Detailed Site Investigation

RAAF Base East Sale – Per- and Poly-fluoroalkyl Substances (PFAS) Investigations

Prepared for:
Department of Defence
26 Brindabella CCT
Canberra, ACT, 2600

7 June 2017

Distribution

Detailed Site Investigation

RAAF Base East Sale – Per- and Poly-fluoroalkyl Substances (PFAS) Investigations

7 June 2017

Copies	Recipient	Copies	Recipient
1 PDF	**Department of Defence** 26 Brindabella CCT Canberra, ACT, 2600	1 PDF	**Senversa Project File**

1 **Reliance** - This document has been prepared solely for the use of Department of Defence. No responsibility or liability is accepted for any damages arising out of the use of this document by any third party.

2 **Copyright and Intellectual Property** – © Senversa Pty Ltd. Intellectual property in relation to the methodology undertaken during the creation of this document remains the property of Senversa.

3 **Principles and Limitations of Investigation -** This document is issued subject to the technical principles, limitations and assumptions provided in **Section 9.0**.

4 **Privacy and Confidentiality** – This report was prepared for Department of Defence and may contain confidential information. Permission from Senversa and the Department of Defence should be sought before any written reference to the contents of this report is made public that identifies any people, person, address or location named within or involved in the preparation of this report.

Senversa Pty Ltd
ABN: 89 132 231 380
Level 6, 15 William Street, Melbourne VIC 3000
tel: + 61 3 9606 0070; fax: + 61 3 9606 0074
www.senversa.com.au

Co-Author	Project Environmental Scientist	**Co-Author**	Associate Environmental Scientist
Co-Author / Project Manager	Senior Associate Environmental Engineer	**Co-Author**	Principal Risk Assessor
Technical Peer Review/ Project Director	Senior Principal Environmental Scientist		

Executive Summary

Introduction, Background and Objectives

Senversa Pty Ltd (Senversa) has been engaged to undertake a detailed environmental investigation of the nature and extent of per- and poly-fluoroalkyl substances (PFAS) impacts, principally the result of the storage and handling of legacy Aqueous Film-Forming Foam (AFFF) on and in the vicinity of RAAF Base East Sale (the site).

AFFFs are 'Class B' firefighting foams used to prevent or extinguish flammable liquid fires. AFFF forms a barrier that inhibits oxygen from feeding the fire, while limiting volatilisation of flammable vapours from fuels. AFFF has been used extensively worldwide, including in Australia, since the 1970's by both civilian and military authorities. Historically, AFFF contained perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) as active ingredients, with perfluorohexane sulfonate (PFHxS) commonly present as an impurity in the manufacturing process or as a breakdown product. This historically used AFFF (herein referred to as legacy AFFF), is distinct from current AFFF formulations that do not contain PFOS and PFOA as active ingredients. From approximately 2004, Defence commenced phasing out legacy AFFF across the Defence Estate, however the chemical characteristics of PFOS, PFOA and PFHxS make them highly resistant to degradation. These and some other PFAS compounds may persist in environmental media such as soil, groundwater or surface water for many years after the release/s occurred. Therefore, the PFAS of interest to the investigation are principally PFOS, PFOA, and PFHxS with other PFAS analysed and considered during the investigations.

The first phase of the detailed environmental investigation, the Preliminary Site Investigation (PSI) was completed by Senversa in October 2016 (Senversa, 2016). The outcomes of the PSI:

- Provided an understanding of site characteristics and environmental setting;
- Identified historical locations and activities where legacy AFFF was used, stored or handled to establish where and when legacy AFFF was used (sources);
- Established an understanding of how PFAS moves in the environment on and off-site (migration pathways) and the possible exposure to people and the environment (receptors); and
- Identified the areas of potential interest for environmental investigation works, and identified data gaps in the understanding of the preliminary conceptual site model (CSM).

The PSI established the priorities of the next stage of the detailed environmental investigations into PFAS impacts on and in the vicinity of the site. Further environmental investigation both on and off-site has been addressed in the current stage of works, this Detailed Site Investigation (DSI) report.

Overall, the objectives of this DSI were to assess the nature and extent of PFAS impacts to be able to assess risks to people and the environment and to determine whether further investigation, management or remediation is required. The works were used to determine that a Human Health and Ecological Risk Assessment (HHERA) should be completed.

The DSI was conducted in accordance with guidance provided in the National Environment Protection (Assessment of Site Contamination) Amendment Measure ('the NEPM') (NEPC, 2013).

