

Ecological Risk Assessment, November 2018 - Executive Summary

RAAF Base Richmond PFAS Investigation

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Executive Summary

Background

The Department of Defence (Defence) commissioned AECOM Australia Pty Ltd (AECOM) to undertake an Ecological Risk Assessment (ERA) to assess the potential for risks to the environment resulting from exposure to per and poly- fluoroalkyl substances (PFAS) from RAAF Base Richmond (the Base) and Defence-owned land to the north-east of the Base (known as Rickabys Drop Zone).

For the purpose of the ERA, the combined area of the Base and Rickabys Drop Zone is referred to as “the Site”. This ERA considers both the Site and surrounding off-Site areas to comprise the ‘Study Area’ (SA). Areas within the SA which do not include the Site are termed “off-Site” for the purposes of this report. The Site and SA are presented on **Figure F1** in **Appendix A**.

The Site is an active military base which was established in 1925. From about 1976, as part of typical airbase activities, aqueous film forming foam (AFFF) was used at the Site for fire training and emergency response. AFFF formulations historically used at the Site contained a range of PFAS, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

The Site has been the subject of a broader investigation (the “RAAF Base Richmond PFAS Investigation”) with the aim of characterising the extent of PFAS impacts resulting from the historical use of AFFF products in fire-fighting training and emergency response activities. These investigations have been reported in the Detailed Site Investigation, RAAF Base Richmond PFAS Investigation (AECOM, 2018a) and included the following scope of work:

- Groundwater sampling both on- and off-Site to determine the nature and extent of groundwater impacts;
- Sediment and surface water sampling from water bodies within the SA, including on-Site drainage channels and off-Site waterbodies such as Hawkesbury River, Rickabys Creek, Cooleys Creek and Bakers Lagoon; and
- Soil sampling in on-Site and off-Site locations to assess PFAS concentrations in surface soil and across the soil profile.

The RAAF Base Richmond PFAS Investigation has identified the presence of a range of PFAS in environmental media in both on-Site and off-Site locations within the SA. Available data from the literature and from similar sites indicate that exposure to PFAS in environmental media has the potential to result in bioaccumulation in ecological receptors that access the Site and surrounding impacted environments.

Objectives

The objectives of this ERA are as follows:

- To assess the potential risks to ecological receptors associated with direct exposure (in soil, sediment and surface water) to PFAS present in on-Site and off-Site environments (terrestrial and aquatic) within the SA.
- To assess the potential for indirect risks (through the food chain) to higher order organisms (e.g. piscivorous birds, terrestrial mammals and birds of prey) from the bioaccumulation of PFAS in terrestrial and aquatic organisms exposed to PFAS impacts, both on- and off-Site (within the SA).

A number of representative bird, mammal and reptile species were selected as part of the quantitative food web modelling to enable assessment of potential risks to animals which inhabit the Site and surrounding SA. It is noted that the representative species have been selected to enable assessment of risks across broad trophic groups which have similar, or more conservative, diet and habitat requirements. Therefore, where a particular species may not have been selected it is likely to be represented by a group covered by one of the selected representative species.

This ERA focuses on risks associated with exposure to PFOS and PFOA as representative of PFAS exposures. This is because the majority of available literature has focused on PFOS and PFOA, and it is not currently possible to quantitatively assess ecological risks associated with other PFAS.

ERA Framework and Methodology

The 2018 ERA was undertaken in accordance with guidelines established by the Australian Government; Australia New Zealand Environment Conservation Council (ANZECC), and the National Environment Protection Council (NEPC), which are recognised by the NSW EPA. The risks to ecological receptors of concern (ROC) within relevant trophic levels have been estimated following a methodology that is representative of industry accepted practice in accordance with both Australian and International guidance.

The ERA scope of work included the collection of biota samples, specifically terrestrial invertebrates and plants, aquatic invertebrates and fish, from the Site and surrounding SA to supplement the existing surface water, pore water, sediment and soil data and to allow direct comparison with adopted Tier 1 screening criteria and for incorporation into modelling completed as part of the Tier 2 assessment.

