



Detailed Site Investigation

Robertson Barracks

Prepared for:
PFAS Investigation and Management Branch
8 Brindabella Circuit
Canberra, ACT, 2600

31 May 2018





Distribution

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Executive Summary

Senversa Pty Ltd (Senversa) has been engaged to undertake a detailed site investigation (DSI) 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) at the Department of Defence (Defence) Robertson Barracks and across surrounding areas (the investigation area) (**Figure 1**).

The first phase of the detailed environmental investigation comprised development of a Sampling Analysis and Quality Plan (SAQP) which included a Preliminary Site Investigation (PSI) component which was completed in September 2017 (Senversa, 2017b). This included a review of historical contamination sources and activities at Robertson Barracks as well as establishing the environmental setting. The SAQP identified areas of potential concern (AoPC) and data gaps in the understanding of the preliminary conceptual site model (CSM) for further environmental investigation within Robertson Barracks and adjacent Defence managed land. No potential AoPC or unacceptable risks to other sensitive receptors were identified outside of the investigation area which was limited to Defence managed land.

Defence's primary objective was to understand potential contamination risks both on Robertson Barracks and the surrounding areas resulting from historical AFFF use (in particular the risks associated with PFAS containing foams). To achieve this primary objective and in consideration of the Data Quality Objectives (DQOs) and identified data gaps as detailed in the SAQP, Senversa completed the following scope of work during the DSI.

- Targeted shallow soil sampling within and in proximity to AoPC as well as down gradient of these areas and associated drainage infrastructure as well as in proximity to the childcare centre.
- Installation and sampling of groundwater monitoring wells (8 to 12 m in depth) in AoPC and down hydraulic gradient of these areas to assess the lateral and vertical extent of PFAS impacted groundwater.
- Targeted surface water and/or sediment sample locations from the drainage system within Robertson Barracks, the southern drainage channel and Milners Creek.
- Sampling of groundwater abstraction bores both within and outside of the investigation area that are used for potable purposes.
- Sampling of surface soils/sediments and surface water from potential areas of inundation where stormwater overflow or surface water is likely to pool.

The DSI confirmed the coincident nature of identified impacts within the source areas identified in the SAQP (Senversa, 2017b), indicating legacy AFFF was unlikely to have been widely used across many parts of Robertson Barracks, with PFAS concentrations detected within three AoPC as follows.

- AoPC 1: the former Emergency Response Squadron (ERS) compound within Building 137 and immediate surrounds (Contaminated sites register (CSR) number – CSR_NT_000162).
- AoPC 2: 17 Combat Service Support BDE Elements where the ERS parked their trucks prior to moving to Building 137 (CSR number – CSR_NT_000133, CSR_NT_000165 and CSR_NT_000245).
- AoPC 5: Wash down bays and refuelling areas within the southern portion of Robertson Barracks. The drainage network also culminates in this area of Robertson Barracks (CSR number – CSR_NT_000241 and CSR_NT_000108).

The key findings of the DSI that included both Dry and Wet season sampling events are briefly summarised below. The analytical results were compared to screening values in accordance with the PFAS National Environmental Management Plan (NEMP) (HEPA, 2018). It is noted that key findings in terms of PFAS concentrations and risk drivers do not vary markedly between Wet and Dry seasons and so findings have been summarised collectively in this Executive Summary but are discussed in detail by season within the body of the report.



Soil

Concentrations of PFAS exceeding the human health screening values for residential use with gardens/accessible soil were reported from verges of access roads or vegetated areas in close proximity to or down gradient of AoPC 1 or AoPC 2 and 5. These screening values were used as a conservative measure for initial screening purposes given the presence of residential units and a childcare centre on Robertson Barracks. However, the areas where exceedances of the screening values for residential use with gardens/accessible soil are not near these sensitive uses and therefore the exceedances of these values for access to soil and gardens is not deemed applicable. No exceedances of the human health screening values for residential with minimal access to soil, public open space or commercial/industrial use were reported which are considered to be more appropriate for the land use in these areas.

No exceedances of the interim ecological direct exposure screening values for public open space were also reported from either sampling events. Ecological screening values for soil have yet to be finalised in Australia and it should be noted that the ecological screening values adopted are interim and not considered to be definitive.

Based on the data collected to date, shallow soils are not considered to pose a direct risk to ecological or human receptors based on current land uses (noting that the potential risks posed by bioaccumulation will require further assessment) nor are soils expected to be significant contributors of PFAS to groundwater. Deeper samples analysed at selected locations were in some cases higher than the surface sample, however, concentrations were within the same order of magnitude and were still well below the adopted screening values.

PFAS detections in soils were generally associated with identified AoPC, particularly AoPC 1 and in proximity to and down gradient of AoPC 2 and 5. PFAS detections outside of AoPC, were noted to correlate with areas in proximity to the drainage network or that are subject to inundation during the Wet season and are therefore related to contaminant transport from the identified AoPC. No PFAS was detected above screening values from soils outside of Robertson Barracks and it is considered that data gaps around the lateral and vertical extent of PFAS impacts in soils within the investigation area have been resolved.

Groundwater

Concentrations of PFAS detected in shallow groundwater within the upper portion of the Bathurst Island Formation were generally localised and limited to groundwater monitoring wells located within Robertson Barracks and the southern drainage channel, with the single exception of PFOS reported equivalent to the laboratory limit of reporting (LOR) but below adopted criteria, from one monitoring well located within the Close Training Area (CTA) during the Wet season. No other concentrations of PFAS in groundwater were reported above the LOR from the CTA or the Marksmanship Training Range (MTR).

