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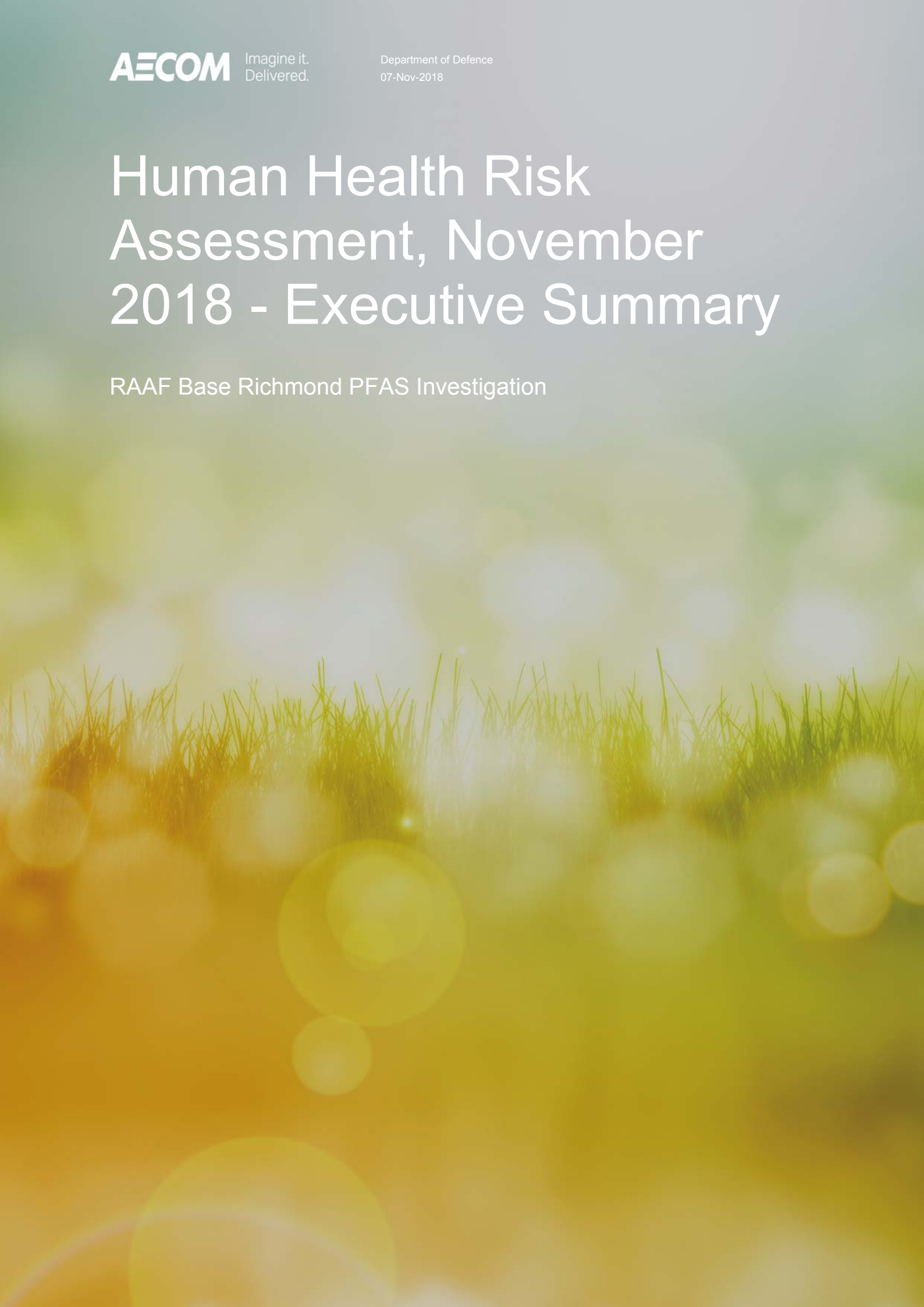
Human Health Risk Assessment, November 2018 - Executive Summary

RAAF Base Richmond PFAS Investigation



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RAAF Base Richmond PFAS Investigation

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Executive Summary

Introduction

The Department of Defence (Defence) commissioned AECOM Australia Pty Ltd (AECOM) to undertake a Human Health Risk Assessment (HHRA) to assess the potential risks to human health resulting from exposure to per- and poly-fluoroalkyl substances (PFAS) from Royal Australian Air Force (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 HHRA, the combined area of the Base and Rickabys Drop Zone is referred to as “the Site”. The surrounding area excluding the Site is referred to as “the Study Area”.

The Site location is shown on **Figure F1** in **Appendix A**, and the Study Area is shown on **Figure F2** in **Appendix A**.

The Site, an active airbase, comprises approximately 414 hectares (ha) of land approximately 55 kilometres (km) to the north-west of the Sydney Central Business District. As part of typical airbase activities, aqueous film forming foam (AFFF) was used at the Site for fire training and emergency response from approximately 1976. AFFF formulations historically used at the Site contained a range of PFAS, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). Between approximately 1976 and 2003 / 2004, the main AFFF product in use at the Site was 3M Lightwater™ which contained PFAS, including PFOS and PFOA.