Site Setting

The site is located in an environmentally sensitive area, close to wetlands of ecological significance, including The Heart Morass to the south, and the Gippsland Lakes RAMSAR site at Lake Wellington to the east. Drainage from the site leads to these areas. The site is considered sensitive to the effects of PFAS presence in the environment given that it is located in an agriculturally significant region. All surrounding land is farm zoned and used principally for dairy farming (and associated pasture irrigation), but also cattle (beef) grazing and associated rural residential uses.

The region is culturally significant for the local indigenous community and the wetlands to the south and lakes systems to the east have cultural heritage significance for the indigenous community.

The complexity of the geology and hydrogeology at the site controls the movement of groundwater in the area. There are three main shallower water bearing zones that were assessed as part of the DSI. A thick, impervious clay layer separates these three shallower units from the deep, regionally significant groundwater unit that supplies drinking water in the region.

Scope of Work

To achieve the objectives of the project, the following scope of work was completed:

- Soil sampling targeted to areas where legacy AFFF may have been used in operational areas (source areas), to understand how legacy AFFF use affected these operational areas and surrounding areas.
- Soil sampling targeted to areas of sensitive land use (e.g. childcare centre, kindergarten and residential accommodation buildings, adjacent private properties and off-site air crash sites) to understand whether legacy AFFF use in operational areas has impacted on sensitive land use areas.
- Soil sampling in a broad, regular grid (non-targeted) manner to assess the potential for soil impacts outside of known source areas. This was completed to understand contaminant migration from the source areas (e.g. overland flow, surface water runoff, or spray drift), and to pick up areas where legacy AFFF may have been used but was not identified from historical information provided by the Base personnel and records.
- Groundwater investigation within on-site source areas and off-site receptors and delineation of known significant impacts, through installation of monitoring wells within the main shallower water bearing zones and sampling of groundwater wells for PFAS. This was completed to understand the extent and movement of the identified impacts from source areas and potential for off-site impacts.
- Sediment and surface water investigation of on and off-site drainage lines, areas where water periodically ponds, irrigation channels and dams, ornamental lakes, rivers and wetlands to assess the potential for off-site migration of PFAS along surface water drainage features.
- Stock trough water and paired grass/soil samples in on- and off-site areas to understand PFAS concentrations in areas where grazing is known to occur.
- Limited sampling of potential PFAS impacted concrete stockpiles located on-site.
- Sampling of the site water supply bore, selected private property rainwater tanks that supply drinking water to residents and groundwater bores on private properties.
- Update the understanding of potential pathways by which people and the environment can be exposed to PFAS through revision of the CSM developed in the PSI.

Investigation Findings

Based on the findings of the DSI, the following conclusions have been made.

PFAS Sources

- The DSI confirmed the coincident nature of identified impacts with the source area findings of the PSI, completed in October 2016, indicating legacy AFFF was widely used across many parts of the site, with higher PFAS concentrations recorded near the following sources:
    - Maintenance areas in the north-west (Source IDs 01-03).
    - The former and current fire stations (Source IDs 04 and 06).
    - The waste burial areas and former fire training areas in the southeast (Source IDs 07-09).
- The DSI also identified impacts surrounding Source ID 16 (grassed areas near runway) to be a more significant source than assessed in the PSI. Further, groundwater quality immediately down gradient of the former refuelling area within the AIR5428 construction area reported elevated PFAS suggesting a further source nearby.

Soil Results

- The principal PFAS of interest is PFOS, as PFOS was reported at highest concentrations and is likely to be the key risk driver at and surrounding the site. However, in some instances the sum of PFOS and PFHxS (concentration sum used in human health screening criteria) is elevated due to the presence of PFHxS. The results indicate the legacy AFFF was of a reasonably uniform formulation.
- On-site, detectable concentrations of PFOS have been reported in soil samples collected across the site, however most concentrations are below adopted screening criteria for protection of human health in a residential setting. Further to this:
    - Soil samples collected within more sensitive areas of the site (including the child care centre, kindergarten, and areas used for residential or accommodation purposes), were many times below the residential (consistent with child care use) human health screening criteria.
    - Locations with exceedences of residential human health screening levels were limited to the identified on-site source areas, but these areas are not used for residential purposes.
    - The reported PFAS concentrations in all samples (with one exception, in the northwest area that was subsequently removed as part of development works) in operational areas were below adopted screening criteria for the protection of human health in a commercial/industrial setting.
- Off-site, at the site boundary and into surrounding areas, detectable but very low PFAS soil concentrations were recorded, at concentrations many more times lower than the residential human health screening criteria.
- Concrete sampling of demolition waste stockpiled in the southwest of the site identified low total and leachable PFAS concentrations indicating the potential for impacts to land or waters, should the material not be managed appropriately.
- Grass sampling identified either low, or not detected PFAS concentrations, except for one sample collected from a former fire training area in the southeast area.
- Given the reported PFAS concentrations in soil and grass, the nature and behaviour of PFAS in the broader environment, there is the potential for risk to aquatic ecosystems off-site and biota that may be in the food chain through bioaccumulation, which requires further assessment and will be completed through the HHERA process.

