken for PCI and PFAS with regards to observed concentrations contours. Where impacts extended off-site, the migration timeframes of the plume and potential mass flux were assessed for the condition where groundwater equilibrates to pre-remediation groundwater flow conditions.

An assessment of plume stability with regards to concentration contours has been undertaken based on visual assessment of the extent of the boundary and whether the areas of elevated concentration are migrating with groundwater. Plume stability was characterised as stable, increasing or contracting.

The continued trends noted in AECOM, 2022c regarding plume stability were contingent on the on-going generally flat groundwater gradients within likely residual contamination source areas. AECOM noted that under the existing flow conditions there were observed off-site impacts to the south above adopted criteria and increasing concentrations of some PCI to the east.

Where there is a change to pre-remediation groundwater flow conditions with groundwater flow to the south, it was deemed likely that there would be an increase in contaminant transport to the south resulting in increased migration of contaminants off-site to Port Phillip Bay, in particular from the vicinity of MW117 (F21MWA). It is not clear how long it would take groundwater to equilibrate to pre-remediation flow conditions.

Hydraulic conductivities presented in AECOM, 2022c, anticipated that the hydraulic conductivity within the vicinity of SZA and residual impacts at MW117 (F21MWA) was in the order of 7 – 74 m/day. Based on this relatively high conductivity and the proximity to Port Phillip Bay, where groundwater flow conditions are observed to return to pre-remediation condition it is anticipated that there will be increase in contaminant transport off-site. This is particularly applicable to contaminant 1, Dichloroethane (contained on-site as reported in AECOM (2017) and AECOM (2022c) and vinyl chloride (off-site impact as reported in AECOM, 2017 and 2022c) as these contaminants appeared to have increased in concentration.

As detailed in AECOM, 2021, key PCI, namely tetrachloroethene, trichloroethene, vinyl chloride, benzene, PFOS and PFOA post-remediation results were discussed in regard to contaminant distribution and plume stability.

A review of the 2020 and 2021 groundwater data against historical groundwater data collected pre- and post-remediation in 2013 to 2016 indicates that the post remediation groundwater monitoring data has shown that whilst the PCI plume extent has remained relatively stable, PCI concentrations

measured over the post remediation monitoring period indicate that PCI concentrations have generally decreased in the majority of shallow aquifer wells, with PCI concentrations decreasing up to four orders of magnitude in wells located in the southern portion of the site, within Monitoring Zone 6.

PCI concentrations in the shallow aquifer are generally observed to be highest in the centre and south-eastern portion of Monitoring Zone 3 and in the south-eastern extent of Monitoring Zone 4 to the east of Monitoring Zone 3 as shown in **Figures F19c and F19d, Appendix A**. Impacts in these areas are delineated to the north by upgradient background locations, to the west by wells in Monitoring Zone 2 and to the east by wells in Monitoring Zone 7.

Distribution of selected key PCI (PCE, TCE, benzene and VC) are shown on the heat maps for the July-August 2021 data, **Figures F25a to F25d in Appendix A**

6.2.1.5 Monitored Natural Attenuation Summary

AECOM, 2022c, noted the following regarding MNA across the shallow aquifer:

- The locational stasis of groundwater and PCI plume has the potential to impact degradation via reductive de-chlorination as limits to the capacity of available and required components to de-chlorination were reached;
- Natural attenuation by advection and or dispersion appeared to be occurring to a lesser extent given the limited movement of groundwater;
- Attenuation via advection was not occurring due the locational stasis of the plume, driven by low and changing groundwater gradients. While groundwater gradients were not observed to be similar to pre-remediation conditions and were low and or away from identified sensitive receptors the risk to sensitive receptors associated with the groundwater impacts due to PCI were limited may not be realised;
- The Shallow Aquifer appeared to have capacity for natural attenuation of PCI and attenuation by reductive de-chlorination was occurring based on reported concentrations of daughter products and degradation products in specific areas of the site; and
- The limited movement of groundwater suggested that natural attenuation via advection and diffusion is likely occurring to a limited extent.

As detailed in AECOM, 2021, key daughter products that indicate degradation of PCIs at the site include vinyl chloride and ethene. The distribution of these daughter products in groundwater at the site supports the conclusion that there is anaerobic degradation of chlorinated hydrocarbons occurring in the shallow aquifer. Elevated concentrations of vinyl chloride and ethene are found in groundwater with high parent compounds concentrations, including tetrachloroethene, trichloroethene, 1,1,2-trichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethene, and trans-1,2-dichloroethene, when compared to other wells, which is consistent with the degradation pathways for these PCIs.

6.2.2 Intermediate Aquifer

6.2.2.1 Groundwater Contaminants of Concern Concentrations Pre, During, Post Remediation

AECOM, 2022c presents a summary of the concentration of contaminants of concern pre, during and post remediation for the Intermediate Aquifer across the Site. The report provides a summary of groundwater contamination for November 2013 (pre-remediation), August 2014 (during remediation) and May 2015 and February 2016 (post-remediation).

Additional post remediation monitoring of the intermediate aquifer was undertaken between 2020-2021, presented in AECOM, 2021 and is further detailed in the sections below.

6.2.2.2 Contaminant Distribution Summary and Plume Stability

AECOM, 2022c reports contaminant distribution as predominantly influenced by observed concentrations at MW185 (F127MWC), which are greater than the reported concentrations observed in the Shallow Aquifer monitoring wells, indicating that the reported concentration may be related to residual contamination within the marine clay. This is further supported by the AECOM 2014b investigation of the sheet pile, which did not identify DNAPL in the immediate vicinity of the existing sheet pile within the Shallow Aquifer lithology.

It was not known where or if the Intermediate Aquifer surfaces within Port Phillip or what the potential dilution impact would be. Assessment of contaminant concentration and distribution was based on the observed contaminant concentration contours developed in the modelling program Surfer. AECOM noted that these are indicative concentration contours only and that the contours will be influenced by the heterogeneity of the sub-surface environment and applicable boundary conditions.

As part of AECOM, 2021 the following is noted in regard to post remediation contamination distribution across the Intermediate aquifer:

- VCH and benzene impacts in the intermediate aquifer were observed to be highest in Monitoring Zone 6, south of Monitoring Zone 3 and to a lesser degree in Monitoring Zone 5 to the south of Monitoring Zone 4. VCH and benzene impacts have been delineated to the north where concentrations were below the laboratory LOR and/ or adopted criteria, however, remain not delineated in other directions;
- TRH C₆-C₁₀ concentrations above the laboratory LOR were detected in groundwater from six out of 19 intermediate aquifer wells. The highest TRH C₆-C₁₀ concentrations were detected in groundwater from Monitoring Zone 6 which correlates with the presence of high PCI concentrations in this area. TRH C₁₀-C₄₀ concentrations above the laboratory LOR were only detected in groundwater from one well in the Monitoring Zone 6;
- PFOS concentrations were detected in groundwater from all but two intermediate aquifer wells sampled across the site. The highest PFOS concentrations were observed south of Monitoring Zone 3 in Monitoring Zone 6. PFOS impacts in groundwater have not been delineated in any direction;
- PFOA concentrations were below the adopted assessment criteria in groundwater from all intermediate aquifer wells; and
- Metal concentrations were either below the laboratory LOR or adopted environmental values.

A summary of the analytical results for the 12 PCI and PFAS across the intermediate aquifer from the four most recent post remediation groundwater monitoring events are presented in **Figure F20, Appendix A**, and **Figure F23, Appendix A**, respectively.

Further detailed in AECOM, 2021, key PCI, namely tetrachloroethene, trichloroethene, vinyl chloride, benzene, PFOS and PFOA post-remediation results were discussed below in regard to contaminant distribution and plume stability.

Contaminant distribution is predominantly influenced by observed concentrations in groundwater at intermediate well MW185 which are greater than those observed in the shallow aquifer monitoring wells indicating that the detected PCI concentrations may be related to residual contamination within the marine clay. This is further supported by the AECOM document titled Assessment of potential DNAPL within the vicinity of the existing cut-off wall, 2014 (AECOM, 2014b) investigation of the sheet pile area which did not identify DNAPL in the immediate vicinity of the existing sheet pile within the shallow aquifer lithology. The PCI plume extent is considered to be stable and potentially decreasing as evident by PCI concentrations at the western plume edge being reported at concentrations below the laboratory LOR over the 2020 – 2021 post remediation monitoring period.

It is not known where or if the intermediate aquifer daylight within Port Phillip Bay or what the potential dilution impact would be. Assessment of contaminant concentration and distribution is based on the observed contaminant concentration heat maps, **Figures F26a – F26d, Appendix A**.

A detailed trend analysis is provided in AECOM, 2021.

6.2.2.3 Monitored Natural Attenuation

As detailed in AECOM, 2021, key PCI concentrations across the intermediate aquifer indicate that the PCI plume has remained relatively stable with slight PCI concentration increases observed during the post remediation monitoring period which are primarily influenced by results for monitoring well MW185 located in Monitoring Zone 6.

'Impacted' wells have a lower median redox potential, as would be expected where anaerobic degradation is occurring. Dissolved oxygen samples were collected ex-situ using Hydrasleeves and may have some slight influence from the ambient air. The distribution of daughter products (vinyl

chloride and ethene) in groundwater at the site supports the conclusion that there is anaerobic degradation of chlorinated hydrocarbons occurring in the shallow and intermediate aquifer.

The distribution of daughter products (vinyl chloride and ethene) in groundwater at the site supports the conclusion that there is anaerobic degradation of chlorinated hydrocarbons occurring in the shallow and intermediate aquifer.

6.2.3 Deep Aquifer

6.2.3.1 Groundwater Contaminants of Concern Concentrations Pre, During, Post Remediation

AECOM, 2022c presents a summary of the concentration of contaminants of concern pre, during and post remediation for the Deep Aquifer across the Site. The report provides a summary of groundwater contamination at these points in time for November 2013 (pre-remediation), August 2014 (during remediation) and May 2015 and February 2016 (post-remediation).

Additional post remediation monitoring of the deep aquifer was undertaken between 2020-2021, presented in AECOM, 2021 and is further detailed in the sections below.

6.2.3.2 Contaminant Distribution Summary and Plume Stability

As detailed in AECOM, 2022c, assessment of PCI in the Deep Aquifer for the February 2016 monitoring event reported non-detect for all PCI with the exception of vinyl chloride. The observed concentration vinyl chloride was likely a product of the reductive de-chlorination of primary contaminants that may have migrated to the Deep Aquifer due to well condition or sampling cross contamination.

As part of AECOM, 2021 the following is noted in regard to post remediation contamination distribution across the Deep aquifer:

- Concentrations of PCI were below the laboratory LOR in all but one deep aquifer well. MW191 located in Monitoring Zone 5 reported a benzene concentration above the Primary Contact Recreation (PCR) Environmental value (EV);
- PFOS concentrations exceeded the Water Dependant Ecosystems (WDES) assessment criteria in groundwater Monitoring Zone 1, Monitoring Zone 5, Monitoring Zone 3 and Monitoring Zone 6. Whilst PFOA concentrations were only detected above the LOR in groundwater from the Monitoring Zone 1 and in Monitoring Zone 5 and were below the adopted assessment criteria; and
- The sum of PFHxS and PFOS concentrations ranged from below the laboratory LOR to 14.7 µg/L, respectively and were above the assessment criterion for the PCR EV in groundwater from background well MW043 only in 2020 and returned to below the laboratory LOR in both sampling events in 2021.

A summary of the analytical results for the 12 PCI and PFAS across the deep aquifer from the four most recent post remediation groundwater monitoring events are presented in **Figure F21, Appendix A**, and **Figure F24, Appendix A**, respectively.

Assessment of PCI in the deep aquifer for the 2020 and 2021 monitoring events reported PCI concentrations in groundwater below the laboratory LOR for all deep aquifer wells, except at one well (MW191) located in Monitoring Zone 5. This well reported benzene concentrations above the PCR EV during the September/October 2020, November 2020 and May 2021 monitoring events and below the laboratory LOR in the most recent July/August 2021 monitoring round.

There is no identified significant contamination in the deep aquifer and therefore no significant natural attenuation occurring there.

A detailed trend analysis is provided in AECOM, 2021.

6.2.3.3 Monitored Natural Attenuation

As detailed in AECOM, 2021, there are limited impacts in the deep aquifer and therefore limited evidence to support that natural attenuation is occurring in the Deep Aquifer. The key degradation daughter products vinyl chloride and ethane were below LOR in this aquifer, and there were only minor concentrations of ethene in MW189 and MW191.

6.2.4 Environmental Values - Groundwater

Part 5 of the ERS provides a statutory framework for protected people and the environment from the effects of contamination. The standards for water, specifically groundwater (Division 2, Part 5) considers a number of aquifer properties to determine which potential EVs apply. Based on AECOM, 2021, 2022a and 2022c, the protected environmental values (EVs) for each aquifer and the likelihood of them being realised is summarised in **Table 11**.

Table 11 Protected Environmental Values for each Aquifer

Environmental Value	Shallow Aquifer – Segment E	Intermediate and Deep Aquifers – Segment F	Likelihood of being Realised
Water dependent ecosystems and species (WDES)	✓	✓	✓
Agriculture and irrigation (stock watering) (A&I)	✓		✓
Water-based recreation (primary contact recreation) (PCR)	✓	✓	✓
Traditional owner cultural values	✓	✓	✓
Cultural and spiritual values	✓	✓	The ERS provides no specific environmental quality indicators for the beneficial uses of Traditional Owner cultural values and cultural and spiritual values, however these EVs are considered to be protected under the environmental quality objectives for the WDES and PCR EVs.
Buildings and structures	✓	✓	✓
Geothermal properties	✓	✓	X The requirement as per the ERS is “groundwater quality that will not affect the natural thermal capacity (including temperature) of the groundwater.” The measured temperature of groundwater at and within the vicinity of the site has not been reported above 30 degrees Celsius (AECOM, 2021), indicating that geothermal use is not protected for the groundwater at the site. As such this use is not considered further.

Based on the Tier 1 screening assessment presented in AECOM (2021), the chemicals of concern (CoC) that were identified based on the groundwater samples analysed at the site (post-remediation) are presented in **Table 12**, along with the exceeded Tier 1 Assessment Criteria applicable for each EV.

Table 12 Exceedances of Tier 1 Assessment Criteria for Groundwater and CoC (post-remediation)

CoC	Groundwater		
	Shallow	Intermediate	Deep
PCE	✓ a,b	✓ a,b	-
TCE	✓ b	✓ b*	-
1,1,2-TCA	✓ b*	✓ b*	-
1,2-DCA	✓ a,b	✓ a,b	-
1,1-DCA	✓ *	✓ *	-
1,1-DCE	✓ a,b	✓ a,b	-
1,1,2,2-TeCA	-	-	-
VC	✓ a,b	✓ a,b	-
Benzene	✓ a,b	✓ a,b	✓ a
Chlorobenzene	✓ b	✓ b	-
Chloroform	✓ b*	✓ b*	-
cis-1,2-DCE	✓ *	✓ *	-
trans-1,2-DCE	✓ *	✓ *	-
TRH	✓ *	✓ *	-
Toluene	✓ b	-	-
Ethylbenzene	✓ b	✓ b	-
Xylenes	-	-	-
PFOS	✓ b	✓ b	✓ b
PFOA	✓ a,b	-	-
Sum PFHxS + PFOS	✓ a	✓ a	✓ a
Arsenic	✓ c	✓ c	✓ c
Cadmium	-	-	-
Chromium	-	-	✓ b
Copper	✓ b	✓ b	✓ b
Lead	-	-	-
Magnesium	✓ c	-	✓ c
Manganese	✓ a	-	✓ a
Mercury	-	-	-
Molybdenum	✓ a,c	✓ a	-
Nickel	-	-	✓ a,b
Selenium	-	-	-
Silver	✓ b	✓ b	✓ b
Tin	-	-	-
Zinc	✓ b	✓ b	✓ b

Notes:

^a Exceeds Water Based Recreation (Primary Contact Recreation)^b Exceeds Water Dependent Ecosystems and Species^c Exceeds Irrigation (Stock Watering)^d Exceeds Public Open Space^{*} No health criteria available, however considered a CoC

- No exceedance of available criteria

These results indicate there is potential harm to the *Water-based recreation (PCR)*, *Water dependent ecosystems and species (WDES)* and *Agriculture and irrigation (stock watering) (A&I)* EVs.

In addition, a number of volatile COPCs were detected above the LOR in groundwater samples collected at the Site. In the absence of vapour instruction Tier screening criteria for groundwater less than 2 m from the ground surface, potential vapour inhalation risks associated with detectable concentrations of volatile COPCs detected in shallow and intermediate aquifer samples were considered by AECOM (2022a) to warrant further assessment.

An HHRA (AECOM, 2022a) and an ERA (AECOM, 2022b) were undertaken to further investigate potential human health and ecological risks associated with these groundwater impacts. The findings of these risk assessments are presented in **Section 8.0**.

6.3 Soil Vapour

Three post remediation soil vapour monitoring events have been completed at the former FTA on 6 August 2015, 16 November 2020 and May 2021. It is noted that only two bores (SV006 and SV009) were sampled in August 2015. As shown on **Figure F27 in Appendix A**, PCI concentrations in soil vapour bore SV006 were observed to remain relatively unchanged between the three events with 1,1-dichloroethane concentrations noted to increase by an order of magnitude between 2015 and 2020 prior to slightly decreasing in 2021. PCI concentrations in SV009 were observed to decrease by two orders of magnitude for some PCI between 2015 and 2020 and have remained relatively stable between the 2020 and 2021 sampling rounds.

PCI concentrations in remaining bores sampled in 2020 and 2021 have fluctuated within an order of magnitude between events. Concentrations of PCI were above the adopted assessment criteria predominantly in bores in Monitoring Zone 3 and Monitoring Zone 4, and to a lesser degree in Monitoring Zone 5.

6.3.1 Environmental Values – Soil Vapour

EPA (2021) notes that the “ERS does not explicitly consider vapour in soil or the movement of vapours in to the ambient air environment. However, in referring to Health Investigation Levels (HILs) and Health Screening Levels (HSLs) in the NEPM (ASC) the ERS give regard to vapour-based groundwater guideline levels.” Therefore, the *Human health (commercial onsite)* EV for land is considered applicable in the context of potential soil vapour inhalation risks.

Based on the Tier 1 screening assessment presented in AECOM, 2022a, the CoC that were identified based on the soil vapour samples analysed from the site are presented in **Table 13**.

Table 13 Exceedances of Tier 1 Assessment Criteria for Soil Vapour – PCI identified post-remediation and CoC

CoC	Soil Vapour
1,1,2,2-tetrachloroethane	✓ ^a
1,1,2-trichloroethane	✓ ^a
1,1-dichloroethane	✓ ^a
1,2-dichloroethane	✓ ^a
Cis-1,2-dichloroethane	✓ ^a
Chloroform	✓ ^a
Hexachlorobutadiene	✓ ^a
Trichloroethene	✓ ^a
Trans-1,2-dichloroethene	✓ ^a
Vinyl chloride	✓ ^a

Notes:

^a – Exceeds Tier 1 soil vapour screening criteria (commercial land use)

These results indicate there is potential harm to the *Human health (commercial onsite)* EV.

AECOM (2022a) undertook an HHRA to further investigate potential human health risk associated with the identified soil vapour concentrations. The findings of this risk assessment are presented in **Section 8.1**.

6.4 Surface Water, Pore Water and Sediment

Early investigation of surface water at the site was focussed on human health risk assessment works (HLA ENSR, 2007) including sampling of Port Phillip Bay at both low and high tides.

Surface water sampling undertaken in 2006 reported only one sample with PCI concentrations above the laboratory limit of reporting. One sample was found to contain elevated 1,2-DCA above the Primary Contact Recreation adopted guideline. Pore water was also sampled in the intertidal zone via passive sampling methods. Low concentrations of 1,1-DCA and benzene were noted in pore water samples across the intertidal zone and no other PCIs were detected.

The recent AECOM 2021 Stage 5 Investigation investigated surface waters, sediment and porewater along Port Phillip Bay, south of the Former FTA and RAAF Lake to the north to support the HHRA and ERA (further detailed in **Section 7.0**), the analytical results are summarised in sections below.

6.4.1 Surface Water and Pore Water

Six surface water grab samples (SW001 – SW006) were collected within RAAF Lake and thirteen pore water samples (PW100 – PW113) were collected along the Port Phillip Bay shoreline during low tide on the 9 – 11 November 2020 as reported in the Stage 5 Monitoring Letter Report (AECOM, 2021).

Pore water samples were collected from approximately 1 mbgl, the pore water was extracted from sediment samples which were collected in the upper 0.5 m of the sediment profile. It is also noted that not all pore water samples were analysed for all CoPC.

With the exception of metals and inorganics (e.g. ammonia, sulphate, chloride, sodium), PCI concentrations were detected below the adopted assessment criteria in the six surface water samples collected from RAAF Lake and the nine pore water samples analysed for PCI from Port Phillip Bay. Low concentrations of TRH and TPH were detected above the laboratory LOR but below the adopted assessment criteria in all surface water samples.

PFOS concentrations in all surface water samples and nine of the pore water samples exceeded the assessment criterion for the WDES EV.

PFOS and sum of PFHxS and PFOS concentrations were detected above the laboratory LOR in all nine pore water samples from Port Phillip Bay. Whilst concentrations of PFOA were detected in eight out of the nine pore water samples. PFOS, PFOA and sum of PFHxS and PFOS concentrations were highest in pore water sample PW105, south of Monitoring Zone 7. PFAS and 1,1-dichloroethane were below the laboratory LOR in all samples analysed except for PW105. Arsenic was detected in all samples analysed and above the criteria in PW102, with one detectable concentration of TRH C₁₆–C₃₄ in the sample analysed from PW100.

PW105 is from a sample located along the foreshore on the western fringe of Parks Victoria Land. The concentrations of PFAS reported within this location are notably higher than the remaining porewater samples across the foreshore. Further interrogation of the data at PW105 provides comparable geochemical parameters (salinity) and analytical results (PFAS) to a groundwater sample analysed from monitoring well, MW150. This monitoring well is located approximately 15 to 20 m north west of the pore water sampling location. In addition, it is noted that PW105 is located at an area of the foreshore which has been subjected to notable foreshore erosion when compared to the remaining foreshore in the area.

While there is only one round of PFAS porewater data, initial results suggest that the source of the PFAS in the pore water from the sample analysed at PW105 is likely to be the groundwater from MW150. The second highest pore water sample is from PW106 located approximately 70 m east of PW105 along the shoreline where the PFAS results are close to an order of magnitude lower than PW105.

It is noted that no surface water samples were collected from the Port Phillip Bay foreshore adjacent to the site and as such, pore water sample data extracted from sediment samples collected from Port Phillip Bay.

Surface Water and Pore Water analytical results for PFAS are presented in **Figure F28, Appendix A**

6.4.2 Environmental Values - Surface Water and Pore Water

Part 5 of the ERS provides a statutory framework for protecting people and the environment from the effects of contamination. The standards for water, specifically surface water and sediment, are outlined in Division 3, Part 5 of the ERS. Based on the surface water receptors within the vicinity of the site being Port Phillip Bay to the southeast and RAAF Lake to the north, the marine and estuarine

segment of *Port Phillip Bay (Geelong Arm subsegment)* and the *Aquatic Reserve (RAAF Lake)* EVs are applicable. The EVs that are applicable to the site include:

- Water dependent ecosystems and species that are
 - Slightly to moderately modified (Port Phillip Bay);
 - Largely unmodified (RAAF Lake);
- Human consumption of aquatic foods;
- Industrial and commercial;
- Water-based recreation (primary and secondary contact);
- Water-based recreation (aesthetic enjoyment);
- Traditional Owner cultural values; and
- Navigation and shipping.

Based on the Tier 1 screening assessment presented in AECOM, 2020, the CoC that were identified based on the surface water and pore water samples analysed at the site (post-remediation) are presented in **Table 14** along with the exceeded Tier 1 assessment criteria applicable to each EV.

Table 14 Exceedances of Tier 1 Assessment Criteria for Surface Water and Pore Water and CoC (post-remediation)

CoC	Pore Water	Surface Water
PFOS	✓ b	✓ b
PFHxS	✓ a	
Sum PFHxS + PFOS	✓ a	
Aluminium	✓ b	✓ a, b
Arsenic	✓ a	✓ b
1,1-Dichloroethane	✓ a	
Boron		✓ a, b
Cobalt		✓ b
Copper		✓ b
Iron	✓ a	✓ a
Lead		✓ b
Manganese		✓ a, b
Molybdenum	✓ b	✓ b
Nickel		✓ b
Zinc	✓ b	✓ b
Chloride	✓ a	✓ a
Sodium	✓ a	✓ a
Ammonia as N		✓ a, b
TDS	✓ a	

Notes:

^a – Exceeds criteria for water-based recreation (primary contact recreation)

^b – Exceeds criteria for water dependent ecosystems and species (Port Phillip Bay, RAAF Lake)

These results indicate there is potential harm to the *Water dependent ecosystems and species* and *Water-based recreation (primary and secondary contact)* EVs.

AECOM (2022a) undertook an HHRA and an ERA (2022b) to further investigate potential human health and ecological risks associated with the identified pore water and surface water impacts. The findings of these risk assessments are presented in **Section 8.0**.

6.4.3 Sediment

Five sediment samples were obtained from both the RAAF Lake (SD006 – SD010) as well as within Port Phillip Bay (SD001 – SD005) within the subtidal zone (during low tide) on the 9 – 11 November 2020 (AECOM, 2021). In addition, analysis was undertaken for pore water (extracted from sediment).

Four samples from RAAF Lake, reported concentrations of Sum of PFHxS and PFOS above the adopted assessment criteria for the public open space EV. PFOA, PFOS and Sum of PFHxS and PFOS concentrations in sediment samples collected from Port Phillip Bay foreshore were below the adopted assessment criteria.

Concentrations of remaining PCI were below the laboratory LOR in all sediment samples collected from Port Phillip Bay foreshore and RAAF Lake.

Sediment analytical results for PFAS are presented in **Figure F29, Appendix A**

6.4.4 Environmental Values - Sediment

Part 5 of the ERS provides a statutory framework for protecting people and the environment from the effects of contamination. As outlined in Section 6.4.2 above, the standards for water, specifically surface water and sediment, are outlined in Division 3, Part 5 of the ERS.

Based on the Tier 1 screening assessment presented AECOM, 2021, the CoC that were identified during the analysis of sediment samples collected from the site (post-remediation) are presented in **Table 15**, along with the exceeded assessment criteria applicable to each EV.

Table 15 Exceedances of Tier 1 Assessment Criteria for Sediment – PCI identified post-remediation and CoC

CoC	Sediment
PFOS	✓ ^a
Sum PFHxS + PFOS	✓ ^b

Notes:

^a – Exceeds criteria for water dependent ecosystems and species (Port Phillip Bay)

^b – Exceeds criteria for public open space (HIL C)

These results indicate there is potential harm to the *Water dependent ecosystems and species* and *Water-based recreation (primary and secondary contact)* EVs.

An HHRA (AECOM, 2022a) and an ERA (AECOM, 2022b) were undertaken to further investigate potential human health and ecological risks associated with the identified sediment impacts. The findings of these risk assessments are presented in **Section 8.0**.

7.0 Conceptual Site Model - Post-Remediation

A CSM is a qualitative description of the mechanisms by which potential and/or complete exposure pathways exist between known or potential sources of site impacts, and human or environmental receptors.

7.1 Sources of Contamination

As noted in **Section 1.2.1**, the primary sources of contamination at the site were related to the historic fire training activities, which had contaminated soil and groundwater with a range of organic chemicals which resulted in contamination plumes with an estimated volume of close to 1 million litres³ of DNAPL.

Since these sources were identified the site has been the subject of numerous investigations and an extensive remediation program. AECOM (2017) estimated that between 85-88% of contaminant mass was removed over the remediation program. The combined volume of DNAPL in soil prior to the remediation program was estimated to be between 460 000 L and 950 000 L within the primary and secondary source zones. An estimated 403,750 L - 807,500 L (367,412 kg – 936,700 kg) of free-phase DNAPL was assessed to have been removed during the source removal remediation program.

Post remediation of the former FTA, the source of contamination at the site is considered to be residual contamination within the marine clay and dissolved phase compounds within groundwater, termed the PCI. AECOM (2017) also identified discrete pockets of residual DNAPL outside the remediated source zones that are either sorbed to the soil matrix or perched on capillary barriers (clay and other low permeability units). It is acknowledged that the ex-situ DTD technology used within the remediation was not evaluated with regards to the treatment of PFAS contamination. Subsequent monitoring for PFAS in groundwater has identified compounds present at concentrations such that they are also considered a source at the site.

7.2 Chemicals of Concern

Based on the post-remediation assessments (AECOM, 2021 and AECOM, 2022c), human health risk assessment (AECOM, 2022a) and ecological risk assessment (AECOM, 2022b), the following CoC have been identified for the site (refer to **Table 16**).

³ This estimated volume is based on calculations presented in AECOM (2013a), in which the volume of DNAPL in Source Zone A was estimated as 310,000 L – 800,000 L and approximately 150,000 L in Source Zone B.

Table 16 Chemicals of Concern identified post remediation

CoC	Soil		Groundwater			Soil Vapour	Surface Water	Pore Water	Sediment
	0-1 m	>1-2m	Shallow	Intermediate	Deep				
PCE	-	-	✓ a,b	✓ a,b	-	-	-	-	-
TCE	-	-	✓ b	✓ b*	-	✓ e	-	-	-
1,1,2-trichloroethane	✓ f, g, h, i	✓ g, h, i	✓ b*	✓ b*	-	✓ e	-	-	-
1,2-dichloroethane	-	✓ g, h, i	✓ a,b	✓ a,b	-	✓ e	-	-	-
1,1-dichloroethane	-	-	✓ *	✓ *	-	✓ e	-	✓ a	-
1,1-DCE	-	-	✓ a,b	✓ a,b	-	-	-	-	-
1,1,2,2-tetrachloroethane	-	-	-	-	-	✓ e	-	-	-
Vinyl Chloride	-	-	✓ a,b	✓ a,b	-	✓ e	-	-	-
Chlorobenzene	-	-	✓ b	✓ b	-	-	-	-	-
Chloroform	-	-	✓ b*	✓ b*	-	✓ e	-	-	-
Cis-1,2-dichloroethene	-	-	✓ *	✓ *	-	✓ e	-	-	-
Trans-1,2-dichloroethene	-	-	✓ *	✓ *	-	✓ e	-	-	-
Hexachlorobutadiene	-	-	-	-	-	✓ e	-	-	-
TRH	-	-	✓ *	✓ *	-	-	-	-	-
TPH C ₆ -C ₁₀	✓ h, j	✓ h, j	-	-	-	-	-	-	-
TPH C ₁₀ -C ₁₆	✓ h, j	✓ h, j	-	-	-	-	-	-	-
TPH C ₁₆ -C ₃₄	✓ j	✓ j	-	-	-	-	-	-	-
Benzene	-	✓ h	✓ a,b	✓ a,b	✓ a	-	-	-	-
Toluene	✓ h, j	✓ h, j	✓ b	-	-	-	-	-	-
Ethylbenzene	-	-	✓ b	✓ b	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-
PFOS	✓ k	✓ k	✓ b	✓ b	✓ b	-	✓ b	✓ b	✓ b
PFOA	-	-	✓ a,b	-	-	-	-	-	-
PFHxS	-	-	-	-	-	-	-	✓ a	-
Sum PFHxS + PFOS	-	-	✓ a	✓ a	✓ a	-	-	✓ a	✓ d

Notes:

^a Exceeds water-based recreation (primary contact recreation)^b Exceeds water dependent ecosystems and species^c Exceeds irrigation (stock watering)^d Exceeds public open space land^e Exceeds soil vapour screening criteria (commercial land use)^f Exceeds Defence worker direct contact pathway^g Exceeds intrusive maintenance worker direct contact pathway^h Exceeds Defence worker vapour inhalation pathwayⁱ Exceeds intrusive maintenance worker vapour inhalation pathway^j Exceeds ecological criteria for urban residential and public open space^k Exceeds ecological criteria for direct and indirect toxicity for areas of ecological significance

- No exceedance of available criteria

* No health criteria available, however considered a CoC

7.3 Potential Transport Mechanisms

7.3.1 Soil

Potential contaminant migration or transport mechanisms in soil from residual contamination in the unsaturated zone (localised impacts of Chemicals of Concern summarised in **Table 16**) include:

- Vertical leaching to groundwater. Given that residual soil impacts are typically localised, and the current nature and extent of residual groundwater impacts it is unlikely that these transport pathways will significantly affect the contamination status of groundwater. However, given the limited amount of PFAS assessment in soil at the Site to date, further investigation of this potential pathway with respect to PFAS is warranted;
- Volatilisation from subsurface impacts and migration of vapour through pore space; and
- Wind erosion and atmospheric dispersion of dust from the upper layer of surface soil.