Based on the reported range of PFOS and PFOA results in biota and standard environmental media, site uses, and the various ecological habitats in the SA, the data were divided into terrestrial and aquatic environments at four assessment areas within the SA (with the latter three areas located off-Site), as follows:

- On-Site;
- Bakers Lagoon;
- Hawkesbury River (aquatic environments only); and
- Off-Site (all remaining locations).

A Tier 1 risk assessment was initially completed for soil, surface water and biota data, adopting national PFOS and PFOA ecological screening criteria as provided in the PFAS National Environment Management Plan (NEMP), released by the Heads of EPAs Australia and New Zealand (HEPA) and the Australian Government Department of the Environment and Energy (DoEE) in January 2018.

For assessment areas where the Tier 1 risk assessment identified the potential for risks to ecological receptors through exposure to PFAS, a Tier 2 risk assessment was undertaken to refine this assessment and further consider the bioaccumulative effects of PFAS within the food chain.

The unique structure and chemical properties of PFAS are such that estimation of bioaccumulation using traditional methods (i.e. application of bioaccumulation factors) is not considered appropriate for receptors with complex exposures from multiple exposure sources. For the purposes of this ERA, and in the absence of Australian specific guidance, quantitative food web modelling has been undertaken based on guidance provided by the United States Environmental Protection Agency (US EPA) to evaluate the potential exposure as a result of bioaccumulation of PFAS in the diet of representative mammals, birds and reptiles in the food chain. Food web modelling involves the estimation of intake rates for contaminants of concern using available environmental data, and assumed species-specific exposure parameters. This total exposure has then been compared to toxicity reference values to assess whether exposure is likely to result in potential for adverse effects. Adopted methods are considered appropriately conservative and robust to provide an assessment of potential risk driving pathways and to enable recommendations as to implementation of management measures.

ERA Conclusions

Overall, the outcomes of the ERA indicate that there is potential for unacceptable risks to ecological receptors which may inhabit both terrestrial and aquatic environments on the Site and in the surrounding SA. These risks have been identified based on comparison with Tier 1 screening criteria as well as toxicity reference values in a Tier 2 risk assessment. Primarily these risks have been identified to be driven by:

- the migration of impacts associated with the airfield foam cannon testing area and STP / WTP to on-Site surface water bodies;
- the discharge of PFAS impacted surface water from the Site to Rickabys Creek;
- the discharge of PFAS impacted surface water from the STP / WTP on the Site through an underground pipe to Bakers Lagoon; and
- the bioaccumulation of PFAS in aquatic (fish and benthic invertebrates) and terrestrial organisms (terrestrial invertebrates).

It is noted that there are uncertainties associated with the Tier 1 and Tier 2 methodologies adopted herein, however a range of conservative assumptions have been adopted in the screening assessment (e.g. comparison to reported maximum reported concentrations) and food web modelling (e.g. exposure point concentrations, spatial factors for migratory species) which are considered likely to result in an overall conservative estimation of risks.

Table ES1 provides a summary of the outcomes of the screening assessment and food web modelling. It is noted that whereas the Tier 1 assessment identified potential risks to ecological receptors across the SA (for all assessment areas) based on the screening of reported soil, surface water and biota data against adopted Tier 1 criteria, the completion of the Tier 2 assessment allowed further refinement of the estimated risks to birds, mammals and reptiles associated with each assessment area.

On-Site, food web modelling indicates that there is moderate to high potential for unacceptable exposure risks to birds, mammals and reptiles; however, it is noted that the Site is comprised of limited habitat for ecological receptors, and that the greatest impacts were associated with operational areas that are limited in extent. Therefore, there is potential for reduced risks where ecological receptors are obtaining the majority of their food from non-operational areas of the Site.

For Bakers Lagoon, the food web modelling indicates that there is potential for unacceptable exposure risks to a range of terrestrial and aquatic receptors that consume plants, invertebrates and fish from the lagoon and adjacent areas, as well as aquatic ecosystems within the Lagoon. Limiting the off-Site discharge of PFAS impacted surface water from the STP / TWP to Bakers Lagoon would likely result in reduced surface water and sediment PFAS concentrations in the Lagoon over time. This, in turn, would likely reduce PFAS exposure by receptors within and adjacent to Bakers Lagoon.