Groundwater Results

- On-site, PFOS concentrations have been reported above the limit of reporting in the majority of on-site groundwater monitoring wells. The highest concentrations were reported in shallow groundwater in or near identified on-site source areas. Whilst the reported concentrations in some locations are well above the adopted recreational screening criteria, shallow groundwater is not extracted or used at the site. Further to this:
    - Detectable PFAS has not been found in the Base supply groundwater extraction bore.
    - Therefore, exposure to impacted groundwater is unlikely other than for intrusive maintenance workers who may incidentally contact groundwater during intrusive works which encounter the shallow water table.
- Sampling of off-site private bores indicates PFAS migration has not occurred in the water bearing zones where these private bores are located, with no detectable PFAS reported, except for one private irrigation bore (currently not used and has not been used for drinking water purposes) where a low concentration of PFAS was recorded below the adopted drinking water screening criteria.
- Two paired off-site publicly available monitoring wells recorded detectable PFAS, at concentrations exceeding the adopted drinking water screening criteria. The two monitoring wells in which PFAS was detected are located adjacent to the southeast corner of the site, where elevated concentrations have been reported in both soil and groundwater on-site. These sampling results indicate that PFAS migration off-site has occurred in this area.

Water and Sediment Results

- Drainage line sampling identified detectable concentrations of PFOS and other PFAS in almost all samples. The highest concentrations were reported close to source areas (including the fire station in the central area, the maintenance and operations area in the northwest corner and the former waste burial and former fire training areas in the southeast corner). Shallow groundwater is also indicated to be discharging into the Eastern Drain and contributing to PFAS impacts within this drain.
- Reported PFAS concentrations in drainage sediments were relatively low (below soil screening levels for protection of human health in a residential setting), however the presence of detectable PFAS in most samples indicates that these have the potential to act as an ongoing source of PFAS to surface water bodies and drainage lines.
- On-site, reported PFAS concentrations in surface waters range up to approximately 100 times the primary contact recreation screening criteria used to assess direct contact activities such as swimming, however the majority are less than 20-30 times this screening level. The drains are not used for recreational purposes.
- Off-site, detectable but low PFOS concentrations were reported in most surface water samples but were generally below the adopted recreational use screening criteria used to assess direct contact activities such as swimming. The detections off-site in sediment and surface water indicate the need for further evaluation of risk which is being progressed in the conduct of the HHERA.

Water Supply Results

- The on-site drinking water supply is partially sourced from the deep groundwater site extraction bore and results from on-site and off-site groundwater bore sampling of this groundwater unit established that detectable PFAS were not present.
- Private property water tank samples were targeted to properties located near to the site boundary and results established that detectable PFAS are not present in the private drinking water supply on these properties.
- Stock troughs located within the site leased grazing area are supplied by water from the on-site water supply and were sampled at four locations. The results established that PFAS does not exceed the adopted stock watering (drinking water) screening criteria.

Overall Assessment of How PFAS Has Migrated Off-site

- In terms of the risk to off-site receptors, the results indicate the main pathway for the possible off-site migration of PFAS impact is via the surface water drainage features at the site and to a lesser extent groundwater. This transport is principally via the main site drainage line that drains to The Heart Morass (the Eastern Drain), but also to a lesser extent drainage originating from the northwest corner of the site that ultimately connects with the Macalister Irrigation Drainage network which discharges to Lake Wellington in the east.
- Given the reported low PFAS in surface soil at and surrounding the site boundary, wind-blown deposition by aerosols and mists or dust has not been shown to be a significant off-site transport pathway.