DNAPL

AECOM (2017) identified a potential for residual DNAPL that exists in discrete pockets outside the remediated areas to vertically migrate under the effects of gravity to the marine clay. Given the localised nature of these impacts and the diminished mass post-remediation, the potential for DNAPL transport in free-phase is unlikely to be significant. There has been no evidence of DNAPL identified in recent groundwater monitoring events, which indicates a lack of mobility of residual impacts.

Partitioning of DNAPL into dissolved phase is discussed further in **Section 7.3.2**.

7.3.2 Groundwater

The pre-remediation transport mechanisms for dissolved phase impacts in groundwater presented in **Section 4.2** are still present post-remediation, with advection, dispersion and degradation of dissolved phase contamination likely to have a greater influence than partitioning of NAPL into dissolved phase. The reduced influence of NAPL partitioning is due to lower mass of NAPL in the saturated zone post-remediation.

Groundwater discharges to Port Phillip Bay, and there is potential for occasional discharge to RAAF Lake depending on hydraulic gradient fluctuations. Concentrations of PCI are delineated offsite to the east within Parks Victoria⁴, with the exception of cis-1,2-dichloroethene in MW167. Cis-1,2-dichloroethene has been detected in samples collected from MW167 at concentrations below the adopted assessment criteria, with no apparent increase in concentrations over the period of sampling (2020-2021). PFAS impacts have been identified in groundwater samples collected from locations within the Parks Victoria area⁴. Further assessment regarding their fate and transport may be considered.

Assessment of these transport mechanism with respect to PFAS, including the impacts of salinity on its mobility, the relative contribution of off-site sources and fluctuating hydraulic gradients has been limited to date and warrants further assessment.

7.3.3 Surface Water

AECOM (2022b) identified migration of contaminants in surface water from the Site via a drainage channels to be a potential transport pathway and considered it to be potentially significant for PFAS migration to RAAF Lake via a shallow unlined drainage channel between the Site and RAAF Lake.

⁴ Offsite Parks Victoria wells target the shallow aquifer only.

7.4 Human and Ecological Receptors

The human and ecological receptors identified at the former FTA include the following.

7.4.1 Potential Human Receptors

Taking into account the current and continued use of the site and off-site foreshore area of Port Phillip Bay, the scope of the HHRA (AECOM, 2022a), and the current depth and extent of the impacted soil, groundwater, soil vapour, sediment, surface water and pore water, the following potential human health receptors have been identified:

On-Site

- Defence workers undertaking dry surface training at the site and overnight camping. It is understood that the dry surface training activities may include direct contact with surface soils at the site, however, will exclude digging.
- Intrusive maintenance workers at the site who may undertake shallow excavations to a maximum depth of 2 m bgl but would not necessarily undertake extensive intrusive works.

In addition to the above, potential future commercial use including Defence workers in a future building at the site has also been assessed to understand the potential future uses of the site as required by the Environment Audit.

Off-site

- recreational users of the Port Phillip Bay foreshore area that may come into incidental contact with shallow uncovered soil (sand) to a maximum depth of 0.5 m bgl whilst walking along the beach foreshore, through playing with sand (i.e. children) and general beach play.
- recreational users of Port Phillip Bay that may come into incidental contact with surface water and sediment during swimming, wading or recreational fishing.
- recreational users of Port Phillip Bay that may be exposed to vapours associated with impacted groundwater whilst sitting on publicly accessible land adjacent to the foreshore area.
- recreational users of RAAF Lake that may come into incidental contact with surface water and sediment during swimming, wading or recreational fishing. Whilst this receptor is not considered to be likely it was assessed as part of the sensitivity analysis in AECOM, 2022a.
- consumers of marine biota (fish and seafood) harvested in close proximity of the site foreshore area. It is noted that biota data was not available at the time of preparing the HHRA and therefore this receptor was not assessed.

7.4.2 Potential Ecological Receptors

The Ecological Risk Investigation Area (ERIA) as detailed by AECOM (2022b) in the most recent Ecological Risk Assessment (ERA), comprised the following areas and associated habitats that were identified following a review of publicly available databases and literature, site-specific ecological survey information, overland surface water flow paths and locations where environmental samples were collected:

On-Site

The former FTA comprises mainly heavily degraded coastal fringe and dunal vegetation with a cover of predominantly exotic grasses, herbs and shrubs. An ecological survey performed in 2007 identified that there is little, if any, value for threatened plant species or plant communities on the site. Fauna present on the site is likely to include soil-dwelling invertebrates, reptiles, small mammals and birds.

Off-site

- Parks Victoria land: similar habitat to the site and is situated along the site's eastern boundary. This area of the ERIA is part of the Point Cook Coastal Park which is designated Crown Land under the Victorian Crown Land (Reserves) Act 1978.

- Port Phillip Bay foreshore: intertidal habitat adjacent to the southern boundary of the site which comprises a narrow stretch of sand and mud, providing a foraging habitat for aquatic birds which feed on sediment dwelling invertebrates and surface water biota.
- RAAF Lake: comprises an ephemeral shallow lake and coastal salt marsh which extends along the eastern boundary from the Property into the adjoining State lands of the Point Cook Coastal Park. This ERIA provides habitat to several protected and endangered flora and fauna. RAAF Lake has been conservatively included as a potential receptor in the ERA (AECOM, 2022b) and in this report on the basis of occasional observed groundwater gradient towards RAAF Lake, as reported by AECOM (2021).

7.5 Human and Ecological Exposure Pathways

7.5.1 Potential Human Exposure Pathways

Human exposure pathways considered to be potentially complete at the site include:

- Direct contact with and incidental ingestion of soil – Direct contact with contaminated soil is a potentially complete pathway for Defence workers and intrusive maintenance workers undertaking shallow excavations (to a maximum depth of 2 m bgl) at the site. Soil data collected from the upper 1 m of the soil profile (for Defence workers) and from the upper 2 m (for intrusive maintenance workers) from site investigations completed by EPS, AECOM and Senversa (Senvessa, 2020) were reviewed for the purposes of the HHRA.
- Direct contact with and incidental ingestion of shallow groundwater – Direct contact with contaminated groundwater is a potentially complete pathway for intrusive maintenance workers undertaking shallow excavations (to a maximum depth of 2 m bgl) at the site. Data from the shallow and intermediate groundwater aquifer collected from groundwater monitoring events completed by AECOM in 2020 and 2021 were reviewed for the purposes of the HHRA.
- Vapour inhalation – Inhalation of vapours associated with contaminated soil and groundwater is a potentially complete pathway for Defence (indoor and outdoor air) and intrusive maintenance workers undertaking shallow excavations to a maximum depth of 2 m bgl (outdoor air only) at the site. Soil data collected from the upper 2 m from site investigations completed by EPS, AECOM and Senversa (Senvessa, 2020) and groundwater and soil vapour data collected by AECOM in 2020 and 2021 were reviewed for the purposes of the HHRA.

Human exposure pathways considered to be potentially complete off-site include:

- Direct contact with sediments – Direct contact with contaminated sediments is a potentially complete pathway for recreational users (swimming, wading or fishing) at Port Phillip Bay foreshore. Sediment data collected by AECOM in 2020 (AECOM, 2021a) were reviewed for the purposes of the HHRA.
- Direct contact with and incidental ingestion of surface water – Direct contact with contaminated surface water is a potentially complete pathway for recreational users (swimming, wading or fishing) at Port Phillip Bay foreshore. In the absence of post remediation surface water data, pore water data collected by AECOM in 2020 (AECOM, 2021a) were reviewed for the purposes of the HHRA.
- Vapour inhalation – Inhalation of vapours associated with contaminated groundwater is a potentially complete pathway for recreational users who may use adjacent land areas to the site for sitting etc. Groundwater data collected by AECOM in 2020 and were reviewed for the purposes of the HHRA.

Potential contaminant transport pathways are summarised in **Table 12** and potential human exposure pathways are summarised in **Table 13**. The exposure pathways that are considered potentially complete and relevant to the identified receptors are direct contact with impacted soil (Defence workers and intrusive maintenance workers), direct contact with impacted groundwater (intrusive maintenance workers), vapour inhalation associated with impacted soil and groundwater (Defence workers and intrusive maintenance workers), vapour inhalation outdoors associated with impacted groundwater (recreational users) and direct contact with sediment and/or surface water (recreational users).

Table 17 Potential contaminant transport pathways

Transport Mechanism	Comments	Likelihood or Significance
Direct contact (incidental ingestion and dermal contact with shallow soil in the top 1 m).	Direct contact is a complete pathway for Defence workers (top 1 m of soil).	This transport pathway was assessed using the data presented in Section 5.3 of AECOM, 2022a.
Direct contact (incidental ingestion and dermal contact with shallow soil in the top 2 m – considered to represent unsaturated vadose zone soil*).	Direct contact is a complete pathway for intrusive maintenance workers (top 2 m of soil).	This transport pathway was assessed using the data presented in Section 5.3 of AECOM, 2022a.
Volatilisation from subsurface impacts in soil and groundwater.	Based on post remediation soil vapour monitoring conducted at the site, this transport pathway is occurring and is a complete human exposure pathway for Defence workers and intrusive maintenance at the site and recreational users off-site that will be assessed in the HHRA.	This transport pathway was assessed using the data presented in Section 5.3 of AECOM, 2022a.
Discharge of impacted groundwater from the site to surface water of Port Phillip Bay.	Impacted groundwater is unlikely to represent pollution with respect to surface water in Port Phillip Bay due to the dilution that would occur at the point of discharge. For this reason, no surface water samples were collected during the Stage 5 investigation in 2020 and 2021. However, to assess the potential risk to recreational users of Port Phillip Bay foreshore (adjacent to the site), pore water data (extracted from sediment samples collected from Port Phillip Bay) has been used to assess this receptor.	This transport pathway was assessed using the pore water data presented in Section 5.3 of AECOM, 2022a.
Wind erosion and atmospheric dispersion of upper layers of surface soil.	This pathway is considered to be potentially significant in uncovered / unvegetated areas of impacted shallow surficial soil (within the top 1 m).	This transport pathway was assessed using the soil data presented in Section 5.3 of AECOM, 2022a.
*it is noted that some samples from the 1-2 m depth range presented in Tables T2, T4, T7 to T10 in Appendix B of AECOM, 2022a may be situated in the saturated zone, however inclusion of these samples in the data set is considered to be conservative.		

Table 18 Potential human exposure pathways

Exposure pathway	Site			Off-site
	Defence workers – dry surface training activities	Defence workers – Future building scenario	Intrusive maintenance Workers	Recreational users
Incidental ingestion of contaminated soil	✓	✓	✓	X
Dermal contact with contaminated soil	✓	✓	✓	X
Inhalation of dust (contaminated surficial soil)	✓	✓	✓	X
Inhalation of contaminated soil-derived vapours in indoor air	X	✓	X	X
Inhalation of contaminated soil-derived vapours in outdoor air	✓	✓	✓	X
Incidental ingestion of contaminated groundwater	X	X	✓	X
Dermal contact with contaminated groundwater	X	X	✓	X
Inhalation of contaminated groundwater-derived vapours in indoor air	X	✓	X	X
Inhalation of contaminated groundwater-derived vapours in outdoor air	✓	✓	✓	✓
Incidental ingestion of contaminated sediments	X	X	X	✓
Dermal contact with contaminated sediments	X	X	X	✓
Incidental ingestion of contaminated surface water	X	X	X	✓
Dermal contact with contaminated surface water	X	X	X	✓
Notes: <i>X: incomplete pathway</i> <i>✓: potentially complete pathway</i>				

7.5.2 Potential Ecological Exposure Pathways

The exposure pathways that have the potential to be present between the source (PCI and CoPC in environmental media) and the ecological receptors are presented in **Table 19** and **Table 20** for terrestrial and aquatic habitats, respectively.

Table 19 Potential ecological exposure pathways - terrestrial receptors

Exposure pathway	Mammals, reptiles and birds	Plants	Soil-dwelling invertebrates	Soil microbial communities
Soil ingestion	✓ Incidental ingestion during foraging and preening/cleaning activities is possible	X Pathway not applicable for plants	✓ Incidental ingestion during foraging and burrowing activities is possible	X Pathway not applicable
Dermal contact with soil	X Not considered a significant pathway due to feathers, scales and fur which limit dermal exposure	X Pathway not applicable for plants	✓ Absorption and uptake of chemicals is possible	✓ Refer to Section 6.2.1 of AECOM, 2022b
Soil pore water uptake	X Pathway not applicable for mammals, reptiles and birds	✓ Uptake of soluble chemicals in soil pore water	✓ Absorption and uptake possible	✓ Refer to Section 6.2.1 of AECOM, 2022b
Dust / vapour inhalation	X Not typically assessed (refer to Section 6.2.2 of AECOM, 2022b)	X Pathway not applicable for plants	X Not considered a significant pathway	X Pathway not applicable
Groundwater exposure	✓ Source of drinking water where groundwater discharges to surface water (surface water and/or pore water data are most appropriate to assess this pathway)	X Refer to Section 6.2.3 of AECOM, 2022b for a discussion on why this pathway is not considered complete	X Pathway not applicable for invertebrates in unsaturated soil	X Pathway not applicable
Prey ingestion (food web considerations)	✓ Higher order predators have potential exposure to chemicals in prey (flora and fauna) which accumulate chemicals in their tissues	✓ Plants comprise a potential food source	✓ Biota comprise a potential food source	X Pathway not applicable

Table 20 Potential ecological exposure pathways - aquatic receptors

Exposure pathway	Aquatic mammals	Amphibians, reptiles & water birds	Aquatic plants	Aquatic fish & invertebrates
Water ingestion	✓ Incidental ingestion during filtering and respiration processes	✓ Source of drinking-water; incidental ingestion during filtering and respiration processes	X Pathway not applicable for plants	✓ Incidental ingestion during filtering and respiration processes
Sediment ingestion	✓ Incidental ingestion during feeding and foraging	✓ Incidental ingestion during feeding and foraging	X Pathway not applicable for plants	✓ Incidental ingestion during feeding and foraging
Dermal contact with water (including sediment pore water)	✓ Absorption and uptake possible	✓ Absorption and uptake possible	✓ Absorption and uptake possible	✓ Absorption and uptake possible
Prey ingestion (food web bioaccumulation considerations)	✓ Higher order predators have potential exposure to chemicals in biota tissue which accumulate chemicals	✓ Higher order predators have potential exposure to chemicals in biota tissue which accumulate chemicals (may also comprise a food source)	✓ Plants comprise a potential food source	✓ Biota comprise a potential food source

8.0 Risk Assessment

8.1 Human Health Risk Assessment

A Human Health Risk Assessment (HHRA) was undertaken by AECOM for the former FTA site, in 2022 (AECOM, 2022a). The overall objective of the HHRA was to quantitatively assess the potential for key groups of people present on and off site to be exposed to site derived contaminants of potential concern (CoPC)⁵ in soil, groundwater, surface water, sediment and pore water. **Table 21**, taken from the HHRA (AECOM, 2022a), summarises the exposure scenarios quantitatively assessed in the HHRA and the resulting conclusions regarding potential health risks to receptors at the site and off-site areas. These conclusions are based on the data available at the time of preparing this HHRA with respect to CoPC concentrations reported in the identified media, and with consideration of the identified data gaps and uncertainties.

⁵ For the purposes of this HHRA, CoPC in this instance is taken to include both primary contaminations of interest (PCIs) and CoPC.

Table 21 Exposure scenarios assessed and corresponding HHRA conclusions

Exposure Scenario	HHRA Conclusion	Summary of Risk Driving CoPC
On-site		
Defence workers: inhalation of vapours associated with impacts in groundwater and soil vapour in outdoor air during dry surface training activities at the site and overnight camping at the site	Quantitative risk estimates indicated low and acceptable health risks to Defence workers who may spend 16 hours per day (8 overnight camping and 8 undertaking dry surface training), 240 days a year at the site.	No specific mitigation controls recommended for this exposure scenario.
Defence workers: inhalation of vapours associated with impacts in groundwater and soil vapour in indoor air (future building) and outdoor	Quantitative risk estimates indicated potentially unacceptable health risks to Defence workers who may spend 8 hours per day, 240 days a year working in a future building at the site.	The contaminants driving the risk for this receptor are PCIs in soil vapour via indoor inhalation. <ul style="list-style-type: none"> Recommended action noted, further detailed in Section 9.6.
Intrusive maintenance workers: Direct contact and incidental ingestion of groundwater and inhalation of vapours associated with impacts in groundwater and soil vapour during excavation activities to a maximum depth of 2 m bgl at the site	Quantitative risk estimates indicated potentially unacceptable health risks to intrusive maintenance workers who may undertake excavations at the site to a maximum depth of 2 m bgl <i>where groundwater is encountered in the trench</i> during the works. The adult ground maintenance worker was assumed to undertake excavation activities for 1 hour each day for 20 days/year over a 30-year period. Quantitative risk estimates indicated low and acceptable health risks to off-site intrusive maintenance workers who may undertake excavations at the site to a maximum depth of 2 m bgl <i>where groundwater does not enter the trench</i> . Again the adult ground maintenance worker was assumed to undertake excavation activities for 1 hour each day for 20 days/year over a 30-year period.	The contaminants driving the risk for this receptor are PCIs in groundwater via direct contact pathways (dermal and incidental ingestion) and vapour inhalation where groundwater is within the excavation. <ul style="list-style-type: none"> Recommended action noted, further detailed in Section 9.6. No specific mitigation controls recommended for the exposure scenario where groundwater does not enter the trench during excavation works.

Exposure Scenario	HHRA Conclusion	Summary of Risk Driving CoPC
Off-site		
Intrusive maintenance workers: Direct contact and incidental ingestion of groundwater and inhalation of vapours associated with impacts in groundwater and soil vapour during excavation activities to a maximum depth of 2 m bgl in Parks Victoria land	Quantitative risk estimates indicated low and acceptable health risks to off-site intrusive maintenance workers who may undertake excavations off site to a maximum depth of 2 m bgl. The adult ground maintenance worker was assumed to undertake excavation activities for 1 hour each day for 20 days/year over a 30-year period.	No specific mitigation controls recommended for this exposure scenario.
Recreational users (swimming) of Port Phillip Bay: Direct contact and incidental ingestion of pore water ¹ (surface water)	Quantitative risk estimates indicated low and acceptable health risks to: <ul style="list-style-type: none"> an adult recreational user who may spend 0.5 hours each day, 150 days a year swimming in the Port Phillip Bay foreshore adjacent to the site. A child recreational user who may spend 0.22 hour each day, 104 days a year swimming in the Port Phillip Bay foreshore adjacent to the site. 	No specific mitigation controls recommended for this exposure scenario.
Recreational users (fishing and wading) of Port Phillip Bay: Direct contact and incidental ingestion of pore water ¹ (surface water)	Quantitative risk estimates indicated low and acceptable health risks to: <ul style="list-style-type: none"> an adult recreational user who may spend 3.6 hour each day, 2 days per week (104 days a year) fishing and wading in the Port Phillip Bay foreshore adjacent to the site. a child recreational user who may spend 0.9 hour each day, 1 day per week (52 days a year) fishing and wading in the Port Phillip Bay foreshore adjacent to the site. 	No specific mitigation controls recommended for this exposure scenario.

Exposure Scenario	HHRA Conclusion	Summary of Risk Driving CoPC
Recreational users (general beach user) of Port Phillip Bay: Direct contact and incidental ingestion of pore water ¹ (surface water) and inhalation of vapours associated with impacts in groundwater	Quantitative risk estimates low and acceptable health risks to a recreational user who may spend 2 hours per day, 365 days a year sitting on land adjacent to the foreshore, walking along the foreshore, digging in the sand in the Port Phillip Bay foreshore adjacent to the site.	No specific mitigation controls recommended for this exposure scenario.
Consumers of marine biota (fish and seafood) harvested in close proximity of the site foreshore area.	It is noted that biota data was not available at the time of preparing this report and therefore this receptor was not assessed herein.	Data gap noted, further detailed in Section 9.6 .

Note: ¹The concentrations of CoPC in pore water extracted from sediment samples collected from Port Phillip Bay have been conservatively considered as representative exposure point concentrations in surface water.

In regard to RAAF Lake, it is noted that the southern half of the lake is not accessible by the public and whilst the northern half of the site is situated in Public Conservation and Resource Zoned (PCRZ) land it is not considered to be frequently accessed by the public due to the lack of public parking, walking tracks and the ephemeral nature of the lake which would restrict recreational use of the lake. Based on this, the potential risk to recreational users of RAAF Lake has not been assessed further in the main body of the HHRA but has been covered in the sensitivity analysis (refer to Section 8.1.5 of AECOM, 2022a), which indicated that risks would be low and acceptable for recreational users (swimming and fishing) based on the assumptions considered.

8.2 Ecological Risk Assessment

An Ecological Risk Assessment (ERA) was also undertaken by AECOM in 2022 for the former FTA (AECOM, 2022b). The overall objective of the ERA was to assess the potential direct and indirect ecological risks to receptors (aquatic and terrestrial) present in the ERIA from exposure to detected primary contaminants of interest (PCI) and chemicals of potential concern (CoPC) in environmental media. As stated in the *Stage 5 Interpretive Report: Groundwater and Soil Vapour* (AECOM, 2021a), PCI includes chlorinated hydrocarbons and benzene, and CoPC include total recoverable hydrocarbons (TRH), metals/metalloids and per- and poly-fluoroalkyl substances (PFAS).

A summary of the Risk Characterisation assessment results is presented in **Table 22**. These results relate to the site (former FTA) and adjacent habitats. Data gaps are provided for the RAAF Lake ERIA where the potential for ecological risk is unknown based on the data that are currently available.

Table 22 Risk Characterisation summary to satisfy requirements of a s.53V audit for the former FTA

ERIA	Potential ecological risk from PCI	Potential ecological risk from CoPC (PFAS)
Port Phillip Bay Foreshore (area adjacent to the site)	Low potential for adverse impacts to intertidal biota from exposure to PCI. No further assessment required.	PFOS was detected in porewater and sediment above the 99% spp. assessment criteria; however, a preliminary assessment suggested that the PFOS detection represent a small area of impact (~150 m stretch of narrow shoreline) which is likely to provide a small proportion (<1%) of foraging habitat for higher order predators such as aquatic birds. Therefore, the PFOS porewater and sediment detections along the Foreshore are unlikely to result in adverse impacts to biota. PFOS was detected in porewater at one location (PW105) above the 95% spp. assessment criteria indicating a potential direct toxicity risk to aquatic ecology. However, direct toxicity is unlikely to be significant at this one location because the sediment-dwelling infauna will be sporadically present in response to tidal fluctuations. There is also some uncertainty whether the porewater concentration at this location is representative of sediment porewater (i.e., infauna exposure medium) or groundwater conditions.
Former FTA (site)*	Low potential for adverse impacts to terrestrial biota from exposure to PCI. No further assessment required.	Low potential for adverse impacts to terrestrial receptors from exposure to CoPC in surface soil.

ERIA	Potential ecological risk from PCI	Potential ecological risk from CoPC (PFAS)
RAAF Lake	Low potential for adverse impacts to terrestrial and aquatic biota from exposure to PCI. No further assessment required.	PFOS was detected in surface soil (< 20 cm) within the salt marsh area (between the site and RAAF Lake) above the indirect and direct assessment criteria. RAAF Lake and adjacent salt marsh area has the potential to provide habitat for higher order predators with small home ranges which consume soil-dwelling invertebrates, flora and surface water. PFOS concentrations in all surface water samples exceeded the assessment criteria for direct and indirect ecotoxicity. The area of surface water impact comprises a habitat which could support higher order predators with home ranges smaller than an aquatic bird. Therefore, there is a potential for adverse impacts to ecological receptors in RAAF Lake (and the salt marsh area) from direct and indirect exposure to PFOS in surface water.

Note: *no soil data are available to characterise PCI and CoPC concentrations on Parks Victoria land. As a conservative approach, conclusions regarding potential risk from soil exposure within the site were used to inform conclusions regarding potential risk to receptors on the Parks Victoria land (within the ERIA).

9.0 Conclusions

A summary of the post-remediation condition of the former FTA site is presented below.

9.1 Soil

As discussed in the Post Remediation Soil Assessment (AECOM, 2017), assessment of the condition of soil within the remediation contract extent, including validation of the marine clay, treated soil and removal of DNAPL was assessed against the requirements of the Remediation Technical Specification ([RTS AZ5054] (2010)). Based on the soil analytical results and field observations the following conclusions were noted in respect to the condition of soil:

- Gross DNAPL within the contract remediation extent has been removed and treated within the DTD Unit;
- The objectives of the remediation program were met with regards to treated soil and validation of the marine clay;
- Residual DNAPL was removed from the contract remediation extent and areas immediately at the boundary of the remediation contract extent to the extent practicable;
- Based on findings of the Soil, DNAPL and Soil Vapour Validation Assessment (AECOM, 2013), soils outside of the contractor remediation extent (refer to **Figure F16 in Appendix A**) generally indicated no evidence of gross contamination at most locations for the CoPC and that the results further indicated that the proposed land use should not be constrained by identified impacts to soil and groundwater;
- The PFAS assessments (AECOM, 2014a) reported concentrations in soil below the adopted human health guidelines for PFOS and PFOA; and
- As presented in AECOM (2022a), Tables T1 to T10, Appendix B, soil analytical results for sample locations representing the final soil condition at the site indicate that residual TPH, VCHs, benzene and toluene concentrations above the adopted human health criteria are present in shallow soil within the top 2 m (above groundwater) at some locations. These are localised in nature. These results indicated there is potential harm to the *Human health (commercial onsite)* EV. AECOM (2022a) undertook an HHRA to further investigate potential human health risk associated with these impacts. The HHRA concluded that there were potentially unacceptable risks to Defence workers who may spend 8 hours per day, 240 days a year in a future building at the FTA Site. The contaminants driving this risk are PCIs in soil vapour via indoor inhalation. Health risks associated with soil impacts for other assessed exposure scenarios were concluded to be low and acceptable.
- As presented in AECOM (2022b), soil analytical results for sample locations representing the final soil condition at the site indicate that residual PFOS, TPH, toluene and metals concentrations above the adopted ecological criteria are present in shallow soil within the top 2 m (above groundwater) at some locations. These results indicated there is potential harm to the *Land dependent ecosystems and species (highly modified ecosystems)* EV. AECOM (2022b) undertook an ERA to further investigate potential ecological risk associated with these impacts. The ERA concluded that there was low potential for terrestrial ecological receptors from exposure to PCIs and COPCs in soil.

9.2 Groundwater

Groundwater data was obtained from the shallow and intermediate aquifers across the seven monitoring zones.

No LNAPL was detected in any of the shallow or intermediate aquifer wells gauged during all gauging events in 2020 and 2021. DNAPL was also not noted during the 2020 and 2021 post-remediation groundwater monitoring events.

RAAF Lake has been identified as a potential ecological receptor due to observations of occasional hydraulic gradients in this direction. Evidence that other areas of the base may be impacted by FTA source areas has not been identified.

9.2.1 Shallow Aquifer

- Concentrations of groundwater PCI measured in 2020 and 2021 were observed to be lower post-remediation compared to pre-remediation and were also observed to be generally lower since the previous GME completed in 2016, except for MW156 located in Monitoring Zone 3;
- PCI residual groundwater impacts above the adopted Tier 1 assessment criteria appear to be mainly associated with the following areas:
 - Central and southern portions of Monitoring Zone 3, within the extent of remediation at MW117, MW158 and MW159;
 - Southern portion of Monitoring Zone 4 in the proximity of the remediation extent at wells MW121 and MW123 and to the south of the remediation extent at MW123. Wells in the northern half of this zone only detected benzene above the adopted assessment criteria; and
 - Central portion of Monitoring Zone 5, immediately southeast of the remediation extent in Monitoring Zone 4.

and to a lesser extent in the following areas:

- Monitoring Zone 2, where only one well in the eastern portion reported benzene concentrations above the adopted assessment criteria; and
- Monitoring Zone 6, where benzene was the only PCI identified above the adopted assessment criteria in two out of five wells.
- PCI concentrations in the shallow aquifer are delineated to the north, east and west but remain not delineated to the south. However, it is noted that sediment and pore water samples collected from Port Phillip Bay foreshore located to the immediate south (AECOM, 2020) reported PCI concentrations below the laboratory LOR and adopted assessment criteria;
- PFOS concentrations were detected in groundwater from all wells sampled across the site. The highest PFOS concentrations were observed in wells located downgradient of Monitoring Zone 4 at the south-eastern boundary of Monitoring Zone 5 and adjacent to Monitoring Zone 6 and Monitoring Zone 7. PFOS impacts in groundwater have not been delineated in any direction;
- PFOA concentrations were detected in groundwater from 34 out of the 35 wells sampled. PFOA concentrations were detected in Monitoring Zone 4, Monitoring Zone 5, Monitoring Zone 6 and Monitoring Zone 7. PFOA concentrations were also observed to be highest in Monitoring Zones 5, 6 and 7;
- The extent of PFOA and PFOS impacts in the shallow aquifer at Parks Victoria has not been delineated;
- Concentrations of metals were below the laboratory LOR or adopted EVs, except for a concentration of molybdenum in groundwater at MW158 in Monitoring Zone 3 which was marginally above the adopted assessment criteria during the July 2021 monitoring event;
- Post remediation groundwater monitoring has shown that the PCI plume has decreased in comparison to pre-remediation conditions. It follows that the PCI concentrations measured over the post remediation monitoring period indicate that PCI concentrations have generally decreased in the majority of shallow aquifer wells; and
- Key daughter products that indicate degradation of PCIs at the site include vinyl chloride and ethene. The distribution of these daughter products in groundwater at the site supports the conclusion that there is anaerobic degradation of chlorinated hydrocarbons occurring in the shallow aquifer. Elevated concentrations of vinyl chloride and ethene are found in groundwater with high parent compounds concentrations, including tetrachloroethene, trichloroethene, 1,1,2-trichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethene, and trans-1,2-dichloroethene, when compared to other wells, which is consistent with the degradation pathways for these PCIs.

9.2.2 Intermediate Aquifer

- The inferred groundwater contours for the intermediate aquifer show a predominantly south-easterly groundwater flow direction;
- A lower groundwater elevation has persisted to the north of the site at MW044 indicating a component of northerly groundwater flow and possible groundwater divide near the site's northern boundary (north of the former pits);
- Dissolved phase PCI impacts are predominantly associated with MW185 located south of Monitoring Zone 3 and in Monitoring Zone 6 adjacent to Port Philip Bay foreshore (this well was installed post remediation and as such comparison to pre-remediation conditions is not possible). PCI concentrations in groundwater at this well are above the adopted assessment for the PCR and WDES EVs. PCI concentrations at this well are also up to two orders of magnitude higher than concentrations in the original source zones;
- Concentrations of PCI have remained relatively stable with slight increases observed for some PCI during the post remediation monitoring period and are primarily influenced by results for monitoring well MW185 located in Monitoring Zone 6. PCI concentrations in the northern half of the monitoring area are generally reported at concentrations below the laboratory LOR and adopted assessment criteria;
- Contaminant distribution is predominantly influenced by observed concentrations at MW185 which are greater than those observed in the shallow aquifer monitoring wells indicating that the detected PCI concentrations may be related to residual contamination within the marine clay. The PCI plume extent is considered to be stable and potentially decreasing as evident by PCI concentrations at the western plume edge being reported at concentrations below the laboratory LOR over the 2020 – 2021 post remediation monitoring period;
- PFOS concentrations were detected in groundwater from all but two intermediate aquifer wells sampled across the site. The highest PFOS concentrations were observed south of Monitoring Zone 3 in Monitoring Zone 6. PFOS impacts in groundwater have not been delineated in any direction;
- PFOA concentrations were below the adopted assessment criteria in groundwater from all intermediate aquifer wells;
- Metal concentrations were either below the laboratory LOR or adopted assessment criteria; and
- The distribution of daughter products (vinyl chloride and ethene) in groundwater at the site supports the conclusion that there is anaerobic degradation of chlorinated hydrocarbons occurring in the shallow and intermediate aquifer.

9.2.3 Deep Aquifer

- Groundwater flow is anticipated to be towards the regional discharge area of Port Phillip Bay;
- Groundwater elevations in the deep aquifer are varied and complex, both spatially and over time;
- Concentrations of PCI were below the laboratory LOR in all but one deep aquifer well. MW191 located in Monitoring Zone 5 reported a benzene concentration above the assessment criterion for the PCR EV;
- PFOS concentrations exceeded the assessment criterion for the WDES EV in groundwater Monitoring Zone 1, Monitoring Zone 5, Monitoring Zone 3 and Monitoring Zone 6. Whilst PFOA concentrations were only detected above the LOR in groundwater from the Monitoring Zone 1 and in Monitoring Zone 5 and were below the adopted assessment criteria;
- The sum of PFHxS and PFOS concentrations ranged from below the laboratory LOR to 14.7 ug/L, respectively and were above the adopted assessment criterion for the PCR EV in groundwater from background well MW043 only in 2020 and returned to below the laboratory LOR in both sampling events in 2021; and
- There is no identified significant contamination in the deep aquifer and therefore no significant natural attenuation occurring there.