PFAS were detected in waters of the Hawkesbury River, but at this time, the available data are insufficient to attribute all PFAS detections within the Hawkesbury River to potential sources originating from the Site. The Tier 1 assessment of birds and mammals exposed to PFAS via fish and invertebrate consumption from the Hawkesbury River identified potential risks, but further assessment using the food web model indicates that risks to these receptors range from "low and acceptable" to minimal and are unlikely to require further assessment and / or management. Potential exposure risks to fish and aquatic invertebrates in the Hawkesbury were identified by comparison of water concentrations of PFOS with aquatic ecosystem guideline levels, however it is noted that the measured PFOS concentrations were below identified effect levels, and therefore there is low potential for adverse effects in fish from the reported PFOS concentrations.

At off-Site locations, food web modelling indicates that there is moderate potential for unacceptable risks to invertivorous and omnivorous terrestrial birds (for both terrestrial and aquatic diet sources) as well as piscivorous birds, although there is a level of uncertainty associated with the likely PFAS exposure. Risks to other food guilds, including mammals and reptiles, were estimated to be "low and acceptable" or minimal. Potential risks within this assessment area are driven by PFOS concentrations in Rickabys Creek. Limiting off-Site discharge of PFAS impacted surface water to Rickabys Creek would likely result in reduced surface water and sediment PFAS concentrations in Rickabys Creek

downstream of the Site. This, in turn, would likely reduce PFAS exposure by downstream aquatic receptors within Rickabys Creek, and potentially exposure by terrestrial receptors along the banks of Creek.

Table ES1 High-Level Risk Summary

Matrix / Food Guild	Potential for Unacceptable Risks				Discussion
	On-Site	Bakers Lagoon	Hawkesbury River	Off-Site (Remaining Locations)	
Tier 1 Assessment					
Soil – potential for toxicity to terrestrial organisms based on reported soil concentrations	Potential	Potential	-	Potential	Reported concentrations of PFOS in surface soils across the SA have the potential to pose an unacceptable risk to ecological receptors as a result of direct contact, bioaccumulation and leaching to groundwater or nearby freshwater environments.
Surface Water – potential for direct toxicity to aquatic organisms based on reported surface water concentrations	Potential	Potential	Potential	Potential	Reported concentrations of PFOS in surface water exceeded the adopted screening criteria (99% species protection criteria for Hawkesbury River and Rickabys Creek and 95% species protection criteria for Cooleys Creek, Bakers Lagoon and on-Site and off-Site unnamed drains and artificial waterbodies). This indicates that there is potential for unacceptable risks to ecological receptors in aquatic environments across the SA. However, for the Hawkesbury River, it is noted that reported maximum concentrations are below the lowest observed effect level for PFOS in fish and therefore the potential for adverse effects is low..
Sediment	?	?	?	?	Not assessed as part of Tier 1 assessment due to a lack of suitable Tier 1 sediment PFAS criteria.
Terrestrial invertebrates – potential toxicity to higher order organisms based on screening of reported terrestrial invertebrate concentrations against wildlife diet values	Potential	Potential	-	Potential	Reported concentrations of PFOS in terrestrial invertebrates across the SA have the potential to pose an unacceptable risk to ecological receptors through consumption by higher order organisms.