PFAS was generally detected in groundwater from and down gradient of AoPC 1 and AoPC 2 and 5 which extends as far south as the southern drainage channel which runs outside of and parallel to the southern boundary of Robertson Barracks. PFAS impacted groundwater in these areas has been delineated and confirms the conceptual understanding of PFAS storage and use at Robertson Barracks. Exceedances of both the drinking water and recreational water quality screening values were reported for these areas.

PFAS was detected outside of these areas near the southern boundary of Robertson Barracks and the north-eastern section of Robertson Barracks. These areas are located outside of the three main AoPC, however, impacts identified at these locations are likely to be related to key surface water/drainage infrastructure and reflect migration from these source areas rather than additional source areas.

PFAS was not identified above the LOR from the MTR to the north and the CTA to the east of Robertson Barracks with the single exception of PFOS reported equivalent to the LOR in the Wet season sampling event from MW021D in the CTA. Further sampling should be undertaken at MW021D to further assess PFAS impacts at this location.



The calculated mass discharges and flux-averaged concentrations of the sum of PFAS in groundwater were in the order of 10^{-4} g/year and 0.01 µg/L (AoPC 1) and 1 g/year and 0.1 µg/L (AoPC 2 and 5). The calculated concentrations are less than those reported in surface waters in or immediately downstream of identified AoPC which supports that groundwater transport is considered a less significant component of PFAS migration, with surface water and sediments being the primary media for consideration. No PFAS was detected in groundwater samples collected from the boundary wells along the western portion of Robertson Barracks confirming that groundwater entering the investigation area from up hydraulic gradient is not impacted by PFAS.

Sampling of groundwater abstraction bores within and outside of the investigation area indicated that PFAS migration has not occurred in the water bearing zones where these private bores are located with no PFAS detected.

Sediment and Surface Water

The sediment and surface water analytical results indicate that PFAS concentrations are generally distributed in areas coincident with, or likely to be receiving drainage from or interacting with groundwater from, the two main source areas where soil and groundwater impacts have also been identified (AoPC1 and AoPC 2 and 5 and down gradient of these two AoPC which are located adjacent to each other). Similar to soil and groundwater, PFOS and PFHxS were the dominant compounds detected in sediment and surface water, with limited PFOA detections indicating a relatively uniform PFAS formulation in the legacy AFFF used at Robertson Barracks.

PFAS concentrations in sediments were generally reported below the LOR and/or the adopted screening values with the exception of immediately down gradient of expected surface water flow of AoPC 1 and along the southern boundary of Robertson Barracks and the southern drainage channel. Concentrations of PFAS in sediment were reported above the human health screening values for residential with gardens/accessible soil from these locations, however, both of these areas are currently used as road verges or vegetated areas.

Concentrations of PFAS were detected in the majority of sediment sampling locations along the southern drainage channel and Milners Creek within the CTA including from the nearest accessible point to Milners Swamp at SD091. Although the full lateral extent of PFAS impacts to below the LOR has not been delineated within sediment down gradient of Robertson Barracks past this point due to access restrictions, no exceedances of the adopted screening values were reported from SD091. Concentrations of PFAS in surface water were detected in the most down gradient surface water sample collected during the Dry season (SW091) with detections of perfluorooctane sulfonate (PFOS) exceeding of the freshwater guideline values for 99% species protection. PFAS was not detected at SW091 during the Wet season, nor in the sample further down gradient within Milners Swamp SW120 during the Wet season.

No discernible trend was identified between concentrations of PFAS compounds in sediment compared with surface water from individual sampling locations, however in general, sampling locations in proximity to the eastern extent of the southern drainage channel generally reported detections of PFAS in both sediment and surface water. A similar pattern is evident in some sampling locations along the eastern boundary of Robertson Barracks and within Milners Creek down gradient of the main drainage channel for the northern portion of Robertson Barracks.

Human Health and Ecological Risks

The refined Conceptual Site Model (CSM) has indicated that a number of exposure pathways have been assessed as being incomplete, particularly in relation to the exposure risks to receptors from impacted soil. Pathways associated with the risk to human and ecological receptors from multiple exposure routes including impacted shallow groundwater, surface water and sediments and the effects of bioaccumulation require further assessment. A human health and ecological risk assessment (HHERA) is being developed to assist with assessing the potential human health and ecological risk as a result of the identified PFAS impacts within the investigation area. Whilst the DSI has not identified any imminent environmental hazards, further receptor assessment at the receiving environment as part of the HHERA process will assist in targeting transport pathways for management considerations for the investigation area.



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 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.

The data collected in this DSI will inform the HHERA Methodology 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 HHERA establishes that an unacceptable risk may be present, the level of risk will be used as a basis to develop mitigation and management measures. The sampling results to date have indicated that the risks to human and ecological receptors may be able to be controlled by the PFAS Management Area Plan (PMAP). The legacy AFFF is no longer in use at Robertson Barracks and therefore the primary source of contamination is no longer present.

Recommendations

The next stage of works for the environmental investigations being undertaken at Robertson Barracks is the completion of the HHERA. Additional sampling is proposed to be undertaken, subject to access, to provide additional data to support the HHERA including an ecological assessment to better understand the aquatic species which may be present and at risk from multiple exposure routes and bioaccumulation of PFAS. This will include additional sediment sampling to include pore water analysis as well as additional sediment and surface water sampling down gradient within Milners Swamp and limited additional groundwater monitoring to confirm previous results.

On-going monitoring at Robertson Barracks should also include additional testing of the groundwater abstraction bores located at the SBRS which are used for potable purposes.