9.2.4 Environmental Values and Risk

The post-remediation groundwater sampling results indicated there is potential harm to the *Water-based recreation (PCR)*, *Water dependent ecosystems and species (WDES)* and *Agriculture and irrigation (stock watering) (A&I)* EVs.

An HHRA (AECOM, 2022a) and an ERA (AECOM, 2022b) were undertaken to further investigate potential human health and ecological risks associated with these groundwater impacts. The HHRA also assessed potential vapour inhalation risks associated with volatile COPCs in the shallow and intermediate aquifers.

The HHRA concluded that there were potentially unacceptable risks to:

- Defence workers who may spend 8 hours per day, 240 days a year in a future building at the FTA Site; and
- Intrusive maintenance workers who undertake excavations to a maximum depth of 2 m bgl, where groundwater is encountered in the trench during the works.

Human Health risks associated with groundwater impacts for other assessed exposure scenarios were concluded to be low and acceptable.

The ERA did not identify a complete exposure pathway between receptors and groundwater and it was considered that sediment, porewater and surface water data were more appropriate media to assess potential ecological exposure.

9.3 Soil Vapour

Three post remediation soil vapour monitoring events have been completed at the site on 6 August 2015, 16 November 2020 and May 2021. VCH concentrations in soil vapour have shown a decrease in concentrations since the 2015 monitoring event at all soil vapour bore locations. Concentrations of VCHs were above the adopted assessment criteria, predominantly in bores in Monitoring Zone 3 and Monitoring Zone 4, and to a lesser degree in Monitoring Zone 5 in all rounds.

The post-remediation soil vapour sampling results indicated there is potential harm to the *Human health (commercial onsite)* EV.

AECOM (2022a) undertook an HHRA to further investigate potential human health risk associated with these soil vapour concentrations.

The HHRA concluded that there were potentially unacceptable risks to:

- Defence workers who may spend 8 hours per day, 240 days a year in a future building at the FTA Site; and
- Intrusive maintenance workers who undertake excavations to a maximum depth of 2 m bgl, where groundwater is encountered in the trench during the works.

Human Health risks associated with assessed soil vapour exposure scenarios were concluded to be low and acceptable.

9.4 Sediment

No VCH or BTEX concentrations were detected above the laboratory LOR in all sediment samples collected from Port Phillip Bay foreshore.

However, PFOS concentrations were detected above the laboratory LOR in all sediment samples with two out of the five sediment samples also containing PFOA concentrations at and/ or marginally above the laboratory LOR.

The post-remediation sediment sampling results indicated there is potential harm to the *Water dependent ecosystems and species* and *Water-based recreation (primary and secondary contact)* EVs.

An HHRA (AECOM, 2022a) and an ERA (AECOM, 2022b) were undertaken to further investigate potential human health and ecological risks associated with these sediment impacts.

The HHRA concluded that Human Health risks associated with assessed sediment exposure scenarios were low and acceptable.

The ERA concluded that if the reported sediment concentrations are representative of exposure conditions sediment dwelling invertebrates, it is unlikely that adverse impacts to higher order predators will result.

9.5 Surface Water and Pore Water

It is noted that no surface water samples were collected from the Port Phillip Bay foreshore adjacent to the site and as such, pore water sample data extracted from sediment samples collected from Port Phillip Bay in addition to sediment data has been considered, in the first instance, in the HHRA (AECOM, 2022a) in the assessment of recreational user direct contact exposures to surface water in Port Phillip Bay foreshore.

No PCI concentrations were detected above the laboratory LOR in the six surface water samples collected from RAAF Lake or the nine pore water samples analysed for PCI from Port Phillip Bay.

PFOS, PFOA and sum of PFHxS and PFOS concentrations were detected in all six surface water samples from RAAF Lake. PFOS, PFOA and sum of PFHxS and PFOS concentrations were highest in surface water sample SW001.

PFOS and sum of PFHxS and PFOS concentrations were detected above the laboratory LOR in all nine pore water samples from Port Phillip Bay. Whilst concentrations of PFOA were detected in eight out of the nine pore water samples. PFOS, PFOA and sum of PFHxS and PFOS concentrations were highest in pore water sample PW105, south of Monitoring Zone 7. In addition to PFAS, 1,1-dichloroethane was below the laboratory LOR in all samples analysed except for PW105. Arsenic was detected in all samples analysed and above the criteria in PW102, with one detectable concentration of TRH C₁₆–C₃₄ in the sample analysed from PW100.

PW105 is from a sample located along the foreshore on the western fringe of Parks Victoria Land. The concentrations of PFAS reported within this location are notably higher than the remaining porewater samples across the foreshore. Further interrogation of the data at PW105 provides comparable geochemical parameters (salinity) and analytical results (PFAS) to a groundwater sample analysed from monitoring well, MW150. This monitoring well is located approximately 15 to 20 m northwest of the pore water sampling location. In addition, it is noted that PW105 is located at an area of the foreshore which has been subjected to notable foreshore erosion when compared to the remaining foreshore in the area.

While there is only one round of PFAS porewater data, initial results suggest that the source of the PFAS in the pore water from the sample analysed at PW105 is likely to be the groundwater from MW150. The second highest pore water sample is from PW106 located approximately 70 m east of PW106 along the shoreline where the PFAS results are close to an order of magnitude lower than PW105.

The post-remediation surface water and pore water sampling results indicated there is potential harm to the *Water dependent ecosystems and species* and *Water-based recreation (primary and secondary contact)* EVs.

An HHRA (AECOM, 2022a) and an ERA (AECOM, 2022b) were undertaken to further investigate potential human health and ecological risks associated with these sediment impacts.

The HHRA concluded that Human Health risks associated with assessed surface water and pore water exposure scenarios were low and acceptable.

The ERA concluded that:

- A PFOS detection in porewater at one location indicated a potential direct toxicity risk to aquatic ecology. However, direct toxicity is unlikely to be significant at this one location because the sediment-dwelling infauna will be sporadically present in response to tidal fluctuations. There is also some uncertainty whether the porewater concentration at this location is representative of sediment porewater or groundwater conditions; and

- There is a potential for adverse impacts to ecological receptors in RAAF Lake (and the salt marsh area) from direct and indirect exposure to PFOS in surface water.

9.6 Revised CRAT Risk Rankings

The CRAT risk ranking assessment is provided in **Appendix B**. The outcomes are compared to existing risk rankings as summarised in **Table 23** below. Revised risk ranking are presented in **Figure F30, Appendix A**.

Table 23 Revised CRAT Risk Rankings

CSR ID	CSR Description	Previous Risk Rating*	Updated CRAT Risk Ranking
CSR_VIC_000125	Old Fire Training Area - Source Zone A (Pit A)	Very High	High
CSR_VIC_000126	Old Fire Training Area - Source Zone C (Pit C)	Medium	High
CSR_VIC_000127	Old Fire Training Area - Source Zone D (Pit D)	Medium	High
CSR_VIC_000128	Old Fire Training Area - Source Zone E (Pit E)	Medium	High
CSR_VIC_000129	Old Fire Training Area - Source Zone B (Pit B)	Very High	High

Notes: (*) denotes risk ranking as per GEMS entry for the Property, no CRAT is accessible via objective for these CSRs therefore the risk ranking source is currently unknown.

9.7 Data Gaps and Recommendations

The follow data gaps and recommendations remain.

9.7.1 Onsite

- There are uncertainties regarding vinyl chloride concentrations in groundwater, including increasing concentrations in some wells, potential for ongoing dechlorination over time and LORs exceeding assessment criteria in a number of samples. These uncertainties warrant further monitoring of groundwater to monitor PCI concentrations, including vinyl chloride with an appropriate detection limit.
- Consideration should be given to the assessment of seasonal variability (i.e. reversal of hydraulic gradient) within the shallow aquifer at the site in relation to migration of dissolved phase contamination across the FTA;
- In the instance that a future building is to be constructed at the site, further soil vapour investigation is undertaken in the proposed area of the proposed building to refine the risk assessment to this receptor; and
- Consideration should be given to refinement of PFAS source-pathway-receptor linkages in future site assessments, including further assessment of PFAS sources (on-site and off-site), transport and attenuation mechanisms, including within the Point Cook Coastal Park.

In relation to Intrusive Maintenance Workers:

- Future risks may be addressed via management actions such as a Site Management Plan (SMP), including measures to minimise incidental exposure of intrusive workers to groundwater and inhalation of vapours.

9.7.2 Offsite

9.7.2.1 Port Phillip Bay & Point Cook Coastal Park

The potential for PFAS bioaccumulation into biota and whether there is a potentially unacceptable risk to consumers is unknown.

As only one round of porewater sampling has occurred to date (AECOM, 2020 and AECOM, 2021), there is uncertainty regarding the reliability of the porewater concentrations to reflect PFAS exposure conditions to aquatic ecology along the Foreshore. Further assessment is required to provide additional lines of evidence to support a low potential for adverse ecological impacts including:

- A desktop assessment to better understand the potential for PFAS direct ecotoxicity to aquatic biota along the foreshore which may include consideration of the porewater results (in particular the sum of PFOS + PFHxS) in the context of relevant published ecotoxicological data;
- A site-specific assessment to further refine exposure assumptions for higher order predators that may consume inter-tidal sediment-dwelling aquatic biota along the Foreshore adjacent to the site, including additional porewater sampling; and
- A desktop assessment to understand whether there is an ongoing PFAS source and migration pathway between the site and Foreshore. In particular, the extent to which the FTA remediation works removed the primary PFAS source and/or whether the sheet pile cut-off wall is effective in reducing PFAS migration to the Foreshore in the future.

9.7.2.2 RAAF Lake

Collection of additional data should be considered as part of a possible Property-wide PFAS investigation, in order to refine the current understanding of adverse ecological impacts (direct and indirect toxicity) from PFAS exposure at RAAF Lake.

10.0 Limitations

AECOM Australia Pty Ltd (AECOM) has prepared this Audit Close Out Report for the Department of Defence for the purpose described herein, in accordance with the usual care and thoroughness of the consulting profession. The report is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The report is prepared in accordance with the scope of work and for the purpose outlined in the project scoping document dated 06 September 2021. This report was prepared between November 2021 – September 2022.

The methodology adopted by AECOM are outlined in the report. The findings and interpretations set out in the report are based on data gathered by and information made available to AECOM within the time available, including publicly available information, data reports prepared for the Property, and inspection and investigations of on-Site and off-Site areas.

It is assumed by AECOM that all relevant data have been provided by those persons from whom it has been requested. Where this report indicates that information has been provided to AECOM by third parties, AECOM has verified or checked that information to the extent required by the agreed scope of work. AECOM assumes no liability for any inaccuracies in or omissions to that information.

AECOM does not assume any liability for misrepresentation of items not visible, accessible or present at the Property during inspections and investigations. This report is not intended as a substitute for legal advice, nor is it an exhaustive review of the conditions at the Property. AECOM makes no warranties about the condition of the Property, or the operations occurring at the property.

From a technical perspective, the subsurface environment at any Site may present substantial uncertainty. It is a heterogeneous, complex environment, in which small subsurface features or changes in geologic conditions can have substantial impacts on water and chemical movement. Uncertainties may also affect source characterisation assessment of chemical fate and transport in the environment, assessment of exposure risks and health effects and remedial action performance.

There is no investigation that is thorough enough to preclude the presence of material, which presently or in the future, may be considered hazardous. As regulatory evaluation criteria change from time to time, concentrations of contaminants presently considered low may, in the future, fall under different regulatory standards that may require a change in action.

Opinions and recommendations presented herein apply to the Property and surrounding areas (as applicable) existing at the time of the investigation and cannot necessarily apply to changes to Property and surrounding areas of which AECOM is not aware and has not had the opportunity to evaluate. This document and the information contained herein should only be regarded as validly representing the Property and surrounding area conditions at the time of the investigation unless otherwise explicitly stated in a preceding section of this report. AECOM disclaims responsibility for any changes that may have occurred after this time.

AECOM believes that its opinions are reasonably supported by the testing and analysis that have been performed, and that those opinions have been developed according to the professional standard of care, regulations and guidelines for the environmental consulting profession in this area at this time. That standard of care, regulations and guidelines may change, and new methods and practices of exploration, testing, analysis and remediation may develop in the future, which might produce different results. AECOM's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or testing and analysis during any future assessment or remedial activities.

AECOM does not represent that this report is suitable for use by any third party. It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements.

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Appendix A

Figures





Australian Government
Department of Defence





DATUM GDA 1994, PROJECTION MGA ZONE 55



0 400 800 m

1 cm = 250 m

(when printed @ A3)

- Legend**
-  Property boundary
 -  Waterbodies
 -  Channels and Drains
 -  Rivers and Streams

OVERVIEW VICTORIA



0 150 300 km



Data Sources:
1. Base Layers (Roads, Local Government Aves, Cadastre, Elevation, Railways, Train Stations, Watercourses, Waterbodies and Localities) © The State of Victoria (Department of Environment, Land, Water and Planning) 2018
2. ImagerySource: Esri, Maxar, GeoEye, Earthstar/Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Base Point Cook

PROPERTY LOCATION

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 5/09/2021
VERSION: 1

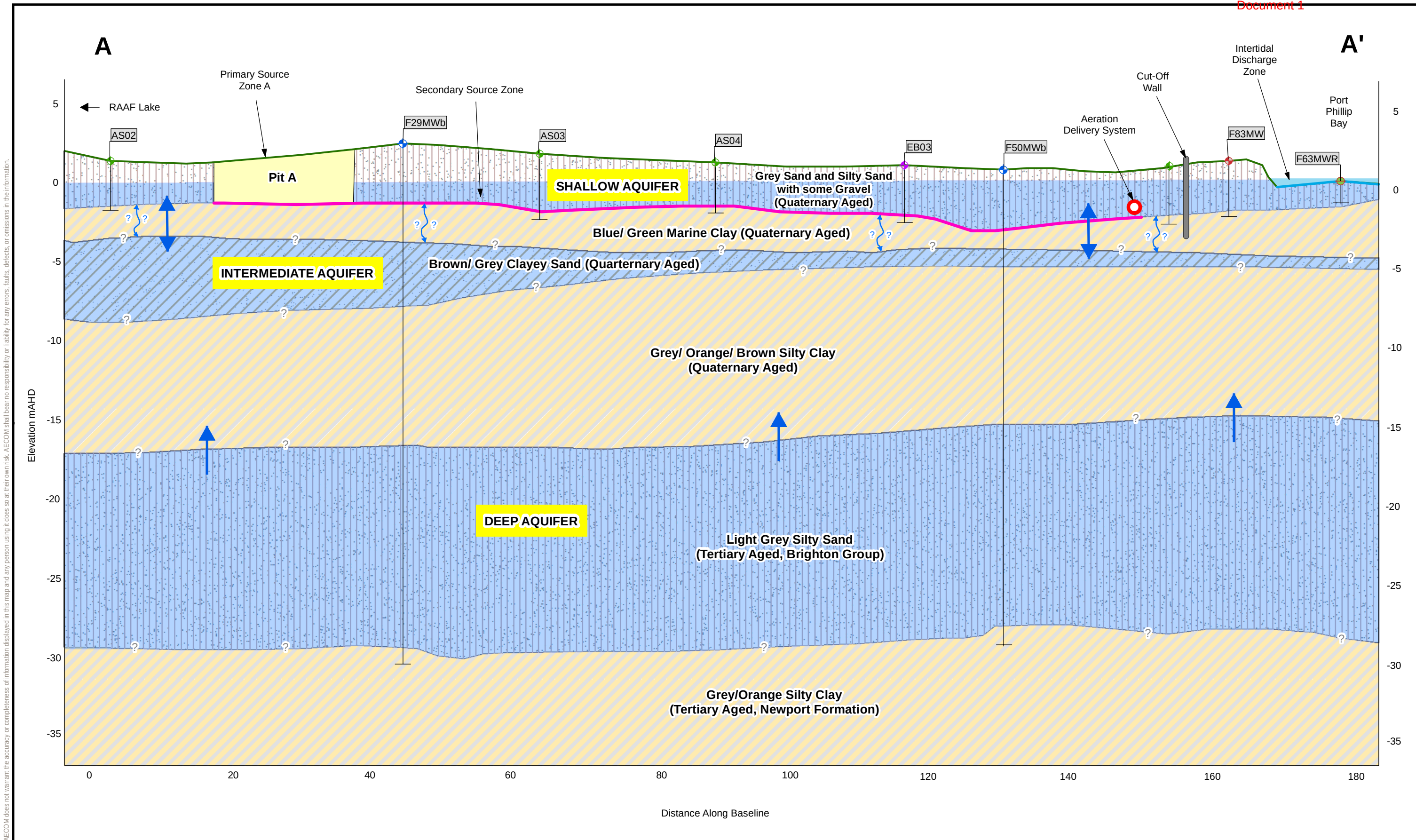
**VIC
PROPERTY ID: 0932
Figure F1**



VIC
PROPERTY ID: 0932
Figure F3



VIC
PROPERTY ID: 0932
Figure F4

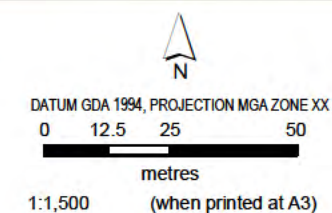


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PROJECT ID 60657609
 CREATED BY DJB
 LAST MODIFIED PK 15 Oct 2021
 www.aecom.com



Legend

- Shallow Aquifer Wells
- Groundwater Contour (mAHD)
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- Site Boundary - Chain Wire Mesh Fence
- Aeration Delivery System
- Cut Off Wall
- Estimated extent of shoreline erosion (July 2012)
- Approximate DNAPL Extent
- Approximate Extent of FTA Burning Pits/Areas as Delineated by HLA Envirosciences 2003
- Bore ID
Reduced Water Level (mAHD)
- DNG - Did Not Gauge

NOTE:
 Could not access to F26MW, F27MWA and F28MW

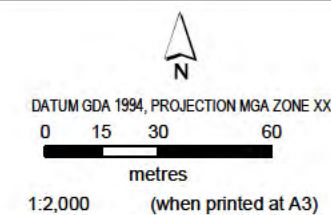
Data sources:
 Aerial Photograph: (c) 2006 QASCO

SHALLOW AQUIFER GROUNDWATER CONTOURS SEPTEMBER 2012 (AECOM, 2017a)

Department of Defence
 RAAF Base Point Cook
 Former Fire Training Area Audit (17174)
 Audit Close Out Report
 Fire Training Area, RAAF Williams -
 Point Cook

Figure
F7

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Legend

- Shallow Aquifer Wells
- Site Boundary - Chain Wire Mesh Fence
- Aeration Delivery System
- Cut Off Wall
- Estimated extent of shoreline erosion (July 2012)
- Approximate DNAPL Extent
- Approximate Extent of FTA Burning Pits/Areas as Delineated by HLA Envirosiences 2003
- Approximate Extent of Remediation including Additional DNAPL
- Former Extent of Remediation
- Groundwater Contour (mAHD)
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- MWXX** BORE ID
- 00.00** Groundwater Elevation (mAHD)
- Approximate extent of infiltration trench

Data sources:
 Aerial Photograph: (c) 2006 QASCO

GROUNDWATER CONTOURS – SHALLOW AQUIFER SEPTEMBER 2014 (AECOM, 2017a)

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 Former Fire Training Area Audit (17174)
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 Fire Training Area, RAAF Williams - Point Cook

Figure
F8



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DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 20 m (when printed @ A3)

- Groundwater monitoring well locations – Shallow aquifer
- Lost / Unable to locate / Unable to gauge
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary -
- Chain Wire Mesh Fence
- Former FTA Site Boundary
- Aeration Delivery System
- Approximate Extent of Remediation including Additional DNAPL
- Approximate Extent of FTA Burning
- Pits/Areas as Delineated by HLA Envirosciences 2003
- Approximate area of infiltration trench(es)

1, Up-gradient Background (UB)
2, General Site South West (GSSW)
3, Source Zone A (SZA)
4, Source Zone B (SZB)
5, General Site East (GSE)
6, Discharge Zone (DZ)
7, Parks Victoria (PV)
0.00 : Groundwater Elevation

Data Sources:
1. Base Layers (Roads, Local Government Areas, Cadastre, Elevation, Railways, Train Stations, Watercourses, Waterbodies and Localities) © The State of Victoria (Department of Environment, Land, Water and Planning) 2018
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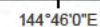
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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

**GROUNDWATER CONTOURS – SHALLOW
AQUIFER (MAY 2021)**

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F9a



DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 20 m (when printed @ A3)

- Groundwater monitoring well locations
 - Shallow aquifer
- Lost / Unable to locate / Unable to gauge
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary -
- Chain Wire Mesh Fence
- Former FTA Site Boundary
- Aeration Delivery System
- Approximate Extent of Remediation including Additional DNAPL
- Approximate Extent of FTA Burning
- Pits/Areas as Delineated by HLA Envirosciences 2003
- Approximate area of infiltration trench(es)

1, Up-gradient Background (UB)
2, General Site South West (GSSW)
3, Source Zone A (SZA)
4, Source Zone B (SZB)
5, General Site East (GSE)
6, Discharge Zone (DZ)
7, Parks Victoria (PV)
0.00 : Groundwater Elevation

Data Sources:
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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Property 0932: RAAF Williams - Point Cook

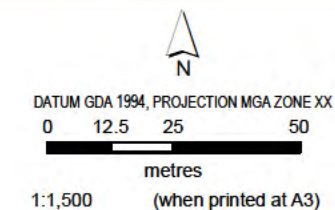
**GROUNDWATER CONTOURS – SHALLOW
AQUIFER (JUL-AUG 2021)**

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F9b

PROJECT ID 60657609
 CREATED BY DJB
 LAST MODIFIED PK 15 Oct 2021

www.aecom.com



Legend

- Intermediate Aquifer Wells
- Groundwater Contour (mAHD)
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- Site Boundary - Chain Wire Mesh Fence
- Aeration Delivery System
- Cut Off Wall
- Estimated extent of shoreline erosion (July 2012)
- Approximate DNAPL Extent
- Approximate Extent of FTA Burning Pits/Areas as Delineated by HLA Envirosciences 2003
- Bore ID
Reduced Water Level (mAHD)
- DNG - Did Not Gauge

NOTE:
 Could not access F27MWC

Data sources:
 Aerial Photograph: (c) 2006 QASCO

INTERMEDIATE AQUIFER GROUNDWATER CONTOURS - SEPTEMBER 2012 (AECOM, 2017a)

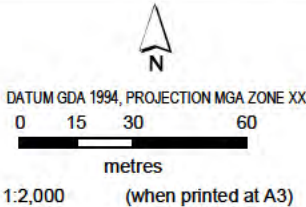
Department of Defence
 RAAF Base Point Cook
 Former Fire Training Area Audit (17174)
 Audit Close Out Report
 Fire Training Area, RAAF Williams -
 Point Cook

Figure
F10

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PROJECT ID 60657609
CREATED BY DJB
LAST MODIFIED PK 15 Oct 2021

www.aecom.com



Legend

- Intermediate Aquifer Wells
- Site Boundary - Chain Wire Mesh Fence
- Aeration Delivery System
- Cut Off Wall
- Estimated extent of shoreline erosion (July 2012)
- Approximate DNAPL Extent
- Approximate Extent of FTA Burning Pits/Areas as Delineated by HLA Envirosiences 2003
- Approximate Extent of Remediation including Additional DNAPL
- Former Extent of Remediation

MWXX BORE ID
00.00 Groundwater Elevation (mAHD)

Data sources:
Aerial Photograph: (c) 2006 QASCO

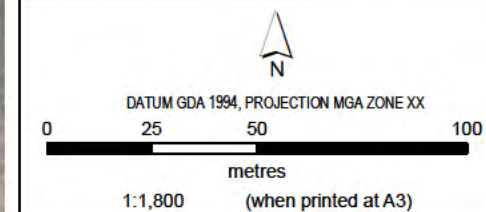
GROUNDWATER ELEVATION –
INTERMEDIATE AQUIFER -
SEPTEMBER 2014 (AECOM, 2017a)

Department of Defence
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Fire Training Area, RAAF Williams -
Point Cook

Figure

F11

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Legend

- DNAPL Observed
- No odour/contamination noted
- Odour Noted
- Sheen Observed
- Soil samples with reported concentrations above guidelines
- Residual DNAPL
- Approximate Extent of Remediation including Additional DNAPL
- Validation Grid Cells
- ▨ Residual DNAPL

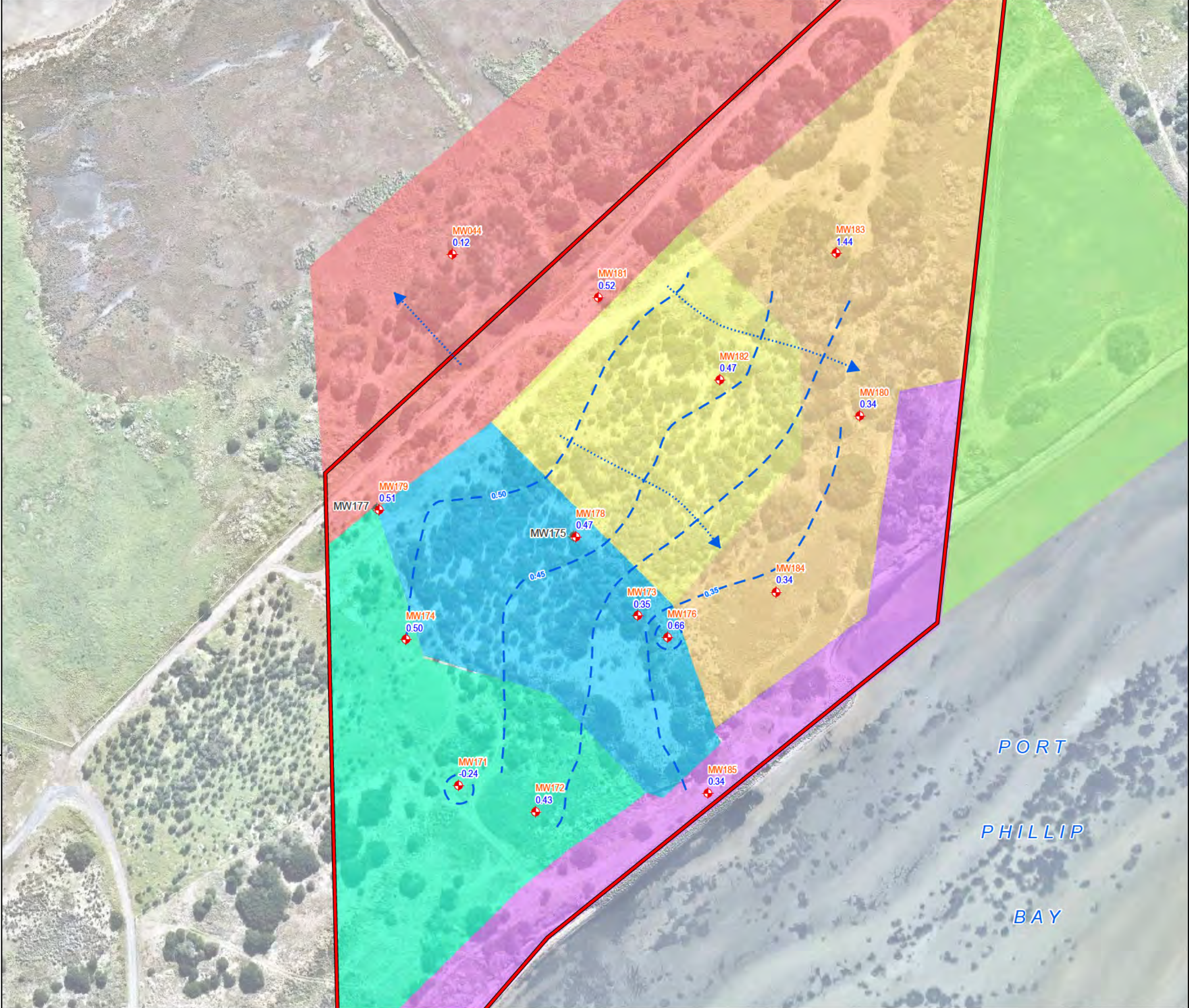
Data sources:
 Aerial Photograph: (c) 2006 QASCO

RESIDUAL DNAPL ASSESSMENT - POST REMEDIATION

Department of Defence
 Post Remediation Soil Assessment, 2016
 Fire Training Area, RAAF Williams - Point Cook

Figure
F12

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DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 17 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Intermediate aquifer
- Lost / Unable to locate / Unable to gauge
- Inferred Groundwater Contour (mAHd)
- Inferred Groundwater Flow Direction
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- Former FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

0.00 :Groundwater Elevation

Date Sources:
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**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Stage 5 Monitoring**

Property 0932: RAAF Williams - Point Cook

**GROUNDWATER CONTOURS –
INTERMEDIATE AQUIFER (MAY 2021)**

PROJECT#: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

**VIC
PROPERTY ID: 0932
Figure F12a**

37°56'0"S

144°46'0"E

144°46'0"E

Document Path: launet\fp001\Projects\60657609\60657609\00\00\00\00\CAD_GIS\GIS02_GIS02_Maps\101044F_Base_PCook_F12a_GW_Conours_Intermediate_Aquifer_May21.mxd



DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 17 m (when printed @ A3)

- Groundwater monitoring well locations – Intermediate aquifer
- Lost / Unable to locate / Unable to gauge
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- Former FTA Site Boundary

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Data Sources:
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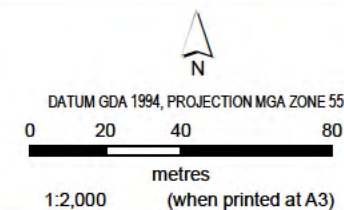
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Property 0932: RAAF Williams - Point Cook

**GROUNDWATER CONTOURS –
INTERMEDIATE AQUIFER (JUL-AUG 2021)**

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 18/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F12b



Legend

- Deep Aquifer Wells
- Groundwater Contour (mAHD)
- Inferred Groundwater Contour
- Inferred Groundwater Flow Direction
- Approximate Extent of Remediation including Additional DNAPL
- Former Extent of Remediation
- Site Boundary - Chain Wire Mesh Fence
- Estimated extent of shoreline erosion (September 2012)
- Cut Off Wall
- Site Boundary

NOTE:
* F27MWB: gauged during groundwater sampling.
#Groundwater elevation may not be reflective of equilibrium groundwater conditions.