Matrix / Food Guild	Potential for Unacceptable Risks				Discussion
	On-Site	Bakers Lagoon	Hawkesbury River	Off-Site (Remaining Locations)	
Terrestrial plants – potential toxicity to higher order organisms based on screening of reported plant concentrations against wildlife diet values	Potential	Potential	-	Low potential	Reported concentrations of PFOS in terrestrial plants On-Site and at Bakers Lagoon have the potential to pose an unacceptable risk to ecological receptors through consumption by higher order organisms.
Aquatic invertebrates – potential toxicity to higher order organisms based on screening of reported benthic invertebrate concentrations against wildlife diet values	Potential	Potential	Potential	Potential	Reported PFOS concentrations in aquatic invertebrate samples collected from all assessment areas indicate that bioaccumulation may result in the potential for adverse effects to higher order organisms that consume the invertebrates.
Fish – potential toxicity to higher order organisms based on screening of reported fish tissue concentrations against wildlife diet values	Potential	Potential	Potential	Potential	Reported PFOS concentrations in fish tissue samples collected from all assessment areas indicate that bioaccumulation may result in the potential for adverse effects to higher order organisms that consume the fish.
Tier 2 Assessment - Terrestrial Ecosystems					
Herbivorous terrestrial mammals	High	Moderate	-	Minimal	Identified risks On-Site and at Bakers Lagoon are primarily a result of the assumed potential for some herbivorous mammals to also consume terrestrial invertebrates. Potentially unacceptable risks have additionally been identified based on the ingestion of surface water and terrestrial plants On-Site.
Herbivorous terrestrial birds	Moderate	Minimal	-	Minimal	Potentially unacceptable risks have been identified based on the ingestion of terrestrial invertebrates and plants On-Site.
Invertivorous / omnivorous mammals	Moderate	Minimal	-	Low and Acceptable	Potentially unacceptable risks have been identified based on the ingestion of terrestrial invertebrates and surface water On-Site.

Matrix / Food Guild	Potential for Unacceptable Risks				Discussion
	On-Site	Bakers Lagoon	Hawkesbury River	Off-Site (Remaining Locations)	
Invertivorous / omnivorous birds	High	Moderate	-	Moderate	Potentially unacceptable risks are primarily based on the ingestion of terrestrial invertebrates across the SA given that this is a key component of the diet. Potentially unacceptable risks have additionally been identified based on the potential for these birds to consume fish, mammals and smaller birds. The sensitivity assessment identified that the adoption of the geometric mean of reported terrestrial invertebrate data Off-Site (Remaining Locations) rather than the maximum results in a 'minimal' risk within this assessment area.
Predatory terrestrial mammals	High	Moderate	-	Minimal	Identified risks On-Site and at Bakers Lagoon are primarily based on the consumption of fish, terrestrial invertebrates and mammals.
Predatory terrestrial reptiles	Moderate	Minimal	-	Low and Acceptable	Potentially unacceptable risks have been identified based on the ingestion of fish, terrestrial invertebrates and mammals On-Site.
Predatory terrestrial birds	High	Moderate	-	Minimal	Potentially unacceptable risks have been identified based on the ingestion of terrestrial invertebrates, mammals and / or birds On-Site and at Bakers Lagoon.
Tier 2 Assessment - Aquatic Ecosystems					
Invertivorous / omnivorous aquatic birds	High	Moderate	Minimal	Minimal	Identified risks On-Site and at Bakers Lagoon are primarily based on the consumption of aquatic invertebrates. In addition, potential risks are associated with the incidental ingestion of sediment from On-Site water bodies.
Invertivorous / omnivorous aquatic reptiles	Moderate	Minimal	Low and Acceptable	Low and Acceptable	Potentially unacceptable risks have been identified based on the ingestion of aquatic invertebrates and fish On-Site.

Matrix / Food Guild	Potential for Unacceptable Risks				Discussion
	On-Site	Bakers Lagoon	Hawkesbury River	Off-Site (Remaining Locations)	
Piscivorous aquatic birds	High	High	Minimal	Moderate	<p>Potentially unacceptable risks have been identified based on the ingestion of fish across the SA, with the exception of the Hawkesbury River for which the potential risks are considered to be minimal. In addition, potential risks are associated with ingestion of aquatic invertebrates from On-Site water bodies and Bakers Lagoon.</p> <p>The sensitivity assessment identified that the adoption of the geometric mean of reported fish data Off-Site (Remaining Locations) rather than the maximum results in a 'minimal' risk within this assessment area.</p>

Notes:

"-" Not assessed.