Human Health and Environmental Risks

- The human receptors/pathways requiring further assessment primarily relate to worker direct contact with surface water in drains and/or shallow groundwater (on-site), or to consumption of agricultural products or wildlife/game into which PFAS have bioaccumulated.
- Ecological receptors requiring further assessment are primarily higher order receptors who may feed on aquatic flora/fauna within open drains or other surface water bodies, on-site terrestrial receptors (within source areas), and aquatic flora and fauna within the Heart Morass and, to a lesser extent, the Latrobe River.
- In accordance with the risk assessment process recommended in the NEPM, the HHERA will further detail the above Tier 1 screening evaluation and associated conclusions on risk, and will provide a detailed evaluation of risks to receptors via the pathways requiring further assessment due to exceedance of adopted screening criteria (or because no relevant screening criteria are available). Given a level of uncertainty in the adopted human health screening levels for soil and sediment, even where exceedances of screening levels have not been identified, all soil and sediment concentrations will be considered further in the HHERA to identify the final pathways to be evaluated in the risk assessment.
- The data collected in this DSI will inform the HHERA Methodology and Sampling Plan currently being developed, and assist in assessing options for potential further investigation, management or remediation based on the assessment of risks to human health and the environment. The HHERA reporting will be the subject of a separate document to this DSI.
- Where the risk assessment establishes that an unacceptable risk may be present, the level of risk will be used as a basis to develop mitigation, management of clean-up measures. The DSI has indicated that risks to on-site receptors may be able to be controlled by an environmental management plan.

The legacy AFFF has stopped being used at the site, and therefore the primary source of impacts is no longer present at the site. However, the impacted environmental media at the site is providing an ongoing (secondary) source of PFAS impacts. Therefore, assessment of temporal variability (in particular groundwater and surface water) is required on an ongoing basis to establish if the risk profile at the site changes over time with migration of impacts.

Areas of Uncertainty

The DSI addressed the data gaps in the preliminary CSM highlighted in the PSI. The sampling of some source areas for the first time, and the assessment of boundary conditions completed to assess the nature and extent of impacts has identified areas of uncertainty for further assessment (data gaps). As per the NEPM process, further infill assessment of these will improve the understanding of the nature and extent of PFAS impacts on the site and surrounds, and will further inform the assessment of risk to human health and the environment. Whilst the DSI has not identified any imminent environmental hazards, further receptor assessment at the receiving environment (principally assessment of biota) as part of the HHERA process will assist in targeting transport pathways for site management considerations.

The HHERA process will include further assessment of specific pathways and receptors to further evaluate current risks posed by the presence of PFAS within environmental media. Where risks may be assessed to be low and acceptable in the HHERA process based on the current receptors, the objective of further investigation would be to focus on the gaps in understanding of the nature and extent of impacts. Aspects of infill assessment for soil, groundwater and surface water are presented below:

Soil Assessment

The soil investigation is considered to have adequately assessed the nature and extent of PFAS impacts to facilitate assessment of risks to people and the environment, thereby achieving the objectives of the assessment. Given a level of uncertainty in the adopted human health screening levels for soil and sediment, even where exceedances of screening levels have not been identified, all soil and sediment concentrations will be considered further in the HHERA to identify the final pathways to be evaluated in the risk assessment. The assessment of nature and extent in soil (and concrete waste) is not likely to provide adequate certainty and delineation of the nature and extent (in particular, vertical distribution) for development of management or remediation options should these be required in future.

Groundwater Assessment

The DSI has established that the current risk to people from groundwater is generally low based on groundwater uses in the area and the results within private bores and water supply. However, the DSI has identified that PFAS presence above adopted screening criteria is potentially migrating off-site at concentrations that may present a future risk to off-site users of shallow groundwater, should the nature or intensity of land uses change and groundwater extraction occurs near to the site. Therefore, the main data gaps in the understanding of nature and extent associated with groundwater are delineation of groundwater impacts from initial assessment of sources not investigated previously, lateral and vertical migration within the shallow aquifer units identified, and migration of impacts off-site including whether shallow groundwater is discharging into The Heart Morass.

Surface Water Assessment

The nature and extent of surface water and sediment impacts may require further investigation and delineation within Lake Wellington and the eastern extents of The Heart Morass (within the RAMSAR wetlands area); however, this will be dependent on the findings of nature of risk to receptors within the ecological risk assessment.

Contents

Figures

Tables

In-Text Tables and Figures