Data sources:
Aerial Photograph: (c) 2006 QASCO

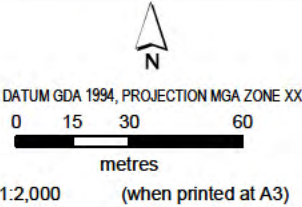
GROUNDWATER CONTOURS – DEEP AQUIFER - NOVEMBER 2013 (AECOM, 2017a)

Department of Defence
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Fire Training Area, RAAF Williams - Point Cook

PROJECT ID 60657609
CREATED BY DJB
LAST MODIFIED PK 15 Oct 2021

Figure
F13





Legend

- Deep Aquifer Wells
- Site Boundary - Chain Wire Mesh Fence
- Aeration Delivery System
- Cut Off Wall
- Estimated extent of shoreline erosion (July 2012)
- Approximate DNAPL Extent
- Approximate Extent of FTA Burning Pits/Areas as Delineated by HLA Envirosciences 2003
- Approximate Extent of Remediation including Additional DNAPL
- Former Extent of Remediation
- Groundwater Contour (mAHD)
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction
- MWXX BORE ID
- 00.00 Groundwater Elevation (mAHD)

Data sources:
Aerial Photograph: (c) 2006 QASCO

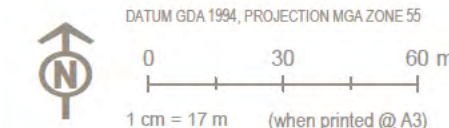
**GROUNDWATER CONTOURS –
DEEP AQUIFER
SEPTEMBER 2014 (AECOM, 2017a)**

Department of Defence
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Fire Training Area, RAAF Williams -
Point Cook

Figure
F14



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- Groundwater monitoring well locations – Deep aquifer
- Lost / Unable to locate / Unable to gauge
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- Former FTA Site Boundary

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Data Sources:
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**GROUNDWATER CONTOURS – DEEP
AQUIFER (MAY 2021)**

VIC
PROPERTY ID: 0932
Figure F15a



Australian Government
Department of Defence



DATUM GDA 1994, PROJECTION MGA ZONE 55



0 30 60 m
1 cm = 17 m (when printed @ A3)

Groundwater monitoring well locations – Deep aquifer

----- Estimated extent of shoreline erosion
(July 2012)

Site Boundary -
Chain Wire Mesh Fence

— Former FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

0.00 :Groundwater Elevation

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2. Imagery

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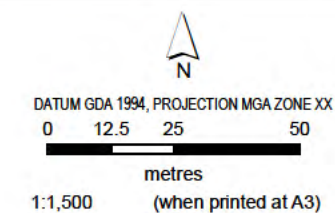
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

GROUNDWATER CONTOURS – DEEP AQUIFER (JUL-AUG 2021)

PROJECT#:	60657609 - VIC
CREATED BY:	prachi.kulkarni1
LAST MODIFIED:	15/10/2021
VERSION:	1

VIC
PROPERTY ID: 0932
Figure F15b



Legend

- Approximate Extent of FTA Burning Pits/Areas as Delineated by HLA Envirosciences 2003
- Site Boundary - Chain Wire Mesh Fence
- Old Timber Post & Wire Fence
- NAPL Extent**
 - Approximate Extent of LNAPL Sheen
 - Approximate DNAPL Extent
 - Aeration Delivery System
 - Cut Off Wall
 - Estimated extent of shoreline erosion (September 2012)
 - Approximate Extent of Remediation
 - Stockpiled Waste

Data sources:
Aerial Photograph: (c) 2006 QASCO

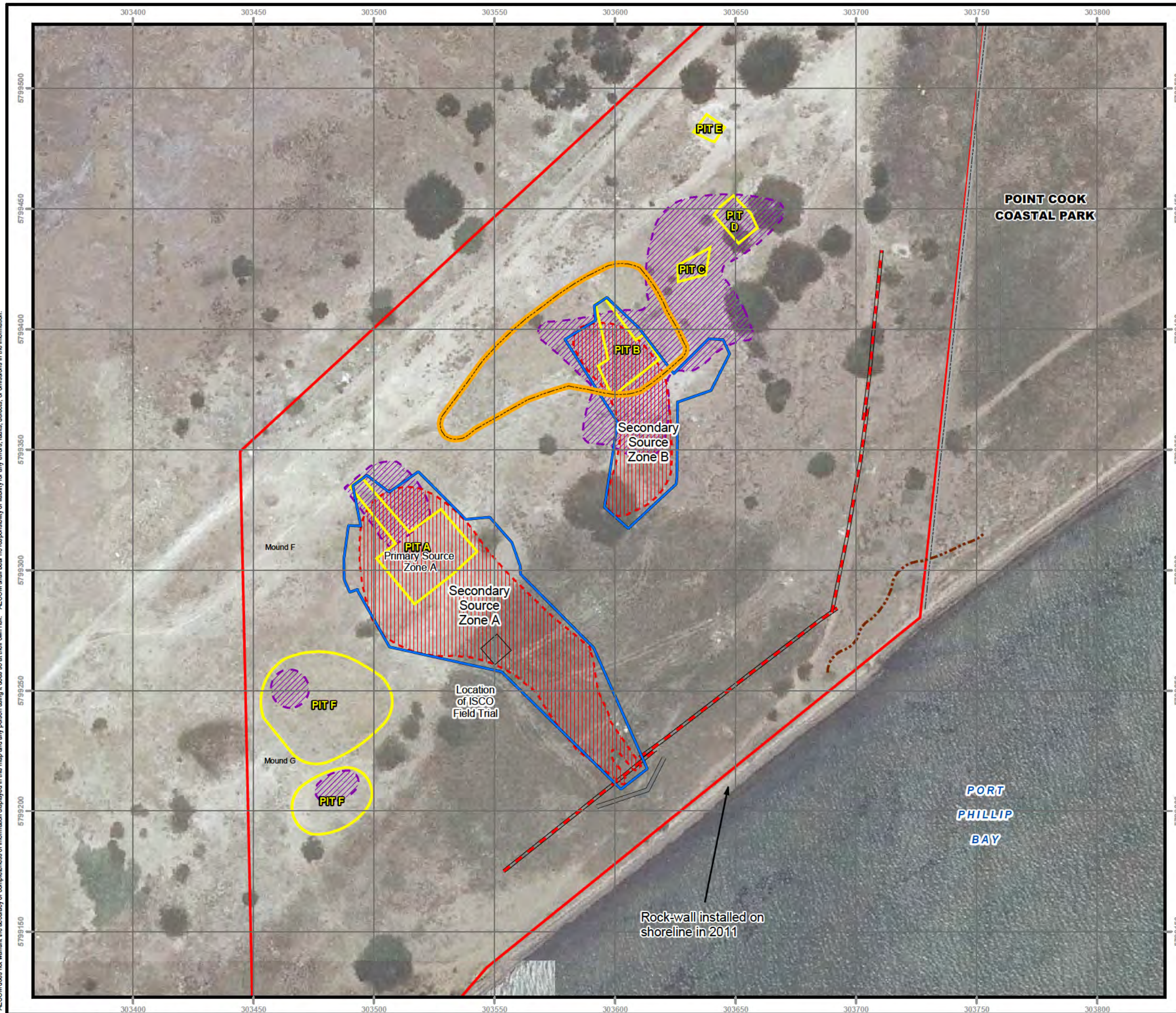
SITE SOURCE ZONES & PLUME EXTENTS PRE SOURCE RE-MOVAL REMEDIATION (2014-2015) (AECOM, 2017a)

Department of Defence RAAF Base Point Cook
Former Fire Training Area Audit (17174) Audit Close Out Report
Fire Training Area, RAAF Williams - Point Cook

Figure

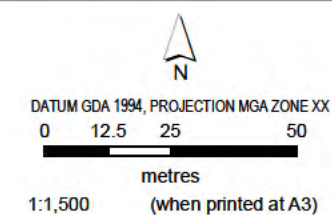
F16

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PROJECT ID 60223484
 CREATED BY DJB
 LAST MODIFIED PK 11/03/2022

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Legend

- DNAPL Observed
- No odour/contamination noted
- Odour Noted
- Sheen Observed
- Soil samples with reported concentrations above guidelines
- Residual DNAPL
- Approximate Extent of Remediation including Additional DNAPL
- Validation Grid Cells
- ▨ Residual DNAPL

Data sources:
 Aerial Photograph: (c) 2006 QASCO

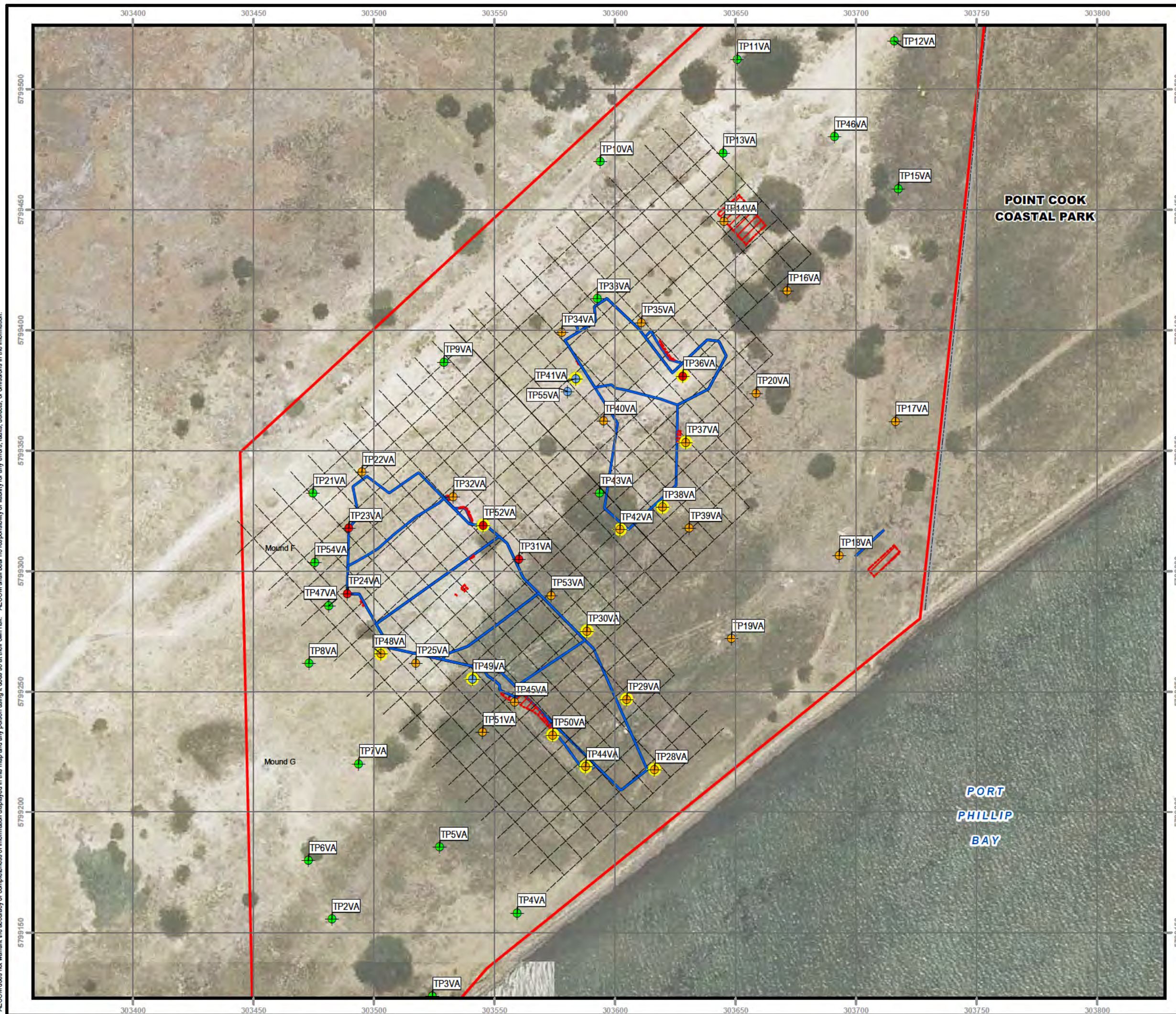
RESIDUAL DNAPL ASSESSMENT – POST REMEDIATION (AECOM, 2017a)

Department of Defence RAAF Base
 Point Cook
 Former Fire Training Area Audit
 (17174) Audit Close Out Report
 Fire Training Area, RAAF Williams –
 Point Cook

Figure

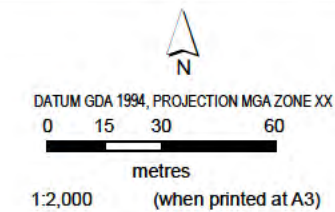
F17

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PROJECT ID 60223484
 CREATED BY DJB
 LAST MODIFIED PK 11/03/2022

www.aecom.com



Legend

- Facility Location
- Cut Off Wall
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- Aeration Delivery System
- PIT A; PIT B
- Site Boundary
- DC - SZA All
- Validation sampling grid
- Surface soil validation sample extent
- Surface soil validation area

Data sources:
 Aerial Photograph: (c) 2006 QASCO

POST REMEDIATION SURFACE VALIDATION SAMPLE GRID (AECOM, 2017a)

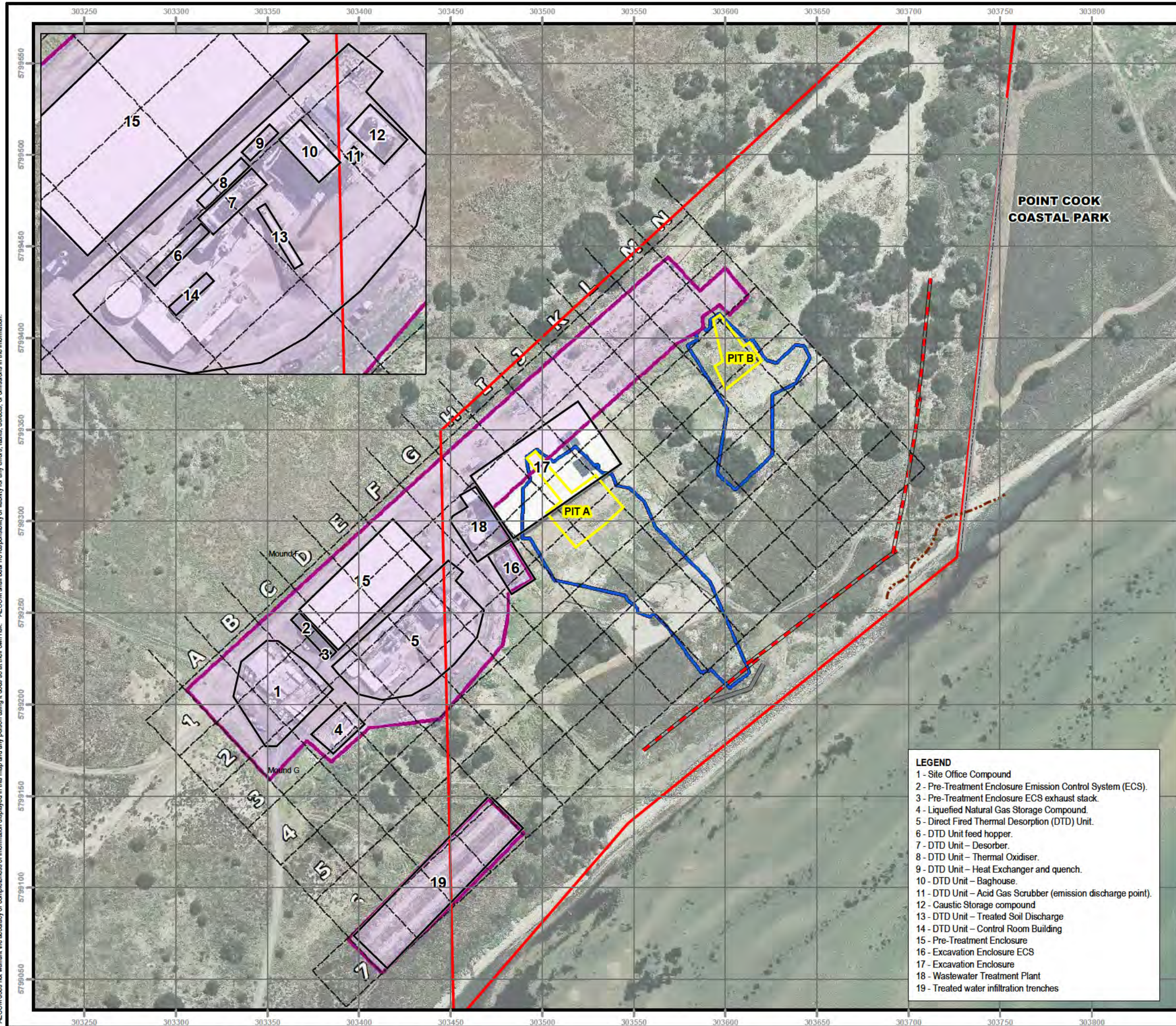
Department of Defence RAAF Base
 Point Cook

Former Fire Training Area Audit
 (17174) Audit Close Out Report
 Fire Training Area, RAAF Williams -
 Point Cook

Figure

F18

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- LEGEND**
- 1 - Site Office Compound
 - 2 - Pre-Treatment Enclosure Emission Control System (ECS).
 - 3 - Pre-Treatment Enclosure ECS exhaust stack.
 - 4 - Liquefied Natural Gas Storage Compound.
 - 5 - Direct Fired Thermal Desorption (DTD) Unit.
 - 6 - DTD Unit feed hopper.
 - 7 - DTD Unit - Desorber.
 - 8 - DTD Unit - Thermal Oxidiser.
 - 9 - DTD Unit - Heat Exchanger and quench.
 - 10 - DTD Unit - Baghouse.
 - 11 - DTD Unit - Acid Gas Scrubber (emission discharge point).
 - 12 - Caustic Storage compound
 - 13 - DTD Unit - Treated Soil Discharge
 - 14 - DTD Unit - Control Room Building
 - 15 - Pre-Treatment Enclosure
 - 16 - Excavation Enclosure ECS
 - 17 - Excavation Enclosure
 - 18 - Wastewater Treatment Plant
 - 19 - Treated water infiltration trenches



DATUM GDA 1994, PROJECTION MGA ZONE 55

0 20 40 m

1 cm = 14 m (when printed @ A3)

Groundwater monitoring well locations – Shallow aquifer

Estimated extent of shoreline erosion
(July 2012)

Site Boundary -
Chain Wire Mesh Fence

— FTA Site Boundary

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
ANZG (2018) Marine water 95% toxicant

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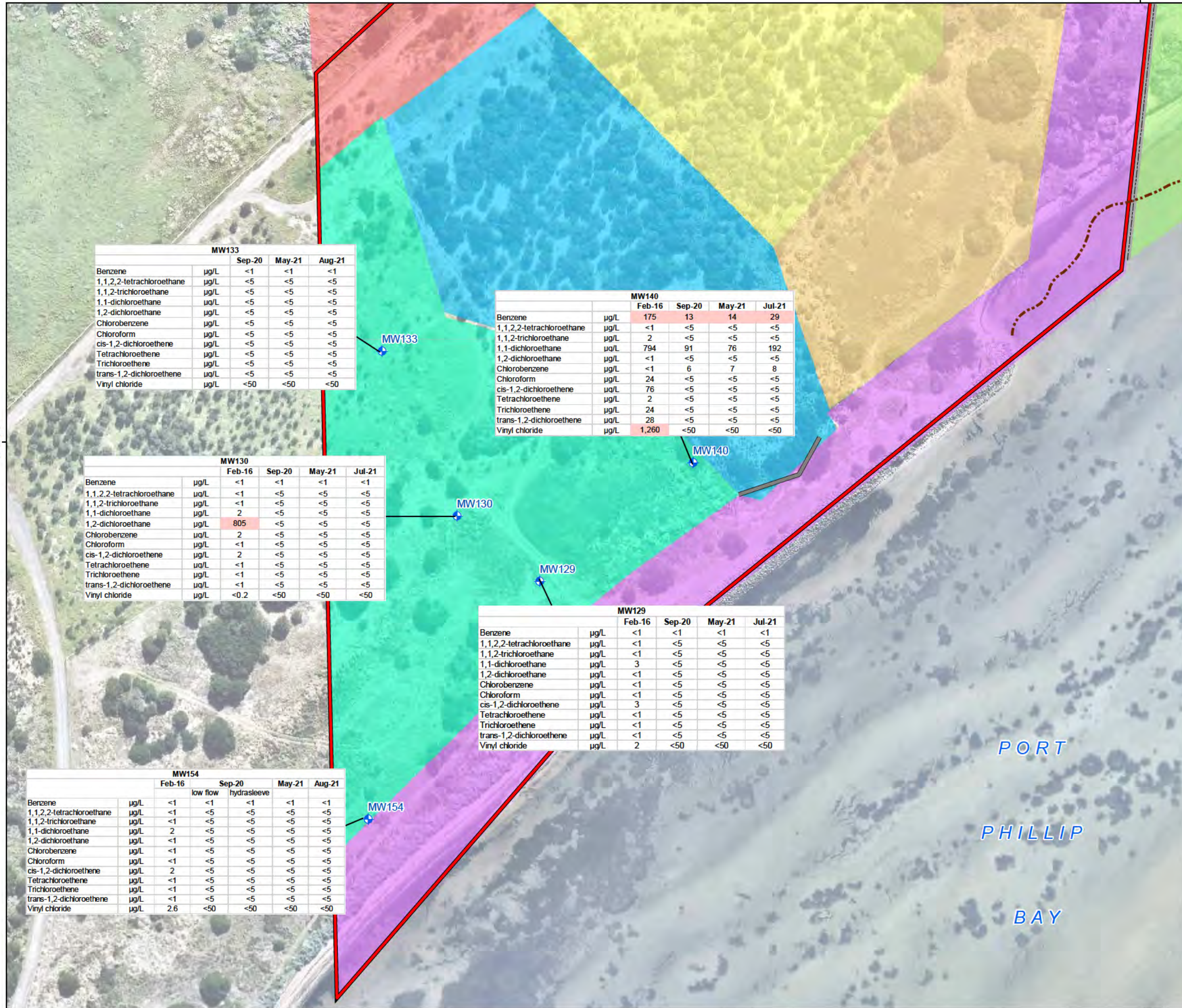
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

SHALLOW AQUIFER UP-GRADIENT BACKGROUND GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F19a



DATUM GDA 1994, PROJECTION MGA ZONE 55

0 20 40 m
1 cm = 13 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines

- NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
- ANZG (2018) Marine water 95% toxicant DGVs

Data Sources:
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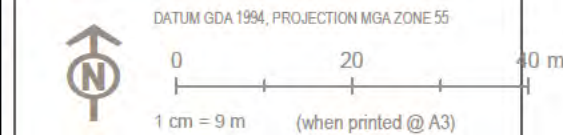
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

SHALLOW AQUIFER SITE SOUTH WEST ZONE
A GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F19b



Groundwater monitoring well locations – Shallow aquifer

Estimated extent of shoreline erosion (July 2012)

Site Boundary - Chain Wire Mesh Fence

FTA Site Boundary

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

	NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
	ANZG (2018) Marine water 95% toxicant DGVs

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Property 0932: RAAF Williams - Point Cook

PROJECT #:	60657609 - VIC
CREATED BY:	prachi.kulkarni1
LAST MODIFIED:	25/11/2021
VERSION:	1

VIC
PROPERTY ID: 0932
Figure F19c

Groundwater monitoring well locations – Shallow aquifer

Site Boundary -
Chain Wire Mesh Fence

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
ANZG (2018) Marine water 95% toxicant DGVs

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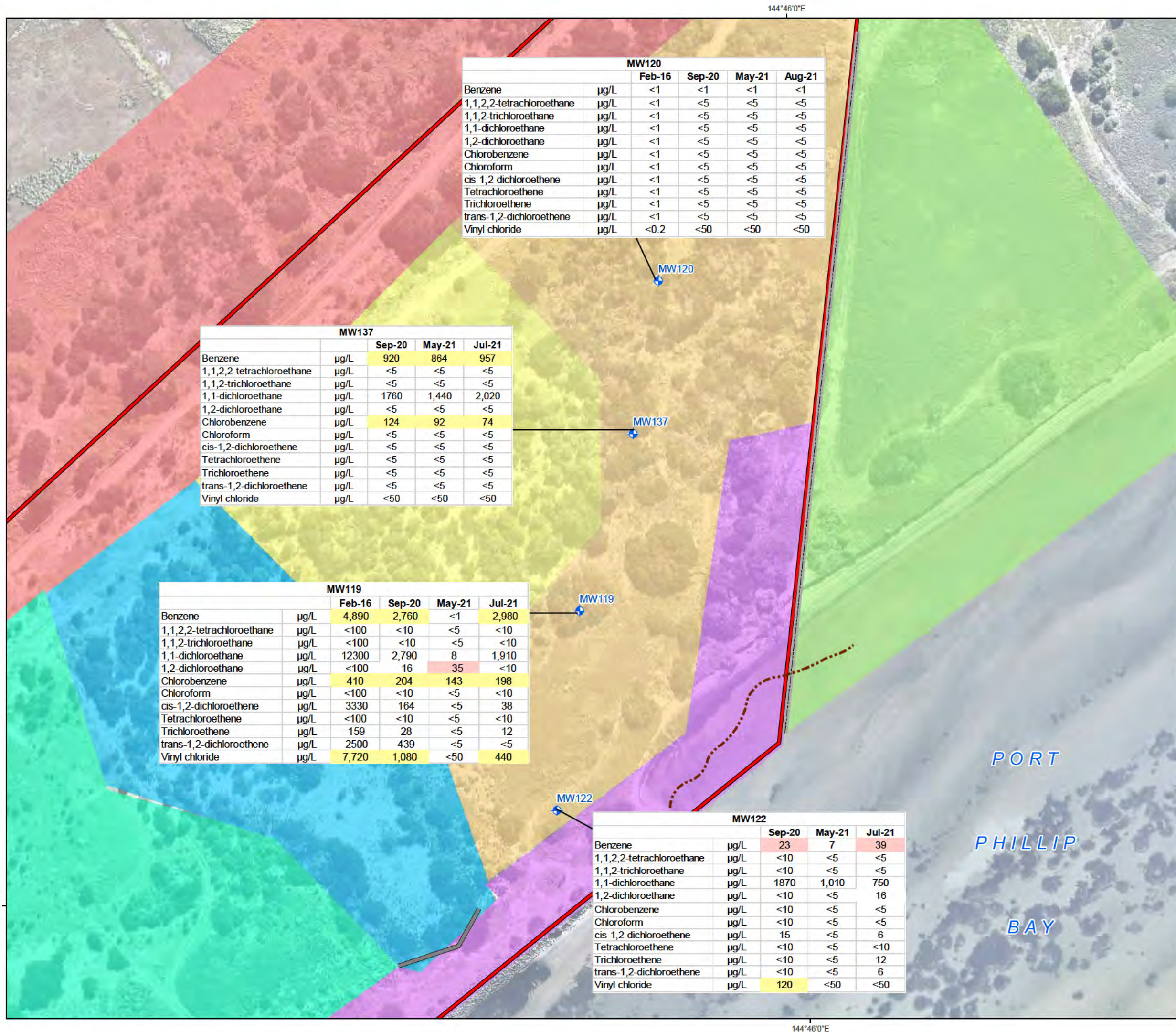
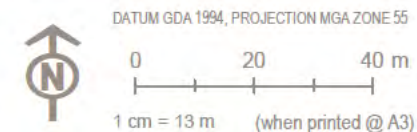
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Property 0932: RAAF Williams - Point Cook

PROJECT #:	60657609 - VIC
CREATED BY:	prachi.kulkarni1
LAST MODIFIED:	25/11/2021
VERSION:	1

VIC
PROPERTY ID: 0932
Figure F19d

MW134MW160MW121MW123Benzene



Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines

- NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
- ANZG (2018) Marine water 95% toxicant DGVs

Note:

* - anomalous results were noted at MW180 and MW119 from the May 2021 monitoring round, likely mis-labelling of bottles at both locations, as such laboratory reports and figures have not been updated to reflect this error, therefore when undertaking trend analysis / interpretation of the data, the associated data for May 2021 will be adopted as follows, MW180 data = MW119, vice versa.

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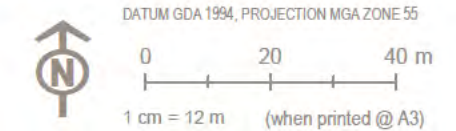
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

SHALLOW AQUIFER GENERAL SITE EAST
GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F19e



Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines

NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
ANZG (2018) Marine water 95% toxicant DGVs

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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

SHALLOW AQUIFER DISCHARGE ZONE
GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F19f

		MW125			
		Feb-16	Sep-20	May-21	Jul-21
Benzene	µg/L	293	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<5	<5	<5
1,1,2-trichloroethane	µg/L	3	<5	<5	<5
1,1-dichloroethane	µg/L	1090	194	159	390
1,2-dichloroethane	µg/L	12	<5	<5	<5
Chlorobenzene	µg/L	31	<5	<5	6
Chloroform	µg/L	<1	<5	<5	<5
cis-1,2-dichloroethene	µg/L	1	<5	<5	<5
Tetrachloroethene	µg/L	<1	<5	<5	<5
Trichloroethene	µg/L	1	<5	<5	<5
trans-1,2-dichloroethene	µg/L	<1	<5	<5	<5
Vinyl chloride	µg/L	3	<50	<50	<50

MW125

MW110

		MW110			
		Sep-20	May-21	Jul-21	
Benzene	µg/L	3	<1	<1	
1,1,2,2-tetrachloroethane	µg/L	<5	<5	<5	
1,1,2-trichloroethane	µg/L	<5	<5	<5	
1,1-dichloroethane	µg/L	325	297	644	
1,2-dichloroethane	µg/L	<5	<5	<5	
Chlorobenzene	µg/L	10	6	22	
Chloroform	µg/L	<5	<5	<5	
cis-1,2-dichloroethene	µg/L	<5	<5	<5	
Tetrachloroethene	µg/L	<5	<5	<5	
Trichloroethene	µg/L	<5	<5	<5	
trans-1,2-dichloroethene	µg/L	<5	<5	<5	
Vinyl chloride	µg/L	<50	<50	<50	

MW142

MW142

		Feb-16	Sep-20		May-21	Jul-21
			low flow	hydraulic		
Benzene	µg/L	192	<1	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<5	<5	<5	<5
1,1,2-trichloroethane	µg/L	<1	<5	<5	<5	<5
1,2-dichloroethane	µg/L	2	<5	<5	<5	<5
Chlorobenzene	µg/L	4	<5	<5	<5	<5
Carbon tetrachloride	µg/L	<1	<5	<5	<5	<5
Chloroform	µg/L	<1	<5	<5	<5	<5
cis-1,2-dichloroethene	µg/L	<1	<5	<5	<5	<5
Tetrachloroethene	µg/L	<1	<5	<5	<5	<5
Trichloroethene	µg/L	<1	<5	<5	<5	<5
trans-1,2-dichloroethene	µg/L	<1	<5	<5	<5	<5
Vinyl chloride	µg/L	3.1	<50	<50	<50	<50

MW114

MW141

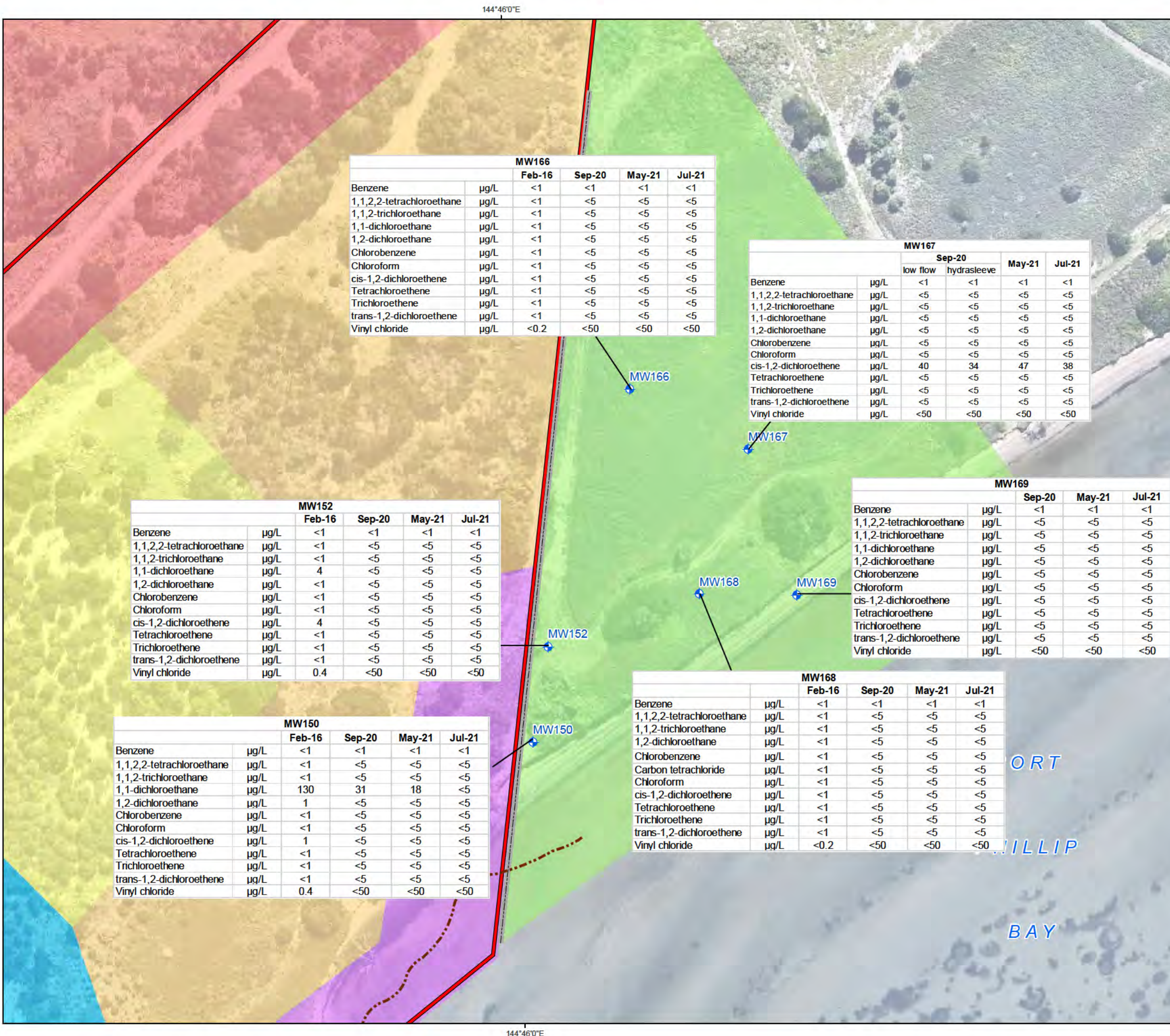
MW114

		Feb-16	Sep-20	May-21	Jul-21
Benzene	µg/L	<1	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<5	<5	<5
1,1,2-trichloroethane	µg/L	<1	<5	<5	<5
1,1-dichloroethane	µg/L	70	151	183	145
1,2-dichloroethane	µg/L	1	<5	<6	<5
Chlorobenzene	µg/L	10	5	13	8
Chloroform	µg/L	<1	<5	<5	<5
cis-1,2-dichloroethene	µg/L	2	<5	<5	<5
Tetrachloroethene	µg/L	<1	<5	<5	<5
Trichloroethene	µg/L	<1	<5	<5	<5
trans-1,2-dichloroethene	µg/L	<1	<5	<5	<5
Vinyl chloride	µg/L	0.4	<50	<50	<50

37°56'0"S

144°46'0"E

144°46'0"E



AECOM

DATUM GDA 1994, PROJECTION MGA ZONE 55

0 20 40 m

1 cm = 11 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines

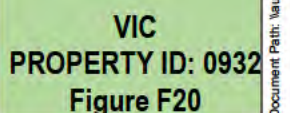
- NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters
- ANZG (2018) Marine water 95% toxicant DGVs

RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Property 0932: RAAF Williams - Point Cook

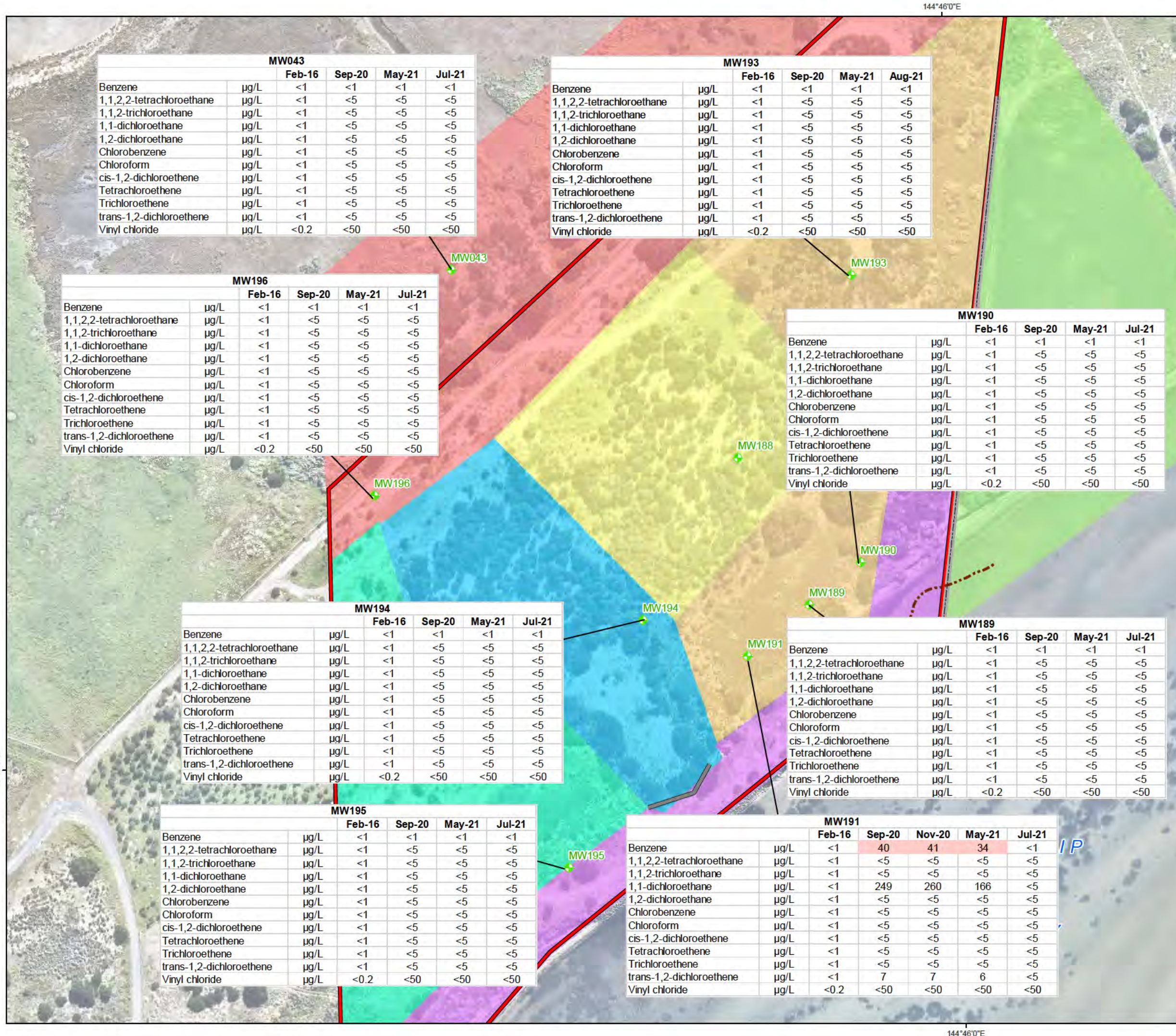
SHALLOW AQUIFER PARKS VICTORIA
GROUNDWATER RESULTS

PROJECT#: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F19g



		MW186			
		Feb-16	Sep-20	May-21	Jul-21
Benzene	µg/L	17	8	<1	14
1,1,2,2-tetrachloroethane	µg/L	<1	<5	<5	<5
1,1,2-trichloroethane	µg/L	43	19	<5	9
1,1-dichloroethane	µg/L	74	37	<5	57
1,2-dichloroethane	µg/L	163	102	<5	116
Chlorobenzene	µg/L	2	<5	<5	<5
Chloroform	µg/L	<1	<5	<5	<5
cis-1,2-dichloroethene	µg/L	40	21	<5	31
Tetrachloroethene	µg/L	2	<5	<5	<5
Trichloroethene	µg/L	26	14	<5	22
trans-1,2-dichloroethene	µg/L	24	12	<5	18
Vinyl chloride	µg/L	67	<50	<50	<50



AECOM

DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 17 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Deep aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines

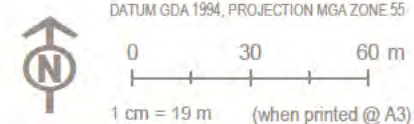
NHMRC 2008 - Guidelines for Managing Risks in Recreational Waters

RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Property 0932: RAAF Williams - Point Cook

DEEP AQUIFER GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 25/11/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F21



Legend

- Groundwater monitoring well locations – Shallow aquifer
- Lost / Unable to locate / Unable to gauge
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines	
	PFAS NEMP Marine 99%
	NHMRC 2019 Guidance on per- and poly-fluoroalkyl substances (PFAS) in recreational water

Note:

* - anomalous results were noted at MW180 and MW119 from the May 2021 monitoring round, likely mis-labelling of bottles at both locations, as such laboratory reports and figures have not been updated to reflect this error, therefore when undertaking trend analysis / interpretation of the data, the associated data for May 2021 will be adopted as follows, MW180 data = MW119, vice versa.

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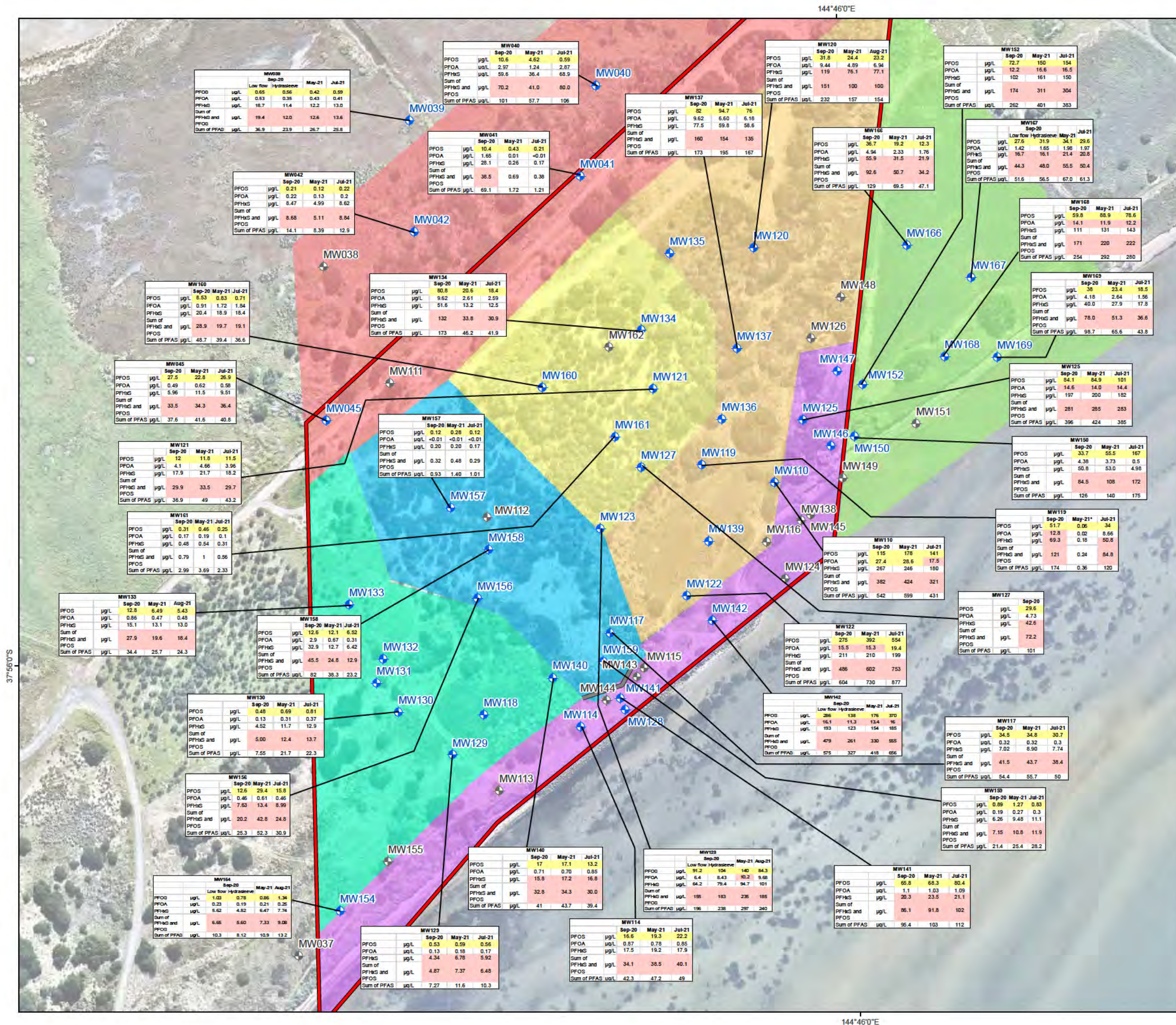
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

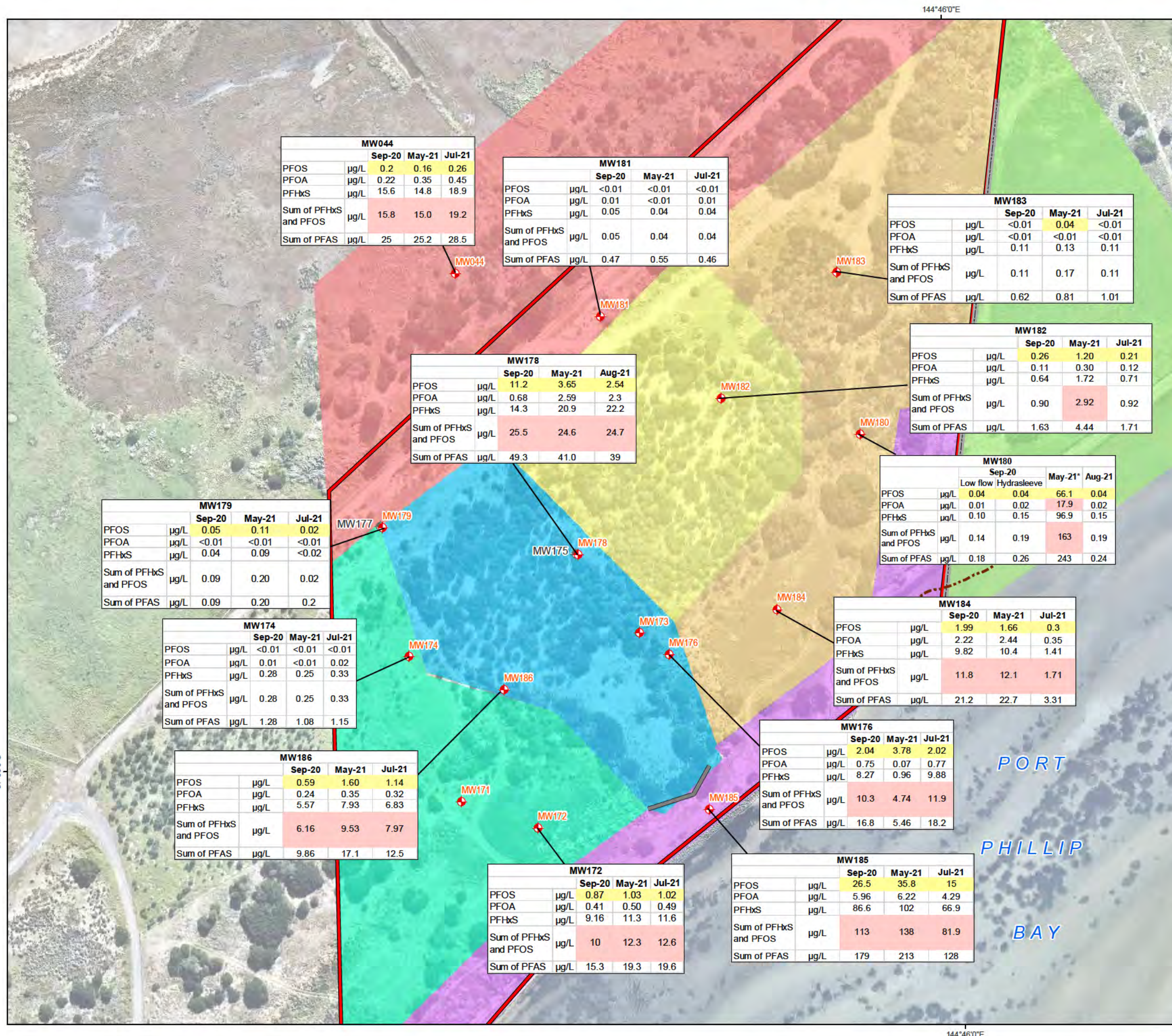
Property 0932: RAAF Williams - Point Cook

SHALLOW AQUIFER PFAS GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F22





AECOM

DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 17 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Intermediate aquifer
- Lost / Unable to locate / Unable to gauge
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines

- PFAS NEMP Marine 99% Species Protection
- NHMR 2019 Guidance on per- and poly-fluoroalkyl substances (PFAS) in recreational water

Note:

* - anomalous results were noted at MW180 and MW119 from the May 2021 monitoring round, likely mis-labelling of bottles at both locations, as such laboratory reports and figures have not been updated to reflect this error, therefore when undertaking trend analysis / interpretation of the data, the associated data for May 2021 will be adopted as follows, MW180 data = MW119, vice versa.

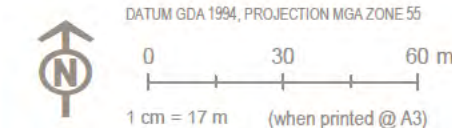
**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Williams - Point Cook

**INTERMEDIATE AQUIFER PFAS
GROUNDWATER RESULTS**

PROJECT#: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

**VIC
PROPERTY ID: 0932
Figure F23**



- Groundwater monitoring well locations – Deep aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

Guidelines	
	PFAS NEMP Marine 99% Species Protection
	NHMRC 2019 Guidance on per- and poly-fluoroalkyl substances (PFAS) in recreational water

Data Sources:
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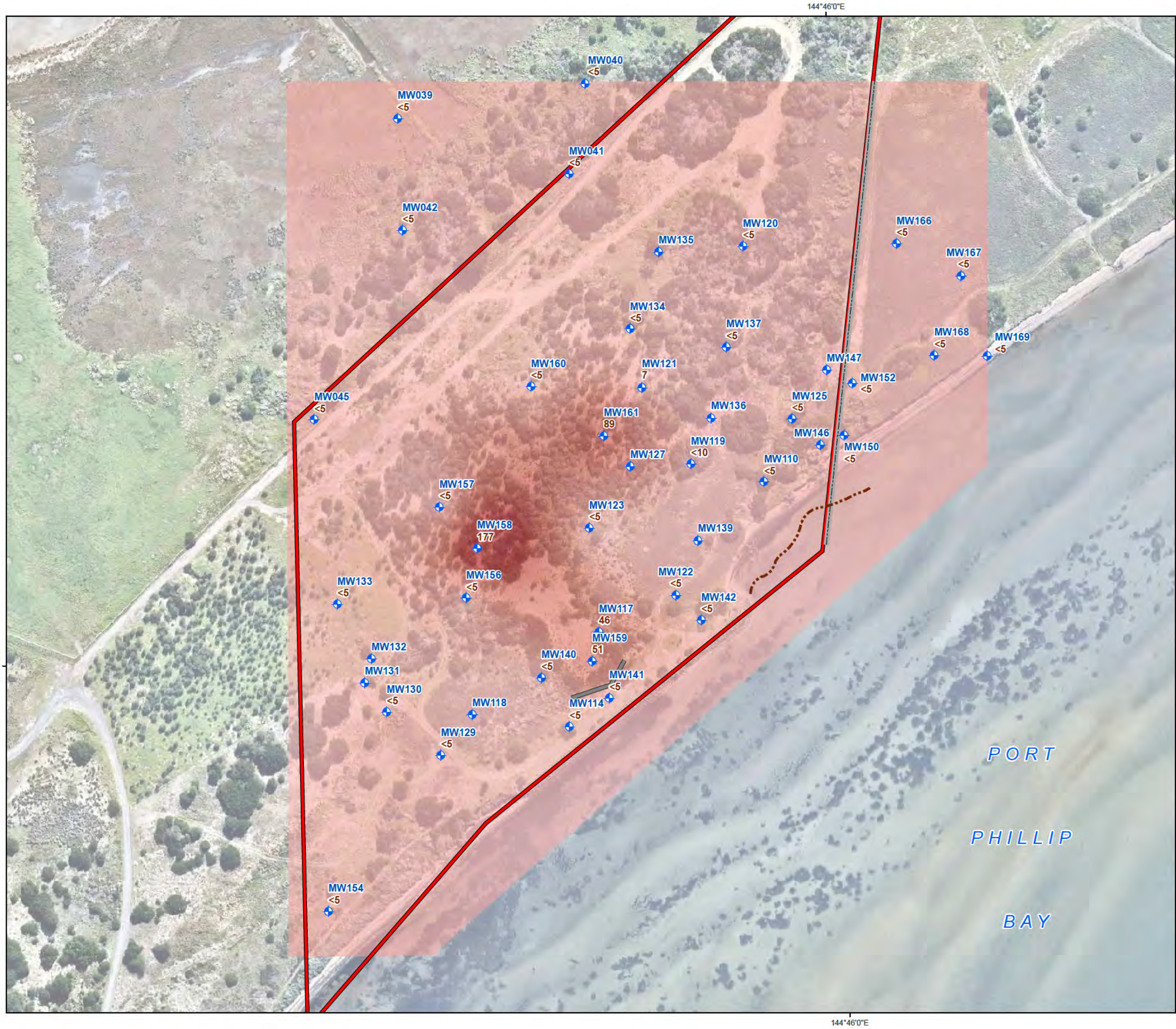
**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Williams - Point Cook

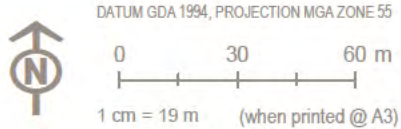
DEEP AQUIFER PFAS GROUNDWATER RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F24



AECOM



Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

PCE Distribution

- High : 177 µg/L
- Low : 5 µg/L

0.00 :PCE Concentration

Data Sources:
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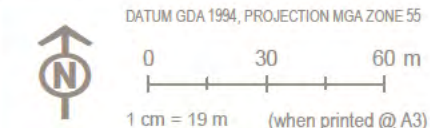
**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Williams - Point Cook

**PCE CONCENTRATION – SHALLOW AQUIFER
(JUL-AUG 2021)**

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

**VIC
PROPERTY ID: 0932
Figure F25a**



Legend

-  Groundwater monitoring well locations – Shallow aquifer
 Estimated extent of shoreline erosion (July 2012)
 Site Boundary - Chain Wire Mesh Fence
 FTA Site Boundary

TCE Distribution

High : 3850 µg/L
Low : 5 µg/L

0.00 :TCE Concentration

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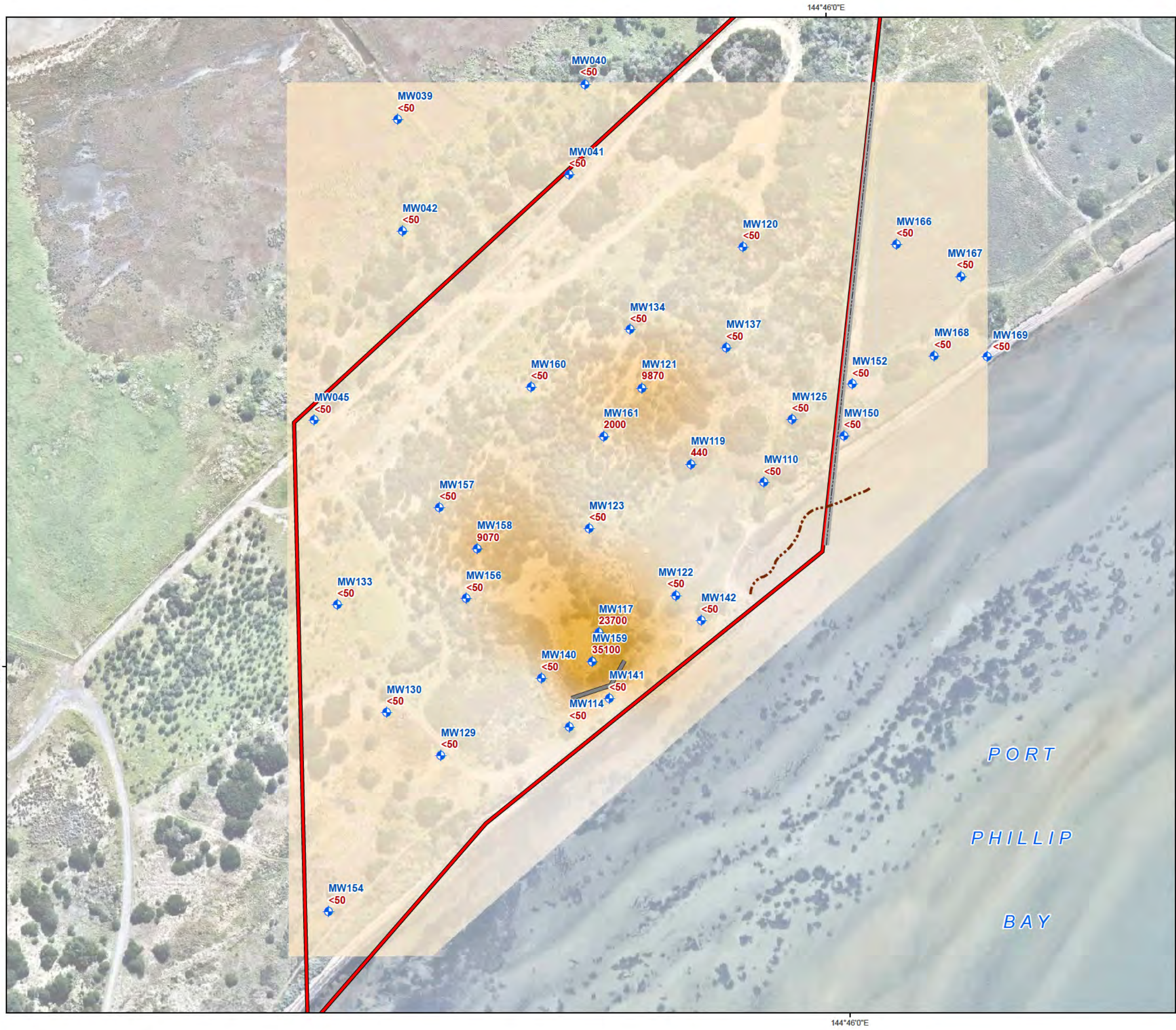
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

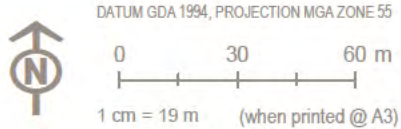
**TCE CONCENTRATION – SHALLOW AQUIFER
(JUL-AUG 2021)**

PROJECT#:	60657609 - VIC
CREATED BY:	prachi.kulkarni1
LAST MODIFIED:	15/10/2021
VERSION:	1

VIC
PROPERTY ID: 0932
Figure F25b



AECOM



Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

VC Distribution

- High : 35100 µg/L
- Low : 50 µg/L

0.00 :VC Concentration

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Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Williams - Point Cook

**VC CONCENTRATION – SHALLOW AQUIFER
(JUL-AUG 2021)**

PROJECT#: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

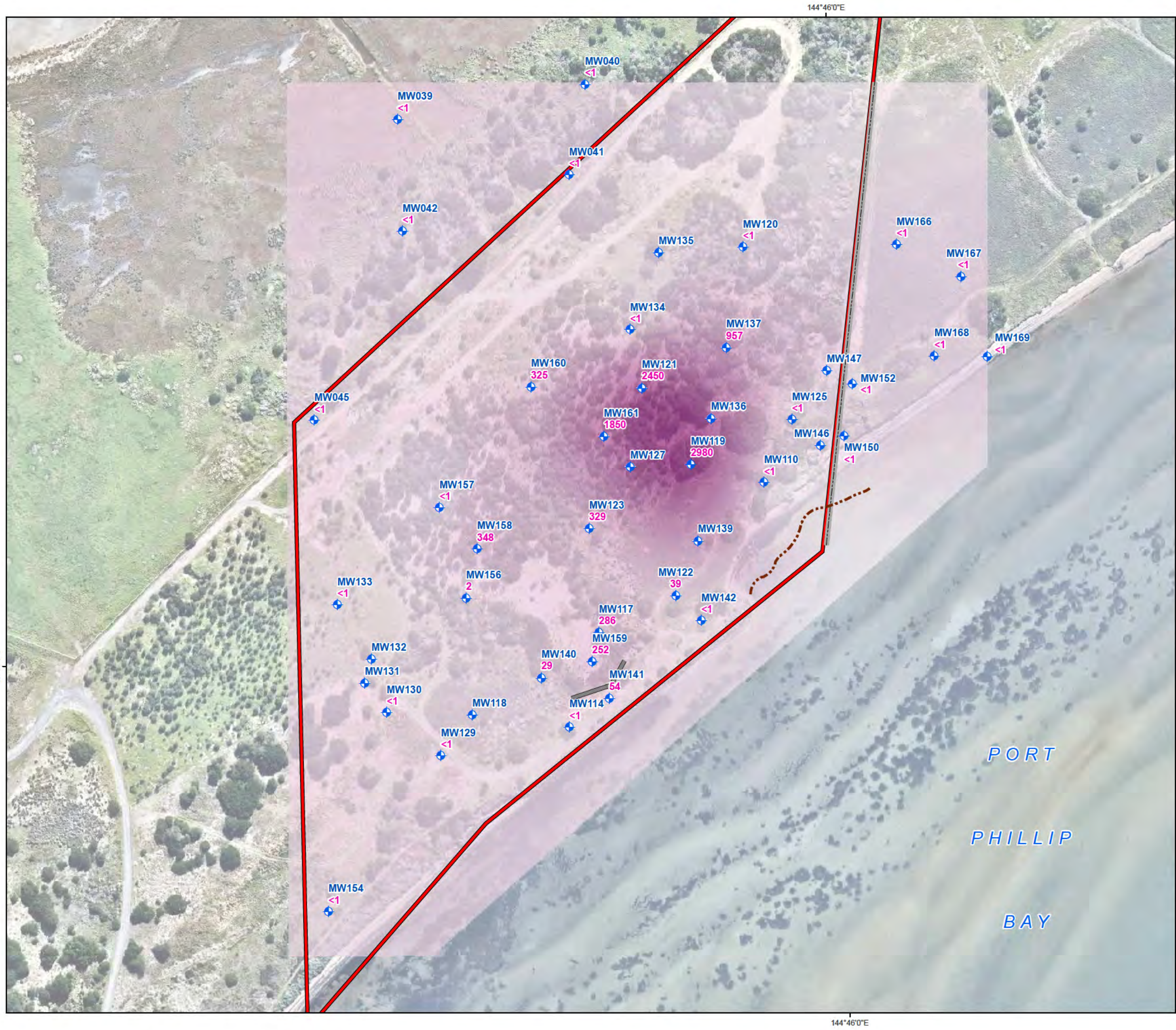
**VIC
PROPERTY ID: 0932
Figure F25c**

37°56'0"S

144°46'0"E

144°46'0"E

Document Path: \\aunet1p001\projects\60657609\60657609\00\00\CAD_GIS\020_GIS\020_GIS\020_Map\1010444_Footer_FTA_AuditF25c_VC_Shallow_Aquifer.mxd



AECOM



DATUM GDA 1994, PROJECTION MGA ZONE 55

0 30 60 m

1 cm = 19 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Shallow aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Benzene Distribution

- High : 2980 µg/L
- Low : 1 µg/L

0.00 :Benzene Concentration

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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report
Property 0932: RAAF Williams - Point Cook

BENZENE CONCENTRATION – SHALLOW
AQUIFER (JUL-AUG 2021)

PROJECT#: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F25d

Document Path: \\aunet1p001\projects\60657609\60657609\00\00\00\CAD_GIS\020_GIS\020_GIS\020_Map\1010444_Footer_FTA_AuditF25d_Benzene_Shallow_Aquifer.mxd



Legend

-  Groundwater monitoring well locations – Intermediate aquifer
-  Estimated extent of shoreline erosion (July 2012)
-  Site Boundary - Chain Wire Mesh Fence
-  FTA Site Boundary

PCE Distribution

-  High : 1080 µg/L
-  Low : 5 µg/L

0.00 :PCE Concentration

Data Sources:
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**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Williams - Point Cook

**PCE CONCENTRATION - INTERMEDIATE
AQUIFER (JUL-AUG 2021)**

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F26a



Australian Government
Department of Defence

AECOM

DATUM GDA 1994, PROJECTION MGA ZONE 55



0 30 60 m
1 cm = 17 m (when printed @ A3)

 Groundwater monitoring well locations – Intermediate aquifer

Site Boundary -
Chain Wire Mesh Fence

— FTA Site Boundary

High : 14200 µg/L

High : 14200 µg/L

-Low : 5 µg/L

0.00 :TCE Concentration

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Property 0932: RAAF Williams - Point Cook

PROJECT #:	60657609 - VIC	<div style="text-align: center;"> VIC PROPERTY ID: 0932 Figure F26b </div>
CREATED BY:	prachi.kulkarni1	
LAST MODIFIED:	15/10/2021	
VERSION:	1	

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F26b



144°46'0"E

144°46'0"E



Australian Government
Department of Defence



DATUM GDA 1994, PROJECTION MGA ZONE 55



0 30 60 m
1 cm = 17 m (when printed @ A3)

Legend

- Groundwater monitoring well locations – Intermediate aquifer
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

VC Distribution

High : 62100 µg/L
Low : 50 µg/L

0.00 :VC Concentration

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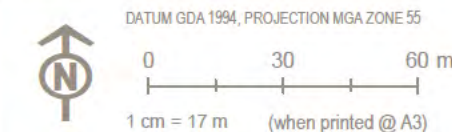
RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

**VC CONCENTRATION – INTERMEDIATE
AQUIFER (JUL-AUG 2021)**

PROJECT#:	60657609 - VIC
CREATED BY:	prachi.kulkarni1
LAST MODIFIED:	15/10/2021
VERSION:	1

VIC
PROPERTY ID: 0932
Figure F26c



 Groundwater monitoring well locations – Intermediate aquifer
 Estimated extent of shoreline erosion (July 2012)
 Site Boundary - Chain Wire Mesh Fence
 FTA Site Boundary

High : 3690 µg/L
Low : 1 µg/L

0.00 :Benzene Concentration

Data Sources:
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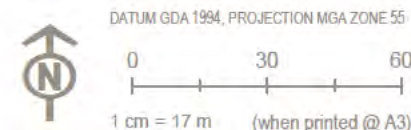
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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni1
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F26d



Legend

- Soil Vapour Well Locations - New
- Soil Vapour Well Locations - Existing
- Unable to locate/Not suitable for sampling
- Estimated extent of shoreline erosion (July 2012)
- Site Boundary - Chain Wire Mesh Fence
- FTA Site Boundary

Risk Ranking

- Very High
- Medium

Monitoring Zones

- 1, Up-gradient Background (UB)
- 2, General Site South West (GSSW)
- 3, Source Zone A (SZA)
- 4, Source Zone B (SZB)
- 5, General Site East (GSE)
- 6, Discharge Zone (DZ)
- 7, Parks Victoria (PV)

WHO (2000) Guidelines for Air Quality
USEPA RSL May 2021 Worker Air
ASC NEPM 2013 Interim HIL Soil Vapour - HIL D

Data Sources:
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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Williams - Point Cook

SOIL VAPOUR ANALYTICAL RESULTS

PROJECT #: 60657609 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F27

SV021			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<3.8	<43
1,1,2-trichloroethane	µg/m3	120	75
1,1-dichloroethane	µg/m3	130	620
1,1-dichloroethene	µg/m3	52	510
Chlorobenzene	µg/m3	<3.2	<37
Chloroform	µg/m3	72	150
cis-1,2-dichloroethene	µg/m3	880	23,000
Tetrachloroethene	µg/m3	1,700	1,000
Trichloroethene	µg/m3	1,000	16,000
trans-1,2-dichloroethene	µg/m3	<3.2	2,000
Vinyl chloride	µg/m3	330	<24

SV022			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<3.5	<3.1
1,1,2-trichloroethane	µg/m3	<4	7.7
1,1-dichloroethane	µg/m3	12	7.0
1,1-dichloroethene	µg/m3	<3	<2.6
Chlorobenzene	µg/m3	<3	<2.6
Chloroform	µg/m3	<4.5	<4
cis-1,2-dichloroethene	µg/m3	<4	6.3
Tetrachloroethene	µg/m3	<5.5	7.3
Trichloroethene	µg/m3	15	13
trans-1,2-dichloroethene	µg/m3	<3	<2.6
Vinyl chloride	µg/m3	<2	<1.8

SV006				
		Aug-15	Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<5.7	<3.8	<3.3
1,1,2-trichloroethane	µg/m3	<4.5	<4.3	7.6
1,1-dichloroethane	µg/m3	14	230	84
1,1-dichloroethene	µg/m3	<3.4	<3.2	<2.9
Chlorobenzene	µg/m3	<3.4	<3.2	15
Chloroform	µg/m3	5.1	<4.8	<4.3
cis-1,2-dichloroethene	µg/m3	<4.5	<4.3	<3.8
Tetrachloroethene	µg/m3	<6.3	<5.9	13
Trichloroethene	µg/m3	<5.1	<4.8	<4.3
trans-1,2-dichloroethene	µg/m3	8.2	<3.2	4.3
Vinyl chloride	µg/m3	<2.3	<2.2	<1.9

SV024			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<4.3	<3.6
1,1,2-trichloroethane	µg/m3	<4.9	<4.1
1,1-dichloroethane	µg/m3	14	4.8
1,1-dichloroethene	µg/m3	<3.7	<3
Chlorobenzene	µg/m3	<3.7	<3
Chloroform	µg/m3	6.8	6
cis-1,2-dichloroethene	µg/m3	110	<4.1
Tetrachloroethene	µg/m3	1,700	20
Trichloroethene	µg/m3	24	14
trans-1,2-dichloroethene	µg/m3	<3.7	3.6
Vinyl chloride	µg/m3	<2.5	<2

SV009				
		Aug-15	Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<680	280	80
1,1,2-trichloroethane	µg/m3	<540	140	73
1,1-dichloroethane	µg/m3	590	<3.5	24
1,1-dichloroethene	µg/m3	580	26	43
Chlorobenzene	µg/m3	<410	<3	<2.9
Chloroform	µg/m3	<610	25	12
cis-1,2-dichloroethene	µg/m3	10,000	46	180
Tetrachloroethene	µg/m3	170,000	1,100	980
Trichloroethene	µg/m3	50,000	470	680
trans-1,2-dichloroethene	µg/m3	5,700	<3	85
Vinyl chloride	µg/m3	<270	<2	<1.9

SV025			
		Nov-20	
1,1,2,2-tetrachloroethane	µg/m3	<3.3	
1,1,2-trichloroethane	µg/m3	<3.8	
1,1-dichloroethane	µg/m3	<3.3	
1,1-dichloroethene	µg/m3	<2.9	
Chlorobenzene	µg/m3	<2.9	
Chloroform	µg/m3	4.7	
cis-1,2-dichloroethene	µg/m3	5.3	
Tetrachloroethene	µg/m3	17	
Trichloroethene	µg/m3	12	
trans-1,2-dichloroethene	µg/m3	<2.9	
Vinyl chloride	µg/m3	<1.9	

SV026			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<3.5	<3.7
1,1,2-trichloroethane	µg/m3	100	71
1,1-dichloroethane	µg/m3	41	31
1,1-dichloroethene	µg/m3	26	14
Chlorobenzene	µg/m3	<3	<3.1
Chloroform	µg/m3	19	13
cis-1,2-dichloroethene	µg/m3	20	15
Tetrachloroethene	µg/m3	14	12
Trichloroethene	µg/m3	72	55
trans-1,2-dichloroethene	µg/m3	<3	8
Vinyl chloride	µg/m3	<2	<2.1

SV028			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<3.4	<3.8
1,1,2-trichloroethane	µg/m3	<3.9	10
1,1-dichloroethane	µg/m3	300	44
1,1-dichloroethene	µg/m3	<2.9	<3.2
Chlorobenzene	µg/m3	<2.9	7.4
Chloroform	µg/m3	16	15
cis-1,2-dichloroethene	µg/m3	<3.9	<4.3
Tetrachloroethene	µg/m3	6.1	31
Trichloroethene	µg/m3	16	8.2
trans-1,2-dichloroethene	µg/m3	<2.9	<3.2
Vinyl chloride	µg/m3	<1.9	<2.1

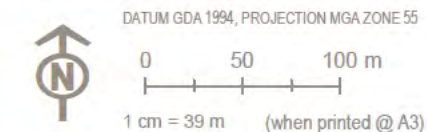
SV029			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<19	<35
1,1,2-trichloroethane	µg/m3	5,200	3,500
1,1-dichloroethane	µg/m3	16,000	13,000
1,1-dichloroethene	µg/m3	1,800	1,400
Chlorobenzene	µg/m3	<16	<30
Chloroform	µg/m3	540	370
cis-1,2-dichloroethene	µg/m3	1,500	550
Tetrachloroethene	µg/m3	520	390
Trichloroethene	µg/m3	4,900	3500
trans-1,2-dichloroethene	µg/m3	2,600	1800
Vinyl chloride	µg/m3	<11	<20

SV020			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<3.7	<3.3
1,1,2-trichloroethane	µg/m3	<4.3	14
1,1-dichloroethane	µg/m3	1,200	570
1,1-dichloroethene	µg/m3	15	3.9
Chlorobenzene	µg/m3	<3.2	<2.8
Chloroform	µg/m3	190	110
cis-1,2-dichloroethene	µg/m3	1,300	74
Tetrachloroethene	µg/m3	86	53
Trichloroethene	µg/m3	56	49
trans-1,2-dichloroethene	µg/m3	<3.2	210
Vinyl chloride	µg/m3	<2.1	<1.9

SV023			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<14	<38
1,1,2-trichloroethane	µg/m3	<16	<43
1,1-dichloroethane	µg/m3	13,000	13,000
1,1-dichloroethene	µg/m3	<12	1,500
Chlorobenzene	µg/m3	<12	<32
Chloroform	µg/m3	49	<49
cis-1,2-dichloroethene	µg/m3	3,500	2,700
Tetrachloroethene	µg/m3	<23	<60
Trichloroethene	µg/m3	<19	110
trans-1,2-dichloroethene	µg/m3	<12	2,600
Vinyl chloride	µg/m3	<8.2	<22

SV019			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<70	<7.9
1,1,2-trichloroethane	µg/m3	<80	<9
1,1-dichloroethane	µg/m3	20,000	4,200
1,1-dichloroethene	µg/m3	1,500	160
Chlorobenzene	µg/m3	<60	<6.8
Chloroform	µg/m3	<91	11
cis-1,2-dichloroethene	µg/m3	160	120
Tetrachloroethene	µg/m3	<110	<12
Trichloroethene	µg/m3	<91	52
trans-1,2-dichloroethene	µg/m3	<60	620
Vinyl chloride	µg/m3	<40	<4.5

SV027			
		Nov-20	May-21
1,1,2,2-tetrachloroethane	µg/m3	<4.2	<3.8
1,1,2-trichloroethane	µg/m3	<4.8	<4.3
1,1-dichloroethane	µg/m3	7,800	2,200
1,1-dichloroethene	µg/m3	510	39
Chlorobenzene	µg/m3	<3.6	<3.3
Chloroform	µg/m3	45	16
cis-1,2-dichloroethene	µg/m3	420	41
Tetrachloroethene	µg/m3	<6.6	7.8
Trichloroethene	µg/m3	2,000	230
trans-1,2-dichloroethene	µg/m3	930	150
Vinyl chloride	µg/m3	<2.4	<2.2



Legend

- Proposed surface water sampling locations
- Proposed pore water sampling locations
- Property boundary
- Waterbodies
- Fire Training Area

PFAS NEMP Marine 99%
Species ProtectionOVERVIEW
VICTORIA

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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Base Point Cook

SURFACE WATER / PORE WATER
ANALYTICAL RESULTS

PROJECT#: 60614548 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F28

PW100		Nov-20
PFOS	µg/L	0.26
PFOA	µg/L	0.02
PFHxS	µg/L	0.34
Sum of PFAS	µg/L	0.64

PW101		Nov-20
PFOS	µg/L	0.17
PFOA	µg/L	0.01
PFHxS	µg/L	0.24
Sum of PFAS	µg/L	0.51

PW102		Nov-20
PFOS	µg/L	3.51
PFOA	µg/L	0.09
PFHxS	µg/L	1.74
Sum of PFAS	µg/L	5.91

PW103		Nov-20
PFOS	µg/L	0.1
PFOA	µg/L	0.01
PFHxS	µg/L	0.2
Sum of PFAS	µg/L	0.35

PW104		Nov-20
PFOS	µg/L	0.67
PFOA	µg/L	<0.01
PFHxS	µg/L	1.07
Sum of PFAS	µg/L	1.89

PW105		Nov-20
PFOS	µg/L	117
PFOA	µg/L	5.13
PFHxS	µg/L	60.1
Sum of PFAS	µg/L	214

PW106		Nov-20
PFOS	µg/L	17.5
PFOA	µg/L	0.56
PFHxS	µg/L	6.02
Sum of PFAS	µg/L	27.6

PW112		Nov-20
PFOS	µg/L	3.22
PFOA	µg/L	0.15
PFHxS	µg/L	0.97
Sum of PFAS	µg/L	4.83

PW111		Nov-20
PFOS	µg/L	4.11
PFOA	µg/L	0.47
PFHxS	µg/L	5.17
Sum of PFAS	µg/L	12.6

PW110		Nov-20
PFOS	µg/L	0.11
PFOA	µg/L	0.02
PFHxS	µg/L	0.11
Sum of PFAS	µg/L	0.33

PW109		Nov-20
PFOS	µg/L	0.18
PFOA	µg/L	0.12
PFHxS	µg/L	0.69
Sum of PFAS	µg/L	1.14

SW003		Nov-20
PFOS	µg/L	7.6
PFOA	µg/L	1.1
PFHxS	µg/L	18
Sum of PFAS	µg/L	97.3

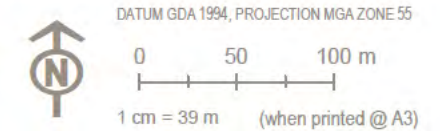
SW005		Nov-20
PFOS	µg/L	1.69
PFOA	µg/L	0.49
PFHxS	µg/L	21.9
Sum of PFAS	µg/L	87.3

SW006		Nov-20
PFOS	µg/L	1.67
PFOA	µg/L	0.53
PFHxS	µg/L	24.9
Sum of PFAS	µg/L	90.8

SW004		Nov-20
PFOS	µg/L	2.62
PFOA	µg/L	0.64
PFHxS	µg/L	25.7
Sum of PFAS	µg/L	91.3

SW001		Nov-20
PFOS	µg/L	7.71
PFOA	µg/L	1.3
PFHxS	µg/L	33.5
Sum of PFAS	µg/L	106

SW002		Nov-20
PFOS	µg/L	4.94
PFOA	µg/L	0.68
PFHxS	µg/L	23
Sum of PFAS	µg/L	88.4



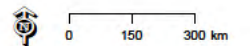
Legend

- Proposed Sediment Sampling Locations
- Property boundary
- Waterbodies
- Fire Training Area

Note:

(*) intralab duplicate results adopted as primary results due to higher concentrations

PFAS NEMP 2020 Public open space (HIL C)

OVERVIEW
VICTORIA

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RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report

Property 0932: RAAF Base Point Cook

SEDIMENT ANALYTICAL RESULTS

PROJECT#: 60614548 - VIC
CREATED BY: prachi.kulkarni
LAST MODIFIED: 15/10/2021
VERSION: 1

VIC
PROPERTY ID: 0932
Figure F29

SD006		Nov-20
PFOS	mg/kg	7.72*
PFOA	mg/kg	0.134*
PFHxS	mg/kg	1.01*
Sum of PFHxS and PFOS	mg/kg	8.73*
Sum of PFAS	mg/kg	9.29*

SD007		Nov-20
PFOS	mg/kg	1.82
PFOA	mg/kg	0.0217
PFHxS	mg/kg	0.308
Sum of PFHxS and PFOS	mg/kg	2.13
Sum of PFAS	mg/kg	2.42

SD008		Nov-20
PFOS	mg/kg	0.454
PFOA	mg/kg	0.0147
PFHxS	mg/kg	0.144
Sum of PFHxS and PFOS	mg/kg	0.598
Sum of PFAS	mg/kg	0.682

SD009		Nov-20
PFOS	mg/kg	0.878
PFOA	mg/kg	0.0130
PFHxS	mg/kg	0.148
Sum of PFHxS and PFOS	mg/kg	1.03
Sum of PFAS	mg/kg	1.11

SD010		Nov-20
PFOS	mg/kg	1.29
PFOA	mg/kg	0.0187
PFHxS	mg/kg	0.192
Sum of PFHxS and PFOS	mg/kg	1.48
Sum of PFAS	mg/kg	1.61

SD005		Nov-20
PFOS	mg/kg	0.0029
PFOA	mg/kg	<0.0002
PFHxS	mg/kg	0.0013
Sum of PFHxS and PFOS	mg/kg	0.0042
Sum of PFAS	mg/kg	0.0042

SD004		Nov-20
PFOS	mg/kg	0.0072
PFOA	mg/kg	<0.0002
PFHxS	mg/kg	0.0009
Sum of PFHxS and PFOS	mg/kg	0.0081
Sum of PFAS	mg/kg	0.0081

SD003		Nov-20
PFOS	mg/kg	0.0209
PFOA	mg/kg	0.0005
PFHxS	mg/kg	<0.0002
Sum of PFHxS and PFOS	mg/kg	0.0209
Sum of PFAS	mg/kg	0.022

SD002		Nov-20
PFOS	mg/kg	0.0006
PFOA	mg/kg	<0.0002
PFHxS	mg/kg	<0.0002
Sum of PFHxS and PFOS	mg/kg	0.0006
Sum of PFAS	mg/kg	0.0006

SD001		Nov-20
PFOS	mg/kg	0.0021
PFOA	mg/kg	0.0002
PFHxS	mg/kg	<0.0002
Sum of PFHxS and PFOS	mg/kg	0.0021
Sum of PFAS	mg/kg	0.0023



DATUM GDA 1994, PROJECTION MGA ZONE 55

0 50 100 m

1 cm = 29 m (when printed @ A3)

Legend

- Property boundary
- Waterbodies
- Channels and Drains
- Fire Training

Risk Ranking

- High

OVERVIEW VICTORIA

**RAAF Base Point Cook
Former Fire Training Area Audit (17174)
Audit Close Out Report**

Property 0932: RAAF Base Point Cook

UPDATED CRAT RISK RANKINGS

PROJECT #:	60657609 - VIC	VIC PROPERTY ID: 0932 Figure F30
CREATED BY:	prachi.kulkarni	
LAST MODIFIED:	2/09/2022	
VERSION:	1	

Appendix B

CRAT

Introduction

Context

Identify Risk

Consequence

Likelihood

Risk Evaluation

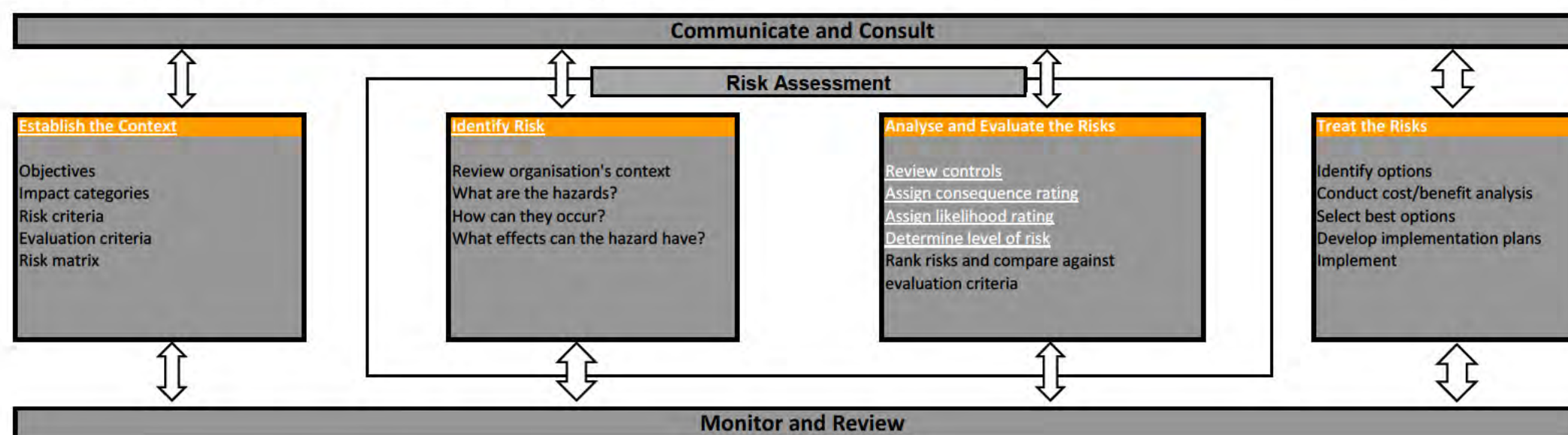
GUIDANCE

Introduction to the Risk Management Framework

The overall Defence risk management process is described in the E&IG Risk Management Process (see DEQMS for details) and follows the broad principles for environmental risk assessment under ISO 31000 Risk Management Standard. The use of the CRAT is aligned with the iterative site investigation process recommended in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended 2013). Pending the complexity of the Stage 1, and during Stage 2 and 3 site investigations, a Risk Assessment workshop is conducted where the associated site investigation report is used to work through the CRAT and assess the individual sites present at a property. Stakeholders for the workshop may include the Technical Adviser, Defence Project Manager, Defence Regional Environment and Sustainability Officer, property staff and the consultant undertaking the site investigation. This forms part of a management strategies workshop that discusses management strategies for the site or property, including remediation requirements, based on the outcomes of the CRAT.

The CRAT workshop should complete the first three stages of the risk management framework below by using the hyperlinks to sequentially move through the workbook. Once the level of risk has been determined this should be recorded in the CSR and used in the Contamination Assessment (Risk) Prioritisation Tool (CARPT) before proceeding to the final stage of the risk management framework (Treat the Risks).

The CRAT can also be used to support preliminary desktop assessment of potential contamination matters where there is limited information available. The CRAT provides a line of evidence to demonstrate systematic assessment of potential contamination matters to determine if further contamination investigation is required.



In this Workbook:

White cells	are for data entry; and
Grey cells	are automatically filled based on previous entries

Note: Do not drag cells around as this will break formula in the tool. Do not insert or delete columns or rows.

Introduction		Context	Identification	Consequence	Guidance	Risk Evaluation	Guidance
CRAT GUIDANCE							
Context Worksheet							
Context Worksheet	Information Field	Definition	Examples	Guidance Notes			
	Region	The region the Contaminated Site is located in.	Example: CW	Select either: 1. CW: Central West Region 2. NSW: Northern NSW Region 3. QLD: Queensland Region 4. NSW: Southern NSW Region 5. VIC: Victoria/Tasmania Region			
	Property Name	The Defence property name.	Example: CW-Cullina Training Area (CUTA)	1. The region has been placed in front of the property to assist with finding the relevant property. 2. If the property is not in the list then select New Property and type in the name overwriting the New Property list.			
	Property ID	The Defence DEMs property ID number as per July 2015.	Example: 655	1. The DEMs ID will populate automatically if the property is in the list.			
	Date of Assessment	Date that CRAT risk assessment was undertaken.	Example: 12 Dec 2016	1. Enter the date of the workshop and/or CRAT assessment.			
	Current or Future Land Use	The CRAT risk assessment can be either an assessment of the current use or it can assess future uses. A Current Land Use risk assessment assesses the current hazard condition in the environment and current activities. A Future assessment considers potential hazardous conditions resulting from future activity scenarios.	Example: Current	1. Select Current or Future Land Use from the drop down. 2. Current should be selected for risk assessments occurring where Defence's current land use and the associated activities are the subject of the risk assessment. 3. Future Land Use should be selected for risk assessments where future activity scenarios are being considered for the risk assessment. 4. This selection affects how the Contamination Hazard description is defined. 5. If there is a change in land use to a more sensitive land use, further contamination investigations and a new CRAT are required to determine the suitability of the site before development commences. Details about the change in land use and the associated Project ID and purpose should be captured in the CRAT Purpose summary also in the context page.			
	CRAT Purpose Summary	A short description providing context about the CRAT assessment including details such as the purpose the CRAT assessment is supporting, project details and stage of assessment the CRAT is supporting.	Example 1: The CRAT supports a Stage 1 assessment being completed for DCARM at RAUF Base Williams. Example 2: The CRAT supports a reassessment of Stage 2 data for the potential development of Defence property for residential development.	1. If there is a change in land use to a more sensitive land use, further contamination investigations and a new CRAT are required to determine the suitability of the site before development commences. Details about the change in land use and the associated Project ID and purpose should be captured in the CRAT Purpose summary also in the context page.			
	Uncertainty Comments	A short description regarding the confidence in the available data and the number of lines of evidence available.	Example: The data confidence is variable across the site. Northern portions of the site are uncertain and based on a site inspection and aerial photograph interpretation. Multiple lines of evidence have been collected and are presented in the Stage 1 report.				
	CRAT Workshop Attendees, Organisation and Role	The name, organisation and role of each person who participates in the risk assessment workshop.	Example: Joe Bloggs, DCARM, Defence project manager	1. At the completion of each stage of site investigation, a Risk Assessment workshop is conducted where the associated site investigation report is used to work through the CRAT and assess the individual sites present at a property. 2. Stakeholders for the workshop may include the Technical Adviser, Defence Project Manager, Defence Regional Environment and Sustainability Officer, the consultant undertaking the site investigation, EMOS contractor, PDS contractor and Defence personnel with the ability to determine non-environmental risk dimensions. E.g. WHS representative, Base operations staff.			
	Relevant reports used in the CRAT Workshop	The title, author and date of each report that supports the risk assessment.	Example: DCSR - Interim Screen Criteria for use on Defence properties, Department of Defence, 2016	1. Ensure all relevant reports are documented to provide evidence of the information supporting the risk assessment.			
Impact Category and Description	The DSO Regional Risk Management Framework relevant impact categories that risk is assessed against. See the Context Worksheet for full definition.	No example - information only					
Risk Matrix	The risk matrix is based on EAG Risk Management Process. See DEIMS for further explanations.	No example - information only					
Risk Identification Worksheet							
Risk Identification Worksheet	Information Field	Definition	Examples	Guidance Notes			
	CSR Number	The Contaminated Sites Register unique alpha numeric identifier.	Example: CSR_NSW_000xxx	1. Ensure consistent exact naming with existing CSR numbers. 2. For new CSR numbers, please send request to the NCRP mailbox: nrcrp@defence.gov.au before commencing the CRAT.			
	CSR Title	The CSR Title	Example 1: Fire Training Area Example 2: Fuel Storage Area Example 3: Old Landfill Example 4: Source Area D1 - Sulphur Dump.	1. Ensure consistent exact naming with existing CSR title. 2. For new CSR titles, please create a name that describes the contaminated site being assessed. 3. The name must be unique e.g. if two old landfills are present on the same property then they should be described to ensure clear definition e.g. Southern Old Landfill and Northern Old Landfill.			
	CSR Description	Description of the contaminated site.	Example 1: Landfill (approx. 1km x 250m) consists of a number of small dump sites. Waste includes demolition/construction waste, fibrous cement sheeting (containing Asbestos), plastic, architectural glass, tin cans, scrap metal, porcelain fragments, bitumen, vehicle parts, trees and old pipes. Example 2: Burning ground and burial trench for small arms ammunition and covers approx. 300m x 300m. Example 3: This area comprises of a former sulphur dump causing soil and groundwater contamination.	1. Develop a one to two sentence description of the CSR including the site and contamination materials. 2. For existing CSR sites, the existing description can be used or improved to meet the guidance communicated for this version of the CRAT.			
	Assessment / Remediation Stage	The CRAT is used for the following stages of assessment as per the Defence Contamination Management Manual: * Stage 1 Preliminary Site Investigation (Stage 1 PSI) * Stage 2 Detailed Site Investigation (Stage 2 DSI) * Stage 3 Risk Assessment/ Remediation Design * Stage 4 Remediation or Management Implementation	Example: Stage 1 Preliminary Site Assessment.	1. Select from the dropdown list. 2. An Assessment Stage is required to be selected in this tab of the worksheet in order to be able to complete the Environment Impact category Consequence and Likelihood Assessments. Once an Assessment Stage is selected here, the Consequence and Likelihood assessments can only be completed for the same Assessment Stage, all others will be greyed out and data will not be able to be entered. 3. The dropdown list does not include Stage 4. The reason for this is that CSRs may move to Stage 4 with varying levels of investigation having been completed. Therefore, for a CSR which is at Stage 4, select the prior assessment stage that best matches the level of investigation that has been completed, add a note to the "Context notes" column explaining the rationale for the selected Assessment Stage, and complete the CRAT using the available data but also taking into consideration how the Stage 4 Remediation/Management activities mitigate potential exposure risk.			
	Source Type (Identified Contaminating Activity)	The infrastructure or activity that released the identified contamination.	Example 1: Leaking UST. Example 2: Historic fire training practice. Example 3: Historic waste disposal practice.	1. Develop one sentence describing the activity or situation which was known or inferred to be the primary factor causing the contamination.			
	Secondary Source (Contaminated Environmental Media)	Contaminated environmental media that represent a source of potential exposure to humans, ecology, infrastructure etc.	Example 1: Free-phase product at the groundwater interface. Example 2: Discoloured phase groundwater contamination by metals.	Describe the environmental media that are known or have potential to be contaminated as a result of the primary source.			
	Contamination Hazard	The ASD NEPM 2013 defines a hazard as "the inherent property of a contaminant or situation having the potential to cause adverse effects when a population may be exposed to that contaminant". In this field, the CRAT user should briefly describe what is known or inferred about the hazard posed by environmental contamination, in terms of its nature and extent in the environment and how humans or ecology could interact with it in various media.	Example 1: Discoloured phase plume in groundwater extending 100m down-gradient from source area, which may discharge to surface water ecosystems, or be extracted by humans for domestic uses. Example 2: 100m ² of surface soil containing asbestos fragments/fibres following uncontrolled building demolition, which have the potential to generate dust which humans could breathe. Example 3: 10m ³ of uncontrolled landfill containing wastes that may leach to groundwater, and groundwater could subsequently discharge to surface water ecosystems, or surface waters where primary contact recreation activities occur. Example 4: 100m free phase product sheen on surface water of a river, which represents a sensitive ecosystem and is also used for extraction of irrigation water and recreation.	1. Develop a one sentence description of the contamination hazard being assessed. 2. The subsequent stages in the CRAT ask the user to characterise the consequences of human or ecological exposure to the identified contamination, and the likelihood that such exposure will occur. It is important to phrase the description of the contamination hazard in the context. 3. Contamination hazard is not described in terms of an event, but is the physical contamination matter. E.g. if asbestos is buried and there is a risk associated with uncontrolled digging exposing the asbestos, then the contamination hazard is human exposure to buried asbestos via dust inhalation. The contamination hazard is not the event of digging up buried asbestos. 4. The description developed will drive the risk rankings and a poor definition will lead to an inaccurate representation of the risk level. 5. The description should aim to expand on the previous identification of the secondary source by identifying the realistic worst case contamination hazard that is considered likely to drive risks for the CSR. For example, a leaking tank may cause localized soil contamination but extensive groundwater contamination, and it is the groundwater contamination that is the most substantial contamination hazard that is to be assessed. 6. The intent of this field is to facilitate a clear understanding of how the identified receptors might interact with the contamination and to focus the next stages of assessment on these source-pathway-receptor linkages. NOTE: CSRs that have no complete source-pathway-receptor linkages (or have sufficient evidence to indicate that there is no complete source-pathway-receptor linkage) have a negligible risk of impacting on receptors and are suitable for archiving. This will require professional judgement and the rationale must be captured in the relevant site investigation report. CSRs to be archived are not to be run through the CRAT to reduce potential confusion about Low (potentially complete/complete S-P-R link) and negligible risk (no S-P-R link and requiring no specific management).			
	Potential Human Health Receptors	A description of the human receptors that may encounter contamination associated with the CSR.	Example 1: Defence personnel on-site may come into direct contact with groundwater during trenching activities. Example 2: Off-site users of groundwater may be exposed to VOC contamination via the vapour inhalation pathway.	1. More than one human receptor can be listed. 2. Provide a one sentence description of the human receptors that may encounter contamination associated with the CSR, and where they are located in relation to the CSR Property (e.g. on-site, on-property, off-site)			

Information Field	Definition	Example	Guidance Notes
Human receptor considered to have greatest potential exposure risk	Based on the CSM and the available data (qualitative or quantitative) identify the human receptor and human health CoPC considered most likely to drive risk estimates for the CSR. See General Guidance notes below.	Example: Residential	1. Select from the drop down list 2. Completing the CRAT requires the assessor to consider the conceptual site model (CSM) for the CSR and use professional judgement to identify the source-pathway-receptor linkage that is most likely to drive risks for the CSR. A robust CSM is critical for completion of the CRAT at each Stage of assessment. At all stages, existing routine controls and management/monitoring plans that could influence whether exposure pathways are complete should be taken into consideration as part of the CSM. 3. The CSM needs to be considered when selecting both the Key CoPC and the receptors with the greatest potential exposure risk, to ensure that there is a potentially complete linkage for these that can be assessed in the CRAT.
Key Human Health CoPC Category (To modify Category you must delete Key Human Health CoPC)	The category that the Key CoPC for human health at the CSR being assessed falls under, based on the categories in the drop down list.	Example: Chlorinated Hydrocarbons.	1. Select from the dropdown list 2. You cannot select the Key Human Health CoPC until this drop down is selected. 3. To change the Category you must delete the Key Human Health CoPC first.
Key Human Health CoPC (Select Category of Key Human Health CoPC First)	The key CoPC that is considered most likely to drive risks to human receptors relevant to the CSR. There must be a potentially complete source-pathway-receptor linkage for the identified Key Human Health CoPC and the human receptor considered to have the greatest potential exposure risk. See General Guidance notes below.	Example: Trichloroethene (TCE).	1. Select from the dropdown list which is dependent on the previous dropdown. 2. To change the Category you must delete the Key Human Health CoPC first.
Potential Ecological Receptors	A description of the ecological receptors present at the site, and how they might be exposed to the contamination.	Example 1: Aquatic ecosystems in the adjacent river may directly contact free phase contamination. Example 2: Grazing and burrowing wildlife may directly ingest contaminated soil.	1. More than one ecological receptor can be presented. 2. Provide a one sentence description of the ecological receptor and potentially complete exposure pathways associated with typical activities.
Ecological receptor considered to have greatest potential exposure risk	Based on the CSM and the available data (qualitative or quantitative) identify the ecological receptor and ecological CoPC considered most likely to drive risk estimates for the CSR. See General Guidance notes below.	Example: Aquatic: Highly Disturbed Ecosystems.	1. Select from the drop down list 2. Completing the CRAT requires the assessor to consider the conceptual site model (CSM) for the CSR and use professional judgement to identify the source-pathway-receptor linkage that is most likely to drive risks for the CSR. A robust CSM is critical for completion of the CRAT at each Stage of assessment. At all stages, existing routine controls and management/monitoring plans that could influence whether exposure pathways are complete should be taken into consideration as part of the CSM. 3. The CSM needs to be considered when selecting both the Key CoPC and the receptors with the greatest potential exposure risk, to ensure that there is a potentially complete linkage for these that can be assessed in the CRAT.
Key Ecological CoPC Category (To modify Category you must delete Key Ecological CoPC)	The category that the Key CoPC for ecology at the CSR being assessed falls under, based on the categories in the drop down list.	Example: Chlorinated Hydrocarbons.	1. Select from the dropdown list 2. You cannot select the Key Ecological CoPC until this drop down is selected. 3. To change the Category you must delete the Key Ecological CoPC first.
Key Ecological CoPC (Select Category of Key Ecological CoPC First)	The primary CoPC that is considered most likely to drive risk estimates for ecological receptors relevant to the CSR. There should be a complete source-pathway-receptor linkage for the identified Key CoPC and the ecological receptor considered to have the greatest potential exposure risk. See General Guidance notes below.	Example: Trichloroethene (TCE).	1. Select from the dropdown list which is based on the previous drop down. 2. To change the Category you must delete the Key Ecological CoPC first.
Other Chemicals of Potential Concern	List other CoPC that have been identified in association with the CSR, but have not been used to complete the CRAT risk assessment.	Example: Metals, petroleum hydrocarbons and nutrients.	
Describe Routine Controls	For Current Land Use: A description of the routine controls currently in place that mitigate the contamination risk. May be implemented by Defence, or outside of Defence control and enforced by relevant regulatory authorities. For Future Land Use: The routine controls that are generally in place for the Defence land use activity being proposed. May be implemented by Defence, or outside of Defence control and enforced by relevant regulatory authorities.	Example 1: There is a standing order at the base that prevents extraction of groundwater. Example 2: All asbestos demolition is conducted in accordance with Defence Asbestos policy. Example 3: The CSR is fenced and signed to prevent unauthorised access. Example 4: Task specific PPE is required for Defence workers in the area as per requirement of e.g. the Base Standing Instructions (SI) that would also give increased protection against direct contact with environmental contamination.	1. The routine controls presented are to be directly applicable to the risk being considered in the assessment. 2. The routine control is to be taken into consideration when determining the likelihood of exposure. 3. Controls can be administrative or physical. 4. The way in which the routine control mitigates or reduces potential risk should be described. 5. This field should be completed in consultation with Base personnel, including but not limited to Base Managers (BM), responsible Environment and Sustainability personnel (ADES/ESMESO), Senior ADF Officers (SADFO), Estate Maintenance and Operation Services (EMOS) Contractors, who have an understanding of what controls are currently in place at CSR locations.
Context notes	Include notes that summarise any assumptions or limitations applied when completing the CRAT and that add to the understanding of the risk profile.	Example 1: CRAT is based on a desktop review with no sampling however there were exceedances reported for relevant CoPC from a previous investigation. Example 2: contamination has been identified but not fully delineated. Example 3: Limited and targeted sampling associated with a Stage 1 PSI is considered sufficient to complete the CRAT Consequence and Likelihood rankings based on the Stage 2 DSI level of assessment. Therefore the Assessment Stage has been set to Stage 2 DSI.	
General Guidance	NA	NA	1. Completing the CRAT requires the assessor to consider the conceptual site model (CSM) for the CSR and use professional judgement to identify the source-pathway-receptor linkage that is most likely to drive risks for the CSR. A robust CSM is critical for completion of the CRAT at each Stage of assessment. At all stages, existing routine controls and management/monitoring plans that could influence whether exposure pathways are complete should be taken into consideration as part of the CSM. 2. The CSM needs to be considered when selecting both the Key CoPC and the receptors with the greatest potential exposure risk, to ensure that there is a potentially complete linkage for these that can be assessed in the CRAT. The CRAT should only be completed using data that are representative of potentially complete source-pathway-receptor linkages. 3. For a Stage 1 PSI (which typically won't have sufficient analytical data to characterise the nature and extent of contamination), this will require qualitative consideration of the type of primary source, magnitude of potential release from the primary source, typical chemical fate and transport properties, and relative toxicity of the identified CoPC (where this information is available). 4. For a Stage 2 DSI, sufficient data is typically available to estimate concentrations relevant to the exposure point for each identified receptor, and compare these to relevant screening criteria to identify the CoPC/receptor combination most likely to drive risks for the CSR. The estimation of exposure point concentrations can include calculation of statistics or fate and transport modelling if sufficient data are available, and the assessor is responsible for using professional judgement and following relevant guidance when making this determination. Otherwise the maximum concentration relevant to each receptor may be conservatively adopted. Additionally, if there is uncertainty as to the exposure point concentrations in a Stage 2 DSI, multiple rows of the CRAT can be completed for the same CSR to evaluate the risk based on different exposure scenarios. 5. For a Stage 3 Risk Assessment, a NEPM-compliant risk assessment report will typically provide sufficient information to identify the risk driving source-pathway-receptor linkage. 6. For a CSR which is at Stage 4, select the prior assessment stage that best matches the level of investigation that has been completed, add a note to the "Context notes" column explaining the rationale for the selected Assessment Stage, and complete the CRAT using the available data but also taking into consideration how the Stage 4 Remediation/Management activities mitigate potential exposure risk.

Consequence	Information Field	Definition	Example	Guidance Notes
Consequence Worksheet	Information Field	Definition	Example	Guidance Notes
	General Guidance	NA	NA	<ol style="list-style-type: none"> When assessing the consequence, the impact needs to be considered with existing routine controls in place. The assessment of consequence will either consider the identified contamination hazard interacting with either current activities conducted at the property or proposed future activities (but not both). Whether the assessment is considering the current situation or future scenarios is recorded on the Context Worksheet under the Current or Future land use dropdown list. The CRAT user is not required to complete Consequence and Likelihood assessments for all Impact Categories. If sufficient information is not available to do so, if all Impact Categories are not completed, the CRAT risk assessment will be based on the highest risk identified from the Categories completed. Multiple rows of the CRAT can be completed to assess different CoPCs/receptors for a single CSR. This can assist the user with assessing risk for CSRs with complex CSMs, where the receptor and CoPC most likely to drive the final risk estimate and potential management actions is not clearly identifiable. The final CRAT risk outcome can then be selected and justified for use going forward.
	CSR ID # (FIELD AUTOMATICALLY POPULATED)	The Contaminated Sites Register unique alpha numeric identifier.	Example: CSR_NSW_000xxx	<ol style="list-style-type: none"> Ensure consistent exact naming with existing CSR numbers. For new CSR numbers, please send request to the NCRP mailbox (ncrp@defence.gov.au) before commencing the CRAT.
	Contamination Hazard (FIELD AUTOMATICALLY POPULATED)	<p>The ASC NEPM 2013 defines a hazard as "the inherent property of a contaminant or situation having the potential to cause adverse effects when a population may be exposed to that contaminant".</p> <p>In this field, the CRAT user should briefly describe what is known or inferred about the hazard posed by environmental contamination, in terms of its nature and extent in the environment and how humans or ecology could interact with it in various media.</p>	<p>Example 1: Dissolved phase plume in groundwater extending 100m down-gradient from source area, which may discharge to surface water ecosystems, or be extracted by humans for domestic uses.</p> <p>Example 2: 100m² of surface soil containing asbestos fragments/fibres following uncontrolled building demolition, which have the potential to generate dust which humans could breathe.</p> <p>Example 3: 10m³ of uncontrolled backfill containing wastes that may leach to groundwater, and groundwater could subsequently discharge to surface water ecosystems, or surface waters where primary contact recreation activities occur.</p> <p>Example 4: 100m free phase product sheen on surface water of a river, which represents a sensitive ecosystem and is also used for extraction of irrigation water and recreation.</p>	<ol style="list-style-type: none"> Develop a one sentence description of the contamination hazard being assessed. The subsequent steps in the CRAT ask the user to characterise the consequences of human or ecological exposure to the identified contamination, and the likelihood that such exposure will occur. It is important to phrase the description of the contamination hazard in this context. Contamination hazard is not described in terms of an event, but is the physical contamination matter. E.g. if asbestos is buried and there is a risk associated with uncontrolled diggings exposing the asbestos, then the contamination hazard is human exposure to buried asbestos via dust inhalation. The contamination hazard is not the event of digging up buried asbestos. The description developed will drive the risk rankings and a poor definition will lead to an inaccurate representation of the risk level. The description should aim to expand on the previous identification of the secondary source by identifying the realistic worst case contamination hazard that is considered likely to drive risks for the CSR. For example, a leaking tank may cause localised soil contamination but extensive groundwater contamination, and it is the groundwater contamination that is the most substantial contamination hazard that is to be assessed. The intent of this field is to facilitate a clear understanding of how the identified receptors might interact with the contamination and to focus the next stages of assessment on these source-pathway-receptor linkages. <p>NOTE: CSRs that have no complete source-pathway-receptor linkages (or have sufficient evidence to indicate that there is no complete source-pathway-receptor linkage) have a negligible risk of impacting on receptors and are suitable for archiving. This will require professional judgement and the rationale must be captured in the relevant site investigation report. CSRs to be archived are not to be run through the CRAT to reduce potential confusion about Low (potentially complete/complete S-P-R link) and negligible risk (no S-P-R link and requiring no specific management).</p>
	Consequence Assessment - Environment Impact Category Contamination causes unacceptable impacts on environment and human health. See below for consequence levels defined under various Stages of Assessment described in Defence Contamination Management Manual.			
	Environment - Stage 1 Preliminary Site Investigation Human receptor considered to have greatest potential exposure risk (FIELD AUTOMATICALLY POPULATED)	<p>Based on the information and lines of evidence collected during the Stage 1, identify the human receptor and CoPC considered most likely to drive risk estimates for the CSR. There must be a potentially complete source-pathway-receptor linkage for the identified Key Human Health CoPC and the human receptor considered to have the greatest potential exposure risk.</p> <p>The consequence classification is based on the combination of the sensitivity of the human receptor and the human health toxicity classification of the Key CoPC.</p> <p>Consequence rankings for environmental impacts associated with the contamination hazard are to be assessed in consideration of existing controls at the site. The consequence rankings, drop down selections and associated consequence definitions are as follows:</p> <ul style="list-style-type: none"> Severe Residential, Agriculture or Recreation land uses. The potential or confirmed source-pathway-receptor has a receptor which has residential, agriculture, or recreation land uses AND the Key Human CoPC has a High toxicity classification. Major Residential, Agriculture or Recreation land uses. The potential or confirmed source-pathway-receptor has a receptor which has residential, agriculture or recreation land uses AND the Key Human CoPC has a Moderate toxicity classification. Moderate Commercial/ Industrial, Defence Outdoor Training or Infrequent Visitors. The potential or confirmed source-pathway-receptor has a receptor with Commercial/ Industrial, Defence Outdoor Training or Infrequent Visitors land uses AND the Key Human CoPC has a High toxicity classification. Minor Commercial/ Industrial, Defence Outdoor Training or Infrequent Visitors. The potential or confirmed source-pathway-receptor has a receptor with Commercial/ Industrial, Defence Outdoor Training or Infrequent Visitors land uses AND the Key Human CoPC has a Moderate toxicity classification. Insufficient No complete Source-Pathway-Receptor linkage. There is no potential or confirmed complete source-pathway-receptor linkage. 	Example: Residential.	<ol style="list-style-type: none"> Conceptual Site Model developed in Stage 1 PSI identifies potential source and receptor however whether there is a complete pathway requires further assessment. If sufficient sampling analysis data are available, the CRAT user can change the Assessment Stage to Stage 2 in the Risk Identification tab and complete the Consequence assessment on the basis of comparison with screening criteria. The rationale for doing this should be clearly captured in the Context Notes on the Risk Identification tab for the CSR. The following should be considered when making this determination: <ol style="list-style-type: none"> A PSI with limited sampling that is insufficient to rule out needing to move on to a Stage 2 DSI = complete the CRAT for this CSR based on the Stage 1 descriptors. A PSI with limited sampling that is adequate to rule out needing to move on to a Stage 2 DSI = complete the CRAT for this CSR based on the Stage 2 DSI descriptors. The Environment Impact Category is assessed on the basis of the potential for health effects associated with chronic exposure to the contamination hazard. Other hazards that may be associated with contamination (such as acute exposure, physical hazards, biological hazards or radiological hazards) can be considered within the Safety Impact Category.
	Relative human toxicity of Key Human Health CoPC (FIELD AUTOMATICALLY POPULATED)	<p>The CoPC were assigned a relative human health toxicity ranking (low, moderate or high) based on a review of threshold and non-threshold toxicity reference values (TRV) sourced from Australian guidance (ASC NEPM 2013) supplemented by US EPA guidance (June 2017 RSLs). The rankings were assigned using professional judgement to apply the following ranking criteria:</p> <ul style="list-style-type: none"> High: Tolerable daily intake (TDI) equal to or less than 0.0005 mg/kg/day and/or tolerable concentration (TC) less than 0.0004 mg/m³ and/or cancer slope factor (CSF) greater than 0.2 (mg/kg/day)-1 and/or inhalation unit risk (IUR) greater than 0.0004 (µg/m³)-1 Moderate: TDI between 0.05 and 0.0005 mg/kg/day and/or TC between 0.4 and 0.0004 mg/m³ and/or CSF between 0.002 and 0.2 (mg/kg/day)-1 and/or IUR between 0.0004 and 0.000004 (µg/m³)-1 Low: TDI between 5 and 0.05 mg/kg/day and/or TC between 0.4 and 40 mg/m³ and/or CSF less than 0.002 (mg/kg/day)-1 and/or IUR less than 0.000004 (µg/m³)-1 <p>CoPC representing groups of chemicals were assigned to a toxicity ranking using professional judgement and taking into account the potential toxicity of the common constituents (e.g. petroleum mixtures were ranked based on the toxicity of benzene).</p> <p>The toxicity criteria above were based on the distribution of the TRV for the CoPC listed, rather than a review of the hazard associated with each chemical. These are therefore relative toxicity rankings only and should only be interpreted in the context of this tool, they are not intended for evaluation risk on a chemical-specific or site-specific basis.</p>	Example: High.	1. Relevant to human health only.
	Ecological receptor considered to have greatest potential exposure risk (FIELD AUTOMATICALLY POPULATED)	<p>Based on the information and lines of evidence collected during the Stage 1, identify the ecological receptor and CoPC considered most likely to drive risk estimates for the CSR. There must be a potentially complete source-pathway-receptor linkage for the identified Key Ecological CoPC and the ecological receptor considered to have the greatest potential exposure risk.</p> <p>The consequence classification is based on the most sensitive ecological receptor via a potential or confirmed source-receptor pathway. Insufficient information is currently available to rank the ecological toxicity of the Key Ecological CoPC.</p> <p>Consequence rankings for environmental impacts associated with the contamination hazard are to be assessed in consideration of existing controls at the site. The consequence rankings, drop down selections and associated consequence definitions are as follows:</p> <p>Terrestrial</p> <ul style="list-style-type: none"> Severe Areas of ecological significance. The potential or confirmed source-pathway-receptor has a receptor which is an area of ecological significance. Major Not used for terrestrial ecological receptors. Moderate Urban Residential, Public Open Space or Agriculture. The potential or confirmed source-pathway-receptor has a receptor which is an area of urban residential, public open space or agricultural land use. Minor Commercial/ Industrial, Defence Outdoor Training. The potential or confirmed source-pathway-receptor has a receptor with commercial/ industrial, Defence outdoor training land uses. Insufficient No complete Source-Pathway-Receptor linkage. There is no potential or confirmed complete source-pathway-receptor linkage for terrestrial ecosystems. <p>Aquatic</p> <ul style="list-style-type: none"> Severe High conservation/ Ecological value. The potential or confirmed source-pathway-receptor has an aquatic ecosystem which is an area of High conservation or Ecological value. Major Slightly to moderately disturbed ecosystem. The potential or confirmed source-pathway-receptor has a receptor which is a slightly to moderately disturbed aquatic ecosystem. Moderate Not used for aquatic ecological receptors. Minor Highly disturbed ecosystem. The potential or confirmed source-pathway-receptor has a receptor which is a highly disturbed aquatic ecosystem. Insufficient No complete Source-Pathway-Receptor linkage. There is no potential or confirmed complete source-pathway-receptor linkage for aquatic ecosystems. 	Example: Terrestrial: Areas of ecological significance.	<ol style="list-style-type: none"> Conceptual Site Model developed in Stage 1 PSI identifies potential source and receptor however whether there is a complete pathway requires further assessment. If sufficient sampling analysis data are available, the CRAT user can change the Assessment Stage to Stage 2 in the Risk Identification tab and complete the Consequence assessment on the basis of comparison with screening criteria. The rationale for doing this should be clearly captured in the Context Notes on the Risk Identification tab for the CSR.

Information Field	Definition	Example	Guidance Notes
Environment - Stage 2 Invasive Sampling and Analysis Investigation	<p>For the identified Key Human Health CoPC and receptor with greatest potential exposure risk, are Tier 1 human health criteria exceeded by the key CoPC in any environmental media?</p> <p>Based on the CSM and the Stage 2 DSI data identify the human receptor and human health CoPC considered most likely to drive risk estimates for the CSR. For a Stage 2 DSI, sufficient data is typically available to estimate concentrations relevant to the exposure point for each identified receptor, and compare these to relevant screening criteria to identify the CoPC/receptor combination most likely to drive risks for the CSR. The estimation of exposure point concentrations can consider spatial and temporal variations and include calculation of statistics or fate and transport modelling if sufficient data are available, and the assessor is responsible for using professional judgement and following relevant guidance when making this determination. Otherwise the maximum concentration relevant to each receptor may be conservatively adopted. Determine whether the key CoPC exceeds human health screening criteria, and if so, by what magnitude. The consequence ranking drop down selections and associated consequence definitions are as follows:</p> <ul style="list-style-type: none"> Severe Yes, by more than 100 times OR visible asbestos containing materials OR measurable free phase. Major Yes, by between 10 to 100 times. Moderate Yes, by between 2.5 to 10 times. Minor Yes, by up to 2.5 times. Insignificant No, maximum concentration is less than the Tier 1 criterion. 	<p>Example 1: Analytical testing of samples identified the following maximum detected concentrations in soil at the point that the receptor could be exposed:</p> <p>CoPC Arsenic: 100 mg/kg Cadmium: 2,000 mg/kg Copper: 100,000 mg/kg</p> <p>The Tier 1 assessment criteria for these contaminants are: Arsenic: 3,000 mg/kg Cadmium: 500 mg/kg Copper: 240,000 mg/kg</p> <p>Cadmium is the risk driving CoPC in this group as it exceeds the Tier 1 criterion by 2.2 times. Therefore the drop down list is used to select "Yes, by up to 2.5 times".</p>	<p>1. For the Key Human Health CoPC identified at the "Risk Identification" step: a) Identify the maximum concentration to which the identified receptor with the greatest potential exposure risk could be exposed. This should be the concentration considered most representative of the point at which the identified receptor could be exposed, with consideration of data gaps and uncertainties. b) Compare this maximum concentration with the relevant Tier 1 screening criteria. c) Identify whether the Tier 1 criteria are exceeded, and if so, by what magnitude. d) Select from the drop down list the Consequence ranking that corresponds with the results for the Key Human Health CoPC that would drive the risk assessment outcome.</p> <p>2. Averaging and/or selection of data that best represent the concentration at the receptor will require professional judgement and should follow the principles outlined in the ASC NEPM 2013. Any assumptions made in selecting the representative data set should be recorded in the Risk Identification context notes.</p> <p>3. Use the following column to describe the environmental data that were considered most representative of the exposure point concentration and were used to select the Consequence ranking for human health.</p> <p>4. The Environment Impact Category is assessed on the basis of the potential for health effects associated with chronic exposure to the contamination hazard. Other hazards that may be associated with contamination (such as acute exposure, physical hazards, biological hazards or radiological hazards) can be considered within the Safety Impact Category.</p>
Are Tier 1 criteria for the most sensitive ecological receptor exceeded by the Key Ecological CoPC in any environmental media?	<p>Based on the CSM and the Stage 2 DSI data identify the ecological receptor and ecological CoPC considered most likely to drive risk estimates for the CSR. For a Stage 2 DSI, sufficient data is typically available to estimate concentrations relevant to the exposure point for each identified receptor, and compare these to relevant screening criteria to identify the CoPC/receptor combination most likely to drive risks for the CSR. The estimation of exposure point concentrations can consider spatial and temporal variations and include calculation of statistics or fate and transport modelling if sufficient data are available, and the assessor is responsible for using professional judgement and following relevant guidance when making this determination. Otherwise the maximum concentration relevant to each receptor may be conservatively adopted. Determine whether the key CoPC exceeds ecological screening criteria, and if so, by what magnitude. The consequence ranking drop down selections and associated consequence definitions are as follows:</p> <ul style="list-style-type: none"> Severe Yes, by more than 100 times. Major Yes, by between 10 to 100 times. Moderate Yes, by between 2.5 to 10 times. Minor Yes, by up to 2.5 times. Insignificant No, maximum concentration is less than the Tier 1 criterion. 	<p>Example: See above for example of the principle of calculations substituting in appropriate ecological criteria.</p>	<p>1. For the Key Ecological CoPC identified at the "Risk Identification" step: a) Identify the maximum concentration to which the identified receptor with the greatest potential exposure risk could be exposed. This should be the concentration considered most representative of the point at which the identified receptor could be exposed, with consideration of data gaps and uncertainties. b) Compare this maximum concentration with the relevant Tier 1 screening criteria. c) Identify whether the Tier 1 criteria are exceeded, and if so, by what magnitude. d) Select from the drop down list the Consequence ranking that corresponds with the results for the Key Ecological CoPC that would drive the risk assessment outcome.</p> <p>2. Averaging and/or selection of data that best represent the concentration at the receptor will require professional judgement and should follow the principles outlined in the ASC NEPM 2013. Any assumptions made in selecting the representative data set should be recorded in the Risk Identification context notes.</p> <p>3. Use the following column to describe the environmental data that were considered most representative of the exposure point concentration and were used to select the Consequence ranking for ecology.</p>
Environment - Stage 3 Risk Assessment	<p>Quantitative Human Health Risk Assessment Outcomes for Most Sensitive Receptor</p> <p>The Stage 3 human health risk assessment report should present conclusions as an estimated Hazard Index (HI) and/or increased Lifetime Cancer Risk (ILCR) for cumulative exposure to the identified CoPC. The consequence classification is based on how these risk estimates compare with the acceptable or tolerable risk limits specified in the ASC NEPM 2013 (i.e. a HI of 1 or an ILCR of 1 in 100,000). The consequence ranking drop down selections and associated consequence definitions are as follows:</p> <ul style="list-style-type: none"> Severe HI>100 and ILCR>1E-03. Major 10<HI<100 and 1E-04<ILCR<1E-03. Moderate 1<HI<10 and 1E-05<ILCR<1E-04. Minor 0.1<HI<1 and 1E-06<ILCR<1E-05. Insignificant HI<0.1 and ILCR<1E-06. 	<p>Example 1: An example of the data and calculation is presented below:</p> <p>HI from Tier 2 HHRA HI = 1</p> <p>ILCR from Tier 2 HHRA ILCR = 5E-05</p> <p>Based on the ILCR, select the drop down box for "1<HI<10 and 1E-05<ILCR<1E-04".</p>	<p>1. The Environment Impact Category is assessed on the basis of the potential for health effects associated with chronic exposure to the contamination hazard. Other hazards that may be associated with contamination (such as acute exposure, physical hazards, biological hazards or radiological hazards) can be considered within the Safety Impact Category.</p>
Ecological Risk Assessment Outcomes for Most Sensitive Receptor	<p>An ecological risk assessment report may present the outcomes as a qualitative or quantitative risk characterisation. This could include Tier 1 comparison to published screening criteria relevant to different ecological receptors or hazard indices based on the outcomes of food web modelling, for bioaccumulative chemicals. To account for this potential variability in approach, the consequence classifications are based on comparison of ecological risk assessment outcomes to acceptable or tolerable limits. The ecological risk assessor should be consulted for assistance with selecting the appropriate classification. The consequence ranking drop down selections and associated consequence definitions are as follows:</p> <ul style="list-style-type: none"> Severe Exposure level exceeds acceptable limits by more than two orders of magnitude. Major Exposure level exceeds acceptable limits by one to two orders of magnitude. Moderate Exposure level exceeds acceptable limits by up to one order of magnitude. Minor Exposure level less than acceptable limits by up to one order of magnitude. Insignificant Exposure level less than acceptable limits by more than one order of magnitude. 	<p>Example 1: An example of the data and calculation is presented below:</p> <p>Tier 1 ERA The maximum concentration of PFAS in surface water exceeds the adopted screening criteria by a factor of 10.</p> <p>Tier 2 ERA Food web modelling of PFAS accumulation through the food chain and exposure of piscivorous birds indicates a hazard index of 23 (where a hazard index of 1 is considered to indicate acceptable risk).</p> <p>Based on the Tier 2 ERA, elect the drop down box for "Exposure level exceeds acceptable limits by one to two orders of magnitude".</p>	
Consequence Assessment - Other Impact Categories			
Capability <ul style="list-style-type: none"> Ability for mission essential tasks to be completed in accordance with Defence Directives. Capacity of the facility to support the user unit in delivery of its primary outputs. Impact on the ability of the ADF to protect Australia and fulfil its national security obligations. Impact on the ADF's ability to train and equip for war and for the conduct of peacetime operations. Impact on the ability of Defence to develop its capability as detailed in the Defence White Paper. Impact on Civil (non-Defence) Capability as a consideration for shared facilities. 	Short Text	<p>The drop down selection is used to select the Consequence ranking:</p> <ul style="list-style-type: none"> Severe Major Moderate Minor Insignificant <p>The associated description from the Defence Risk Management Framework is shown in the adjacent cell.</p>	
	Description	<p>Full description (lookup) of short text above.</p> <ul style="list-style-type: none"> A strategically important operational capability is functionally unfit for its intended purpose (i.e. unable to perform core mission or essential tasks) due to estate or E&G and Defence service failure(s). A strategically important operational capability is partially functional due to estate failure(s) - i.e. is not fit for purpose and requires significant workarounds that limits the performance of some key missions or essential tasks. A strategically important operational capability requires enduring workarounds due to estate failure(s), which impacts the performance of some key missions or essential tasks. A strategically important capability is supported by the estate for all desired missions or tasks, but there would be some qualification to the level it would perform non-critical elements of the mission or task. Minimal capabilities are curtailed. Missions, training or activities can be conducted with minor degradation to several mission or training requirements. 	
Delivery of Services <ul style="list-style-type: none"> Impact on the delivery of services provided to customer units / facilities / training areas. Impact on Defence's ability to deliver an affordable and sustainable estate and reducing the overall estate liability in the long-term. Impact on achieving reductions in capability support costs. 	Short Text	<p>The drop down selection is used to select the Consequence ranking:</p> <ul style="list-style-type: none"> Severe Major Moderate Minor Insignificant. <p>The associated description from the Defence Risk Management Framework is shown in the adjacent cell.</p>	
	Description	<p>Full description (lookup) of short text above</p> <ul style="list-style-type: none"> Would have a severe impact on the ability of E&G and Defence to provide services to our customers. Greater than 20% of essential national tasks will not be achieved. Would have a major impact on the ability of E&G and Defence to provide services to our customers. 10% - 20% of national essential tasks will not be achieved. Would have a moderate impact on the ability of E&G and Defence to provide services to our customers. 5% - 10% of essential regional tasks will not be achieved. Would have a minor impact on the ability of E&G and Defence to provide services to our customers. Less than 5% of essential tasks will not be achieved. Would have an insignificant impact on the ability of E&G and Defence to provide services to our customers. Some non-essential tasks will not be able to be achieved. 	

Information Field	Definition	Example	Guidance Notes
Financial • An assessment of the potential for increased costs that would be incurred if the works or services were not performed during the specified period. This includes costs effectively directly related to the work itself and any flow on costs that may result if the works are not performed. • Short-term cost of prevention vs. long-term cost of recovery. This would also cover reductions in costs and return on investment (i.e. shorter payback period if work performed now, costs now for long term savings).	Short Text The drop down selection is used to select the Consequence ranking: • Severe • Major • Moderate • Minor • Insignificant The associated description from the Defence Risk Management Framework is shown in the adjacent cell.		
	Description Cost range linked to (lookup) short text above • >\$4M increase in financial liability • >\$2M increase in financial liability • >\$100K increase in financial liability • >\$25K increase in financial liability • <\$25K increase in financial liability	• Example 1: An underground storage tank is releasing 5,000 L of fuel per year. The cost for clean-up is estimated to be 250 K, but as a result of the continued release is expected to be between \$25 K and \$100 K greater than this in 12 months' time. In this case a \$250 K liability is noted in the context tab, and a consequence rating of 'Minor' (>\$25 K) entered as the input to the financial risk dimension. • Example 2: The financial liability for an asbestos in soil issue has been estimated at \$5 M based on off-site disposal to a local landfill. In 12 months' time, the legislation will be changing and asbestos contaminated soil will no longer be accepted by the local landfill. As a result, an onsite engineered containment facility is the next best option but will cost \$8 M. A \$5 M liability is noted in the context tab, and a consequence rating of 'Major' (>\$2 M) entered as the input to the financial risk dimension. • Example 3: A heavily used rifle range has a lead contaminated stop butt that is eroding and causing lead contaminated sediment to be released along connected local drainage channels. The cost of de-leading, clean-up of contaminated sediments and establishment of erosion controls is \$100 K. This cost is expected to increase by up to \$10 K per year as more sediments become mobilised. A \$100 K liability is noted in the context tab, and a consequence rating of 'Insignificant' (<\$25 K) entered as the input to the financial risk dimension.	1. The consequence for this Impact Category should be assessed on the basis of potential increases in financial liability associated with the contamination hazard, not the total magnitude of the liability. 2. The total magnitude of the liability should, however, be recorded in the CRAT Context Notes column of the Risk Identification tab. 3. Consider both a) potential increases in cost if the contamination hazard is not managed; and b) short term cost of prevention vs long-term cost of recovery.
Legislative Compliance • Compliance with regulatory requirements and the impact of failing to comply. Including but not limited to federal, state, territory, local, foreign treaty, indigenous land use agreements, Defence instructions or contracts. Matters for consideration include whether or not the base or site: • is currently breaching one or more laws, agreements etc.; • in the absence of some remedial work will shortly be contravening a legislative or other obligation; or • needs work to be completed within or by some specified time to ensure that it remains compliant with all obligations.	Short Text The drop down selection is used to select the Consequence ranking: • Severe • Major • Moderate • Minor • Insignificant The associated description from the Defence Risk Management Framework is shown in the adjacent cell.		
	Description Full description (lookup) of short text above • Multiple breaches of legislation that have the potential for prosecution or civil class actions. • Breach of legislation that has potential for prosecution and/or civil action. • Breach of legislation with potential for sanction, but no potential for prosecution; and/or Non-compliance with Departmental Policy. • Technical breach of legislation without potential for sanction or prosecution.		In the context of the CRAT the reference to "remedial work" in the description of this Impact Category refers to management actions intended to mitigate exposure to the contamination hazard. This could range from precautionary advice to avoid exposure pathways through to active remediation works to clean up contamination.
Reputation • Impact on Defence's reputation in provision of E&IG and Defence services, political and media attention to E&IG and Defence service delivery matters, community concerns or actions over activities. • Impact on compliance with government commitments as opposed to specific government policy / legislation.	Short Text The drop down selection is used to select the Consequence ranking: • Severe • Major • Moderate • Minor • Insignificant. The associated description from the Defence Risk Management Framework is shown in the adjacent cell.		
	Description Full description (lookup) of short text above • Sustained detrimental international or national media reports with lasting impact on public confidence or reputation of E&IG and Defence. • Detrimental national or state media reports impacting on public confidence or reputation of E&IG and Defence. • Limited detrimental national or state media reports; or Government and or Ministers express some dissatisfaction with E&IG and Defence. • Detrimental local media reports; or Subject of local government complaints; or Random substantiated complaints from the community. • Low profile detrimental local media reports; or Trivial substantiated complaints from the community; or Stakeholder relationships.		
Safety • Impact on the physical and psychological well being of ADF and APS employees, contractors, visitors, communities in Defence regions and the public in general, that results from the liability of E&IG and Defence to deliver agreed products and services and meet its obligations under the WHS Act 2011.	Short Text Short text dropdown of full descriptions below: • Severe: Multiple fatalities or 10+ 'critical' injuries. • Major: Single fatality/permanent disability or 10+ 'major' injuries. • Moderate: Serious injury or 10+ 'moderate' injuries. • Minor: Injury or 10+ 'minor' injuries. • Insignificant: Minor injury treated with first aid.	Example 1: Historic landfill contains building demolition waste materials which pose a hazard of injury via cuts and abrasions. However the area is fenced off and signposted to prevent unauthorised access. Example 2: Corrosive liquids have been spilled at the ground surface and are present in surface soil. These may pose an acute dermal contact hazard for workers without appropriate protective equipment. However the area has been demarcated with fencing and signage to prevent unauthorised access. Remediation workers are required to wear personal protective equipment, including hand protection and protective footwear.	1. Potential risks to health from long term (chronic) exposure to contamination have been considered in the assessment of human health in the Environment Category. It is therefore suggested that when completing the Safety Impact Category, chronic risks to health from chronic exposure to contamination are excluded, and consideration is instead given to risks associated with acute exposure to contamination, or other hazards (e.g. physical, biological etc) associated with the CSR that may result in health impacts occurring in a short time frame. 2. Consider incidents that have been reported to date as well as whether health and safety incidents may occur in the future. 3. Take into account routine controls that may mitigate the potential for health and safety incidents to occur.
	Description Full description (lookup) of short text above • Multiple fatalities OR 10 or more injuries/illnesses categorised as 'critical'. • Single fatality and/or permanent total disability OR 10 or more injuries or illnesses categorised as 'major'. • Serious injury or illness requiring immediate admission to hospital as an inpatient and/or permanent partial disability OR 10 or more injuries/illnesses categorised as 'moderate'. • Injury or illness causing no permanent disability, which requires nonemergency medical attention by a registered health practitioner OR 10 or more injuries or illnesses categorised as 'minor'. • Minor injury or illness that is treatable in the workplace (first aid) or by a registered health practitioner, with no follow up treatment required.		
Security • Impact on the physical security of Defence facilities and bases that results from the liability of E&IG and Defence to effectively maintain or implement the mandated security controls articulated in the Defence Security Manual.	Short Text The drop down selection is used to select the Consequence ranking: • Severe • Major • Moderate • Minor • Insignificant The associated description from the Defence Risk Management Framework is shown in the adjacent cell.		
	Description Full description (lookup) of short text above • Would cause exceptionally grave security incident with national and international attention that has a significant impact on the reputation of E&IG and Defence; or Destruction or damage to physical assets or infrastructure sufficient to prevent delivery of a Defence outcome for a protracted period. • Would cause serious security incident with long term ongoing national attention that has a major impact on the reputation of E&IG and Defence; or Destruction or damage to physical assets or infrastructure causing significant impact on delivery of Defence's outcomes. • Would cause security incident with short term national attention that has a moderate impact on the reputation of E&IG and Defence; or Damage to physical assets or infrastructure impacting on delivery of Defence's outcomes. • Would cause minor security incident with short term local attention that has a minor impact on the reputation of E&IG and Defence; or Damage to physical assets or infrastructure resulting in manageable delays in achieving organisational objectives. • Would cause minor security incident with that has no impact on the reputation of E&IG and Defence; or Damage to physical assets or infrastructure resulting in inconvenience but no impact on achievement of organisational objectives.	Example 1: Free phase product has leaked from an underground storage tank into the subsurface in an area where critical utilities are present that service a Defence facility with a key role in national security. Free phase product may permeate plastic utility pipes and taint water supply. Water supply has been 'turned off' to the facility while investigations are undertaken, resulting in minor disruption to workers in the Defence security facility that may cause delays in processing critical information. Example 2: potential vapour intrusion risks from TCE formerly used as a degreaser have resulted in the evacuation of a Defence facility with a key role in national security while further remediation measures are implemented and monitoring conducted to verify the risks have been minimised. The facility is unable to undertake it's security role until remediation is completed and verified.	1. Consider whether the identified contamination may directly or indirectly affect Defence physical assets or infrastructure that play a role in national and international security.

Likelihood	Information Field	Definition	Example	Guidance Notes
Likelihood Worksheet	Information Field	Definition	Example	Guidance Notes
	CSR ID # (FIELD AUTOMATICALLY POPULATED)	The Contaminated Sites Register unique alpha numeric identifier.	Example: CSR_NSW_000xx	1. Ensure consistent exact naming with existing CSR numbers. 2. For new CSR numbers, please send request to the NCRP mailbox [ncrp@defence.gov.au] before commencing the CRAT.
	Contamination Hazard (FIELD AUTOMATICALLY POPULATED)	The ASC NEPM 2013 defines a hazard as "the inherent property of a contaminant or situation having the potential to cause adverse effects when a population may be exposed to that contaminant". In this field, the CRAT user should briefly describe what is known or inferred about the hazard posed by environmental contamination, in terms of its nature and extent in the environment and how humans or ecology could interact with it in various media.	Example 1: Dissolved phase plume in groundwater extending 100m down-gradient from source area, which may discharge to surface water ecosystems, or be extracted by humans for domestic uses. Example 2: 100m ² of surface soil containing asbestos fragments/fibres following uncontrolled building demolition, which have the potential to generate dust which humans could breathe. Example 3: 10m ³ of uncontrolled backfill containing wastes that may leach to groundwater, and groundwater could subsequently discharge to surface water ecosystems, or surface waters where primary contact recreation activities occur. Example 4: 100m free phase product sheen on surface water of a river, which represents a sensitive ecosystem and is also used for extraction of irrigation water and recreation.	1. Develop a one sentence description of the contamination hazard being assessed. 2. The subsequent steps in the CRAT ask the user to characterise the consequences of human or ecological exposure to the identified contamination, and the likelihood that such exposure will occur. It is important to phrase the description of the contamination hazard in this context. 3. Contamination hazard is not described in terms of an event, but is the physical contamination matter. E.g. if asbestos is buried and there is a risk associated with uncontrolled diggings exposing the asbestos, then the contamination hazard is human exposure to buried asbestos via dust inhalation. The contamination hazard is not the event of digging up buried asbestos. 4. The description developed will drive the risk rankings and a poor definition will lead to an inaccurate representation of the risk level. 5. The description should aim to expand on the previous identification of the secondary source by identifying the realistic worst case contamination hazard that is considered likely to drive risks for the CSR. For example, a leaking tank may cause localised soil contamination but extensive groundwater contamination, and it is the groundwater contamination that is the most substantial contamination hazard that is to be assessed. 6. The intent of this field is to facilitate a clear understanding of how the identified receptors might interact with the contamination and to focus the next stages of assessment on these source-pathway-receptor linkages. NOTE: CSRs that have no complete source-pathway-receptor linkages (or have sufficient evidence to indicate that there is no complete source-pathway-receptor linkage) have a negligible risk of impacting on receptors and are suitable for archiving. This will require professional judgement and the rationale must be captured in the relevant site investigation report. CSRs to be archived are not to be run through the CRAT to reduce potential confusion about Low (potentially complete/complete S-P-R link) and negligible risk (no S-P-R link and requiring no specific management).
	Consequence (FIELD AUTOMATICALLY POPULATED)	The consequence of land use activities (current or future, as defined on the Context tab of the CRAT) on either capability, safety, compliance, finance, delivery of service, reputation and environment due to the identified contamination hazard. The consequence is automatically populated from the data in the Consequence worksheet.	Example: Major	1. No data is to be entered. This field is automatically populated based on data entry in the Consequence worksheet.
	Likelihood	The likelihood of the identified consequence occurring for either current land use activities or future land use activities as determined in the context worksheet under the land use option.	Example: Unlikely	1. Select from the drop down box for fields where the consequence data is presented. 2. For Stage 2 and Stage 3 Environment Impact Category consequences, the likelihood represents the likelihood of exposure of the identified receptor at the concentration used to estimate the risk.

Risk Evaluation	Information Field	Definition	Example	Guidance Notes
Risk Evaluation Worksheet	Information Field	Definition	Example	Guidance Notes
	CSR ID # (FIELD AUTOMATICALLY POPULATED)	The Contaminated Sites Register unique alpha numeric identifier.	Example: CSR_NSW_000xx	1. Ensure consistent exact naming with existing CSR numbers. 2. For new CSR numbers, please send request to the NCRP mailbox [ncrp@defence.gov.au] before commencing the CRAT.
	Contamination Hazard (FIELD AUTOMATICALLY POPULATED)	The ASC NEPM 2013 defines a hazard as "the inherent property of a contaminant or situation having the potential to cause adverse effects when a population may be exposed to that contaminant". In this field, the CRAT user should briefly describe what is known or inferred about the hazard posed by environmental contamination, in terms of its nature and extent in the environment and how humans or ecology could interact with it in various media.	Example 1: Dissolved phase plume in groundwater extending 100m down-gradient from source area, which may discharge to surface water ecosystems, or be extracted by humans for domestic uses. Example 2: 100m ² of surface soil containing asbestos fragments/fibres following uncontrolled building demolition, which have the potential to generate dust which humans could breathe. Example 3: 10m ³ of uncontrolled backfill containing wastes that may leach to groundwater, and groundwater could subsequently discharge to surface water ecosystems, or surface waters where primary contact recreation activities occur. Example 4: 100m free phase product sheen on surface water of a river, which represents a sensitive ecosystem and is also used for extraction of irrigation water and recreation.	1. Develop a one sentence description of the contamination hazard being assessed. 2. The subsequent steps in the CRAT ask the user to characterise the consequences of human or ecological exposure to the identified contamination, and the likelihood that such exposure will occur. It is important to phrase the description of the contamination hazard in this context. 3. Contamination hazard is not described in terms of an event, but is the physical contamination matter. E.g. if asbestos is buried and there is a risk associated with uncontrolled diggings exposing the asbestos, then the contamination hazard is human exposure to buried asbestos via dust inhalation. The contamination hazard is not the event of digging up buried asbestos. 4. The description developed will drive the risk rankings and a poor definition will lead to an inaccurate representation of the risk level. 5. The description should aim to expand on the previous identification of the secondary source by identifying the realistic worst case contamination hazard that is considered likely to drive risks for the CSR. For example, a leaking tank may cause localised soil contamination but extensive groundwater contamination, and it is the groundwater contamination that is the most substantial contamination hazard that is to be assessed. 6. The intent of this field is to facilitate a clear understanding of how the identified receptors might interact with the contamination and to focus the next stages of assessment on these source-pathway-receptor linkages. NOTE: CSRs that have no complete source-pathway-receptor linkages (or have sufficient evidence to indicate that there is no complete source-pathway-receptor linkage) have a negligible risk of impacting on receptors and are suitable for archiving. This will require professional judgement and the rationale must be captured in the relevant site investigation report. CSRs to be archived are not to be run through the CRAT to reduce potential confusion about Low (potentially complete/complete S-P-R link) and negligible risk (no S-P-R link and requiring no specific management).
	Overall Risk Ranking	The overall risk ranking is the maximum risk across all the impact categories assessed for a CSR. The largest risk from either capability, safety, compliance, financial, deliver of services, reputation or environment for the identified contamination hazard is termed the overall risk ranking.	Example: High	1. A blank result (no rating) means that this element has not been scored.
	Environment	The risk is determined using the risk matrix presented on the Context worksheet. The most progressed Stage of assessment will be used for the risk rating.		1. A blank result (no rating) means that this element has not been scored.
	Capability	The risk is determined using the risk matrix presented on the Context worksheet.	Example: Low	1. A blank result (no rating) means that this element has not been scored.
	Delivery of Services	The risk is determined using the risk matrix presented on the Context worksheet.	Example: Low	1. A blank result (no rating) means that this element has not been scored.
	Legislative Compliance	The risk is determined using the risk matrix presented on the Context worksheet.	Example: Low	1. A blank result (no rating) means that this element has not been scored.
	Financial	The risk is determined using the risk matrix presented on the Context worksheet.	Example: Low	1. A blank result (no rating) means that this element has not been scored.
	Reputation	The risk is determined using the risk matrix presented on the Context worksheet.	Example: High	1. A blank result (no rating) means that this element has not been scored.
	Safety	The risk is determined using the risk matrix presented on the Context worksheet.	Example: Low	1. A blank result (no rating) means that this element has not been scored.
	Risk Evaluation and Risk Close Out Notes	A free text box where the risk assessor/s can record notes regarding the risk evaluation outcome, response plans and objectives and strategies to close out the risk.		

Step 1: Establish the Context of the Assessment

Region:
VT
Property Name:
VT-RAAF Base Williams - Point Cook
Property ID:
0932
Date of Assessment:
22-Aug-22
Current or Future Land Use:
Current

CRAT Purpose Summary
Update of the CRAT for post-remediation status of Former Fire Training Area CSRs
Uncertainty Comments
Uncertainties identified in HHRA and ERA were addressed by adopting conservative assumptions. Uncertainties include: Spatial and temporal variabilities, no biota sampling data, PFAS in GW not fully delineated, no surface water sampling+reliability of

[illegible]

Impact Category	Description
Capability	<p>Ability for mission essential tasks to be completed in accordance with Defence Directives.</p> <p>Capacity of the facility to support the user unit in delivery of its primary outputs.</p> <p>Impact on the ability of the ADF to protect Australia and fulfil its national security obligations.</p> <p>Impact on the ADF's ability to train and equip for war and for the conduct of peacetime operations.</p> <p>Impact on the ability of Defence to develop its capability as detailed in the Defence White Paper.</p> <p>Impact on Civil (non-Defence) Capability as a consideration for shared facilities.</p>
Delivery of Services	<p>Impact on the delivery of services provided to customer units / facilities / training areas.</p> <p>Impact on Defence's ability to deliver an affordable and sustainable estate and reducing the overall estate liability in the long-term.</p> <p>Impact on achieving reductions in capability support costs.</p>
Environment	Impact on the environment due to contamination.
Legislative Compliance	<p>Compliance with regulatory requirements and the impact of failing to comply. Including but not limited to federal, state, territory, local, foreign treaty, indigenous land use agreements, Defence instructions or contracts. Matters for consideration include whether or not the base or site:</p> <ul style="list-style-type: none"> · is currently breaching one or more laws, agreements etc.; · in the absence of some remedial work will shortly be contravening a legislative or other obligation; or · needs work to be completed within or by some specified time to ensure that it remains compliant with all obligations.
Financial	<p>An assessment of the potential for increased costs that would be incurred if the works or services were not performed during the specified period. This includes costs effectively directly related to the work itself and any flow on costs that may result if the works are not performed.</p> <p>Short-term cost of prevention vs. long-term cost of recovery. This would also cover reductions in costs and return on investment (i.e. shorter payback period if work performed now, costs now for long term savings).</p>
Reputation	<p>Impact on Defence's reputation in provision of services, political and media attention to Defence service delivery matters, community concerns or actions over activities.</p> <p>Impact on compliance with Government commitments as opposed to specific government policy / legislation.</p>
Safety	Impact on the physical and psychological wellbeing of military and Defence employees, contractors, communities in Defence regions and the public in general.
Security	Impact on the physical security of Defence facilities and bases that results from the inability of E&IG to effectively maintain or implement the mandated security controls articulated in the Defence Security Manual.

Relevant reports used in the CRAT Workshop
AECOM (2017), Post Remediation Soil Assessment, Point Cook Remediation Project, RAAF Williams, Point Cook
AECOM (2022), Post Remediation Groundwater Assessment Report, Point Cook Remediation Project, RAAF Williams, Point Cook
AECOM (2022), Stage 3 Human Health Risk Assessment, RAAF Base Point Cook (0932): Former Fire Training Area
AECOM (2022), Stage 3 Ecological Risk Assessment, RAAF Base Point Cook (0932): Former Fire Training Area
AECOM (2022), Audit Closeout Report, RAAF Base Point Cook (0932) Former Fire Training Area

Risk Matrix					
Likelihood Rating	Consequence Rating				
	Severe	Major	Moderate	Minor	Insignificant
Almost Certain	Very High	Very High	High	Medium	Low
Likely	Very High	High	High	Medium	Low
Possible	High	High	Medium	Medium	Low
Unlikely	High	Medium	Medium	Low	Low
Rare	Medium	Medium	Low	Low	Low



ADDITIONAL OPERATIONS
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Step 2: Identify Risk (Contaminated Sites on the Property) - Enter the details for the most significant contamination hazard associated with each CSR entry

CSR Number	CSR Title	CSR Description	Assessment / Remediation Stage	Source Type (Identified Contaminating Activity)	Secondary Source (Contaminated Environmental Media)	Contaminant Hazard	Potential Human Health Receptors	Human Receptor considered to have greatest potential exposure risk	Key Human Health CoPC Category (To modify Category you must select Key Human Health CoPC)	Key Human Health CoPC (Select Category of Key Human Health CoPC First)	Relative Toxicity of Key Human Health CoPC	Relevant Ecological Receptors	Ecological receptor considered to have greatest potential exposure risk	Key Ecological CoPC Category (To modify Category you must select Key Ecological CoPC)	Key Ecological CoPC (Select Category of Key Ecological CoPC First)	Other Chemicals of Potential Concern	Describe Baseline Controls	Comment Notes
CSR_VIC_000125	Old Fire Training Area Source Zone A (Pit A)	Excavated pit in Fire Training Area exposing groundwater, then waste hydrocarbon-rich liquids poured into the pits (onto groundwater) and set alight to practice fire drills.	Stage 3 - Risk Assess / Remediation Design	Fire Training Area	Soil, groundwater, soil vapour, sediment, surface water	Human exposure (on-site) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to onsite workers (on-site) and direct contact to chlorinated hydrocarbons in porewater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in porewater/surface water (off-site).	On-property intrusive maintenance workers. Off-property recreational users of Port Phillip Bay and RAAF Lake.	Commercial/ Industrial	Chlorinated Hydrocarbons	Vinyl Chloride (VC)	High	Degraded coastal vegetation; soil dwelling fauna (on-site) Degrated coastal vegetation; sediment-dwelling invertebrates, surface water biota, aquatic birds, endangered flora and fauna (off-site)	Aquatic: High conservation/ Ecological Value	PFAS	PFOS + PTHs	Petroleum Hydrocarbons	The site is not currently being used but is understood to be potentially used for dry training activities in the future. There are no buildings or hard surfaces at the site and it is understood that there are currently no plans to construct permanent structures in this area. No buildings currently on-site, which avoids potential indoor inhalation risk. Fishing is prohibited along the shoreline adjacent to Parks Victoria and access to the Property is restricted to recreational users of the bay.	On-property ecological risk from PFAS characterised as low in ERA (2022). Potential for adverse impacts to off-property ecological receptors is uncertain - further assessment recommended to address data gaps and resolved uncertainties. Human health risks from PFAS to off-property consumers of marine biota harvested near the shoreline are uncertain due to absence of PFAS in-biota data (NHRA, 2022). Risks to on-property human receptors associated with PFAS were characterised as low and acceptable in the NHRA.
CSR_VIC_000126	Old Fire Training Area Source Zone C (Pit C)	Pit C contains miscellaneous fill. However, no visual evidence of fire training activities was observed at this location.	Stage 3 - Risk Assess / Remediation Design	Fire Training Area	Soil, groundwater, soil vapour, sediment, surface water	Human exposure (on-site) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to onsite workers (on-site) and direct contact to chlorinated hydrocarbons in porewater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in porewater/surface water (off-site).	On-property intrusive maintenance workers. Off-property recreational users of Port Phillip Bay and RAAF Lake.	Commercial/ Industrial	Chlorinated Hydrocarbons	Vinyl Chloride (VC)	High	Degraded coastal vegetation; soil dwelling fauna (on-site) Degrated coastal vegetation; sediment-dwelling invertebrates, surface water biota, aquatic birds, endangered flora and fauna (off-site)	Aquatic: High conservation/ Ecological Value	PFAS	PFOS + PTHs	Petroleum Hydrocarbons	The site is not currently being used but is understood to be potentially used for dry training activities in the future. There are no buildings or hard surfaces at the site and it is understood that there are currently no plans to construct permanent structures in this area. No buildings currently on-site, which avoids potential indoor inhalation risk. Fishing is prohibited along the shoreline adjacent to Parks Victoria and access to the Property is restricted to recreational users of the bay.	On-property ecological risk from PFAS characterised as low in ERA (2022). Potential for adverse impacts to off-property ecological receptors is uncertain - further assessment recommended to address data gaps and resolved uncertainties. Human health risks from PFAS to off-property consumers of marine biota harvested near the shoreline are uncertain due to absence of PFAS in-biota data (NHRA, 2022). Risks to on-property human receptors associated with PFAS were characterised as low and acceptable in the NHRA.
CSR_VIC_000127	Old Fire Training Area Source Zone D (Pit D)	Pit D contains miscellaneous fill. However, no visual evidence of fire training activities was observed at this location.	Stage 3 - Risk Assess / Remediation Design	Fire Training Area	Soil, groundwater, soil vapour, sediment, surface water	Human exposure (on-site) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to onsite workers (on-site) and direct contact to chlorinated hydrocarbons in porewater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in porewater/surface water (off-site).	On-property intrusive maintenance workers. Off-property recreational users of Port Phillip Bay and RAAF Lake.	Commercial/ Industrial	Chlorinated Hydrocarbons	Vinyl Chloride (VC)	High	Degraded coastal vegetation; soil dwelling fauna (on-site) Degrated coastal vegetation; sediment-dwelling invertebrates, surface water biota, aquatic birds, endangered flora and fauna (off-site)	Aquatic: High conservation/ Ecological Value	PFAS	PFOS + PTHs	Chlorinated Hydrocarbons, Petroleum Hydrocarbons	The site is not currently being used but is understood to be potentially used for dry training activities in the future. There are no buildings or hard surfaces at the site and it is understood that there are currently no plans to construct permanent structures in this area. No buildings currently on-site, which avoids potential indoor inhalation risk. Fishing is prohibited along the shoreline adjacent to Parks Victoria and access to the Property is restricted to recreational users of the bay.	On-property ecological risk from PFAS characterised as low in ERA (2022). Potential for adverse impacts to off-property ecological receptors is uncertain - further assessment recommended to address data gaps and resolved uncertainties. Human health risks from PFAS to off-property consumers of marine biota harvested near the shoreline are uncertain due to absence of PFAS in-biota data (NHRA, 2022). Risks to on-property human receptors associated with PFAS were characterised as low and acceptable in the NHRA.
CSR_VIC_000128	Old Fire Training Area Source Zone E (Pit E)	Pit E contains miscellaneous fill. However, no visual evidence of fire training activities was observed at this location.	Stage 3 - Risk Assess / Remediation Design	Fire Training Area	Soil, groundwater, soil vapour, sediment, surface water	Human exposure (on-site) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to onsite workers (on-site) and direct contact to chlorinated hydrocarbons in porewater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in porewater/surface water (off-site).	On-property intrusive maintenance workers. Off-property recreational users of Port Phillip Bay and RAAF Lake.	Commercial/ Industrial	Chlorinated Hydrocarbons	Vinyl Chloride (VC)	High	Degraded coastal vegetation; soil dwelling fauna (on-site) Degrated coastal vegetation; sediment-dwelling invertebrates, surface water biota, aquatic birds, endangered flora and fauna (off-site)	Aquatic: High conservation/ Ecological Value	PFAS	PFOS + PTHs	Petroleum Hydrocarbons	The site is not currently being used but is understood to be potentially used for dry training activities in the future. There are no buildings or hard surfaces at the site and it is understood that there are currently no plans to construct permanent structures in this area. No buildings currently on-site, which avoids potential indoor inhalation risk.	On-property ecological risk from PFAS characterised as low in ERA (2022). Potential for adverse impacts to off-property ecological receptors is uncertain - further assessment recommended to address data gaps and resolved uncertainties. Human health risks from PFAS to off-property consumers of marine biota harvested near the shoreline are uncertain due to absence of PFAS in-biota data (NHRA, 2022). Risks to on-property human receptors associated with PFAS were characterised as low and acceptable in the NHRA.
CSR_VIC_000129	Old Fire Training Area Source Zone B (Pit B)	Excavated pit in Fire Training Area exposing groundwater, then waste hydrocarbon-rich liquids poured into the pits (onto groundwater) and set alight to practice fire drills.	Stage 3 - Risk Assess / Remediation Design	Fire Training Area	Soil, groundwater, soil vapour, sediment, surface water	Human exposure (on-site) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to onsite workers (on-site) and direct contact to chlorinated hydrocarbons in porewater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in porewater/surface water (off-site).	On-property intrusive maintenance workers. Off-property recreational users of Port Phillip Bay and RAAF Lake.	Commercial/ Industrial	Chlorinated Hydrocarbons	Vinyl Chloride (VC)	High	Degraded coastal vegetation; soil dwelling fauna (on-site) Degrated coastal vegetation; sediment-dwelling invertebrates, surface water biota, aquatic birds, endangered flora and fauna (off-site)	Aquatic: High conservation/ Ecological Value	PFAS	PFOS + PTHs	Petroleum Hydrocarbons	The site is not currently being used but is understood to be potentially used for dry training activities in the future. There are no buildings or hard surfaces at the site and it is understood that there are currently no plans to construct permanent structures in this area. No buildings currently on-site, which avoids potential indoor inhalation risk. Fishing is prohibited along the shoreline adjacent to Parks Victoria and access to the Property is restricted to recreational users of the bay.	On-property ecological risk from PFAS characterised as low in ERA (2022). Potential for adverse impacts to off-property ecological receptors is uncertain - further assessment recommended to address data gaps and resolved uncertainties. Human health risks from PFAS to off-property consumers of marine biota harvested near the shoreline are uncertain due to absence of PFAS in-biota data (NHRA, 2022). Risks to on-property human receptors associated with PFAS were characterised as low and acceptable in the NHRA.



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Table 3: From Table 1.0, create a Consequence Ranking of the Contamination Hazard for Each Asset Category.

Guidance: With reference to available reports for each CSR entry, enter quantitative or qualitative values for actual or best estimate of potential consequence for each parameter. Fields may be left blank if insufficient information is available.

Please assess consequence impacts with existing routine controls in place.

CSR ID	CSR Item	Contamination Source	Endorsement - Table 1 Preliminary Site Investigation					Endorsement - Table 2 Detailed Site Investigation					Endorsement Table 9 Risk Rating	
			Human receptor considered to have greatest potential exposure risk	Relative toxicity of key issues under CoC	Human Health Consequence Ranking	Ecological receptor considered to have greatest potential exposure risk	Ecological Consequence Ranking	For the identified key human health CoC and receptor with greatest potential exposure risk, are Tier 1 human health criteria exceeded by the key CoC in any environmental media?	Describe the environmental data that were considered most representative of the exposure path concentration and were used to select the Consequence ranking for human health	Human Health Consequence Ranking	For the identified key Ecological CoC and receptor with greatest potential exposure risk, are Tier 1 ecological criteria exceeded by the key CoC in any environmental media?	Describe the environmental data that were considered most representative of the exposure path concentration and were used to select the Consequence ranking for ecology	Ecological Consequence Ranking	Stage 3 Risk Assessment Outcome for human receptors with greatest potential exposure risk
CSR_VC_000115	Old Fire Training Area - Source Zone A (PFA) A)	Human exposure (mobile workers and intrusive maintenance workers) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to mobile workers (mobile) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (off-site) and to intrusive maintenance workers (on-site).											0-100 and 0.25-10-03	Severe
CSR_VC_000116	Old Fire Training Area - Source Zone C (PFA) C)	Human exposure (mobile workers and intrusive maintenance workers) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to mobile workers (mobile) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (off-site) and to intrusive maintenance workers (on-site).											0-100 and 0.25-10-03	Severe
CSR_VC_000117	Old Fire Training Area - Source Zone D (PFA) D)	Human exposure (mobile workers and intrusive maintenance workers) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to mobile workers (mobile) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (off-site) and to intrusive maintenance workers (on-site).											0-100 and 0.25-10-03	Severe
CSR_VC_000118	Old Fire Training Area - Source Zone E (PFA) E)	Human exposure (mobile workers and intrusive maintenance workers) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to mobile workers (mobile) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (off-site) and to intrusive maintenance workers (on-site).											0-100 and 0.25-10-03	Severe
CSR_VC_000119	Old Fire Training Area - Source Zone F (PFA) F)	Human exposure (mobile workers and intrusive maintenance workers) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to mobile workers (mobile) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (off-site) and to intrusive maintenance workers (on-site).											0-100 and 0.25-10-03	Severe
CSR_VC_000120	Old Fire Training Area - Source Zone G (PFA) G)	Human exposure (mobile workers and intrusive maintenance workers) to chlorinated hydrocarbons and petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to mobile workers (mobile) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (off-site) and to intrusive maintenance workers (on-site).											0-100 and 0.25-10-03	Severe

Risk Assessment		Capability		Delivery of Services		Financial		Legislative Compliance		Reputation		Safety		Security	
Stage 3 Risk Assessment Outcomes for ecological receptor with greatest potential exposure risk	Ecological Consequence Ranking	Short Text	Description	Short Text	Description	Short Text	Description	Short Text	Description	Short Text	Description	Short Text	Description	Short Text	Description
Exposure level exceeds acceptable limits by more than two orders of magnitude	Severe	Insignificant	Minimal activities curtailed with negligible performance impact. Missions, training or activities can be conducted from the estate with minor degradation to one mission or training requirement.	Insignificant	Would have an insignificant impact on the ability of E&G to provide services to our customers. Some non-essential tasks will not be able to be achieved	Insignificant	<\$25k increase in financial liability	Insignificant	No breach of legislation	Minor	Detrimental local media reports; or Subject of local government complaints; or Random substantiated complaints from the community; or Will have a moderate impact on the reputation of E&G within its stakeholder community and may reduce confidence for a short period.	Insignificant	Minor injury or illness that is treatable in the workplace (first aid) or by a registered health practitioner, with no follow up treatment required.	Insignificant	Would cause minor security incident with that has no impact on the reputation of E&G; or damage to physical assets or infrastructure resulting in inconvenience but no impact on achievement of organisational objectives.
Exposure level exceeds acceptable limits by more than two orders of magnitude	Severe	Insignificant	Minimal activities curtailed with negligible performance impact. Missions, training or activities can be conducted from the estate with minor degradation to one mission or training requirement.	Insignificant	Would have an insignificant impact on the ability of E&G to provide services to our customers. Some non-essential tasks will not be able to be achieved	Insignificant	<\$25k increase in financial liability	Insignificant	No breach of legislation	Minor	Detrimental local media reports; or Subject of local government complaints; or Random substantiated complaints from the community; or Will have a moderate impact on the reputation of E&G within its stakeholder community and may reduce confidence for a short period.	Insignificant	Minor injury or illness that is treatable in the workplace (first aid) or by a registered health practitioner, with no follow up treatment required.	Insignificant	Would cause minor security incident with that has no impact on the reputation of E&G; or damage to physical assets or infrastructure resulting in inconvenience but no impact on achievement of organisational objectives.
Exposure level exceeds acceptable limits by more than two orders of magnitude	Severe	Insignificant	Minimal activities curtailed with negligible performance impact. Missions, training or activities can be conducted from the estate with minor degradation to one mission or training requirement.	Insignificant	Would have an insignificant impact on the ability of E&G to provide services to our customers. Some non-essential tasks will not be able to be achieved	Insignificant	<\$25k increase in financial liability	Insignificant	No breach of legislation	Minor	Detrimental local media reports; or Subject of local government complaints; or Random substantiated complaints from the community; or Will have a moderate impact on the reputation of E&G within its stakeholder community and may reduce confidence for a short period.	Insignificant	Minor injury or illness that is treatable in the workplace (first aid) or by a registered health practitioner, with no follow up treatment required.	Insignificant	Would cause minor security incident with that has no impact on the reputation of E&G; or damage to physical assets or infrastructure resulting in inconvenience but no impact on achievement of organisational objectives.
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Department of Defence - Contamination Risk Assessment Tool

Version 1.1

Information

Context

Identify Risk

Consequence

Likelihood

Risk Definition

Recommendation

Step 6: Assign a Likelihood Rating for the Contamination Hazard (Determining the Consequence for each Impact Category)

10000	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.
1000	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.
100	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.
10	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.
1	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.

CIR ID #	CIR Name	Contamination Hazard	Assessment - Step 1: Preliminary Risk Investigation					Assessment - Step 2: Detailed Risk Investigation					Assessment - Step 3: Risk Assessment					Consequence	Likelihood			
			Human Health Consequence	Human Health Likelihood	Likelihood - Full Description	Ecological Consequence	Ecological Likelihood	Likelihood - Full Description	Human Health Consequence	Human Health Likelihood	Likelihood - Full Description	Ecological Consequence	Ecological Likelihood	Likelihood - Full Description	Human Health Consequence	Human Health Likelihood	Likelihood - Full Description			Ecological Consequence	Ecological Likelihood	Likelihood - Full Description
CIR_MC_000120	Old Fire Training Area - Source Zone A (P6 A)	Exposure to petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to stable workers (on-site) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in groundwater/surface water (off-site).													Severe	Rare	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.	Severe	Possible	Even probability of consequence occurring before the risk assessment is reviewed (12 months). Has occurred two or three times during the past 5 years OR has a 40-60% chance of occurring before the risk assessment is reviewed (12 months) if the risk is not mitigated.	Insignificant	Rare
CIR_MC_000120	Old Fire Training Area - Source Zone C (P6 C)	Exposure to petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to stable workers (on-site) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in groundwater/surface water (off-site).													Severe	Rare	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.	Severe	Possible	Even probability of consequence occurring before the risk assessment is reviewed (12 months). Has occurred two or three times during the past 5 years OR has a 40-60% chance of occurring before the risk assessment is reviewed (12 months) if the risk is not mitigated.	Insignificant	Rare
CIR_MC_000120	Old Fire Training Area - Source Zone D (P6 D)	Exposure to petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to stable workers (on-site) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in groundwater/surface water (off-site).													Severe	Rare	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.	Severe	Possible	Even probability of consequence occurring before the risk assessment is reviewed (12 months). Has occurred two or three times during the past 5 years OR has a 40-60% chance of occurring before the risk assessment is reviewed (12 months) if the risk is not mitigated.	Insignificant	Rare
CIR_MC_000120	Old Fire Training Area - Source Zone E (P6 E)	Exposure to petroleum hydrocarbons in groundwater via direct contact or vapour intrusion, to petroleum hydrocarbons in soil via vapour intrusion to stable workers (on-site) and direct contact to chlorinated hydrocarbons in groundwater/surface water (off-site). Potential human exposure to PFAS via consumption of marine biota harvested in close proximity to the shoreline (off-site). Ecological exposure to PFAS in soil and groundwater (on-site) and in groundwater/surface water (off-site).													Severe	Rare	Has not occurred in the past 5 years OR may occur in exceptional circumstances, i.e. less than 10% chance of occurring in the next funding period if the risk is not mitigated.	Severe	Possible	Even probability of consequence occurring before the risk assessment is reviewed (12 months). Has occurred two or three times during the past 5 years OR has a 40-60% chance of occurring before the risk assessment is reviewed (12 months) if the risk is not mitigated.	Insignificant	Rare

[illegible]

Step 5: Risk Evaluation

[illegible]