Previous investigations, including the 2018 AECOM detailed site investigation (DSI), identified the presence of PFAS on and in the vicinity of the Site in soil, groundwater, surface water and sediment. Surface water and groundwater from the Study Area are understood to be currently (or to have been historically) used for a range of purposes, including irrigation and non-potable supply.

Objectives of the HHRA

The objective of this HHRA is to quantitatively assess the potential for key groups of people present off-Site within the Study Area to be exposed to PFAS in soil, groundwater, surface water, sediment, terrestrial biota and finfish.

The HHRA aims to identify:

- Pathways where PFAS exposure is estimated to be low and expected to be associated with no adverse health effects.
- Pathways where PFAS exposure is estimated to have the potential to be elevated in comparison to the tolerable daily intake (TDI) and can be managed to most effectively reduce exposure to PFAS in the future.

HHRA Framework and Methodology

The assessment of potential human health risks associated with environmental contamination has been conducted in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended 2013 (ASC NEPM 2013). The HHRA has been prepared in accordance with the ASC NEPM 2013 and *Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards* (enHealth, 2012a).

Conceptual Site Model

To facilitate preparation of the HHRA, a conceptual site model (CSM) was prepared based on the available information to identify the following:

- A source and mechanism of chemical release.
- A retention or transport medium (or media where chemicals are transferred between media).
- A point of potential human contact with the contaminated media.
- An exposure route (e.g. ingestion, inhalation) at the point of exposure.

Where a linkage between a source and receptor via a complete pathway was identified, these were assessed quantitatively in the HHRA.

The 2018 DSI (AECOM, 2018a) identified a number of activities on- and off-Site which are considered to have resulted in PFAS impacts on soil, sediment, surface water and / or groundwater. This information was used to inform investigations that have described the nature and extent of PFAS impact in the environment, which has subsequently been assessed in this HHRA.

The representative groups of people in the Study Area (receptors) who may be exposed to the PFAS contamination assessed in the HHRA were considered to be:

- Residents (including adults, children and infants).
- Horticultural and agricultural workers.
- Recreational users of publicly accessible surface water including the Hawkesbury River and tributaries. It is assumed that the assessment of recreational users is also protective of infrequent visitors to the area.
- Recreational users of the publicly accessible open spaces in the Study Area such as parks and sporting fields.
- Council workers that during a work day may undertake activities such as maintenance of service pits (where these extend below the groundwater table) and surface water drainage networks.

The key exposure pathways considered in the HHRA are summarised below:

- Incidental ingestion, dermal contact and dust inhalation exposures associated with off-Site activities that involve direct contact with surface soil.
- Consumption of home-grown plant produce (e.g. fruit, vegetables) irrigated with groundwater or surface water, grown in soil historically irrigated with groundwater or historically inundated with floodwater.
- Consumption of home-grown animal produce (e.g. poultry eggs, red meat) where animals drink groundwater / surface water or eat plants irrigated with groundwater or surface water, grown in soil historically irrigated with groundwater or historically inundated with floodwater.
- Consumption of finfish from local waterways.
- Incidental ingestion and dermal contact exposure to surface water, sediment and / or soil associated with outdoor recreation at playing fields or local waterways (e.g. fishing, boating, swimming).
- Incidental ingestion and dermal contact exposure associated with commercial agriculture uses of surface water / groundwater (e.g. irrigation, washing vehicles, washing animals).

Exposure Assessment

Identification of the potential frequency, extent and duration of exposure to environmental media by the above groups of people via identified exposure pathways was based on information gathered from water use surveys and from published data from Australian and international sources.

Human behavioural patterns vary from one individual to another. To account for this while remaining protective of general population exposures, this HHRA considers a range of exposure assumptions:

- A ‘typical’ exposure was based on mean or median parameters for the general population. It is anticipated that the assessment of the typical scenario will be applicable to the majority of the population.
- Upper range exposure was based on reasonable maximum exposure parameters to provide an estimate of exposure that is reflective of the upper / high end of the range of potential exposure. It is considered that the exposure frequency and quantity assumed by the upper scenario will only apply to a small percentage of the population.

Representative exposure point concentrations (EPC) were identified through evaluation of the available data characterising the environmental media and the current understanding of how off-Site

receptors might be exposed to PFAS contamination in the environment. In the estimation of the EPC for home-grown red meat, two sets of EPC were estimated based on two scenarios:

- Scenario 1 assumes that cattle have access to soil and / or surface water in and around Bakers Lagoon; however poultry do not have access.
- Scenario 2 assumes no cattle access to soil and / or surface water in and around Bakers Lagoon.

Overall the data quantity and quality are considered to be sufficient for refinement and characterisation of PFAS related contamination in off-Site areas for the purpose of this HHRA.

Toxicity Assessment

A Tier 1 assessment is not considered appropriate for this HHRA because PFAS have the potential to bioaccumulate within the food chain. Available Tier 1 guideline values have not been established which are protective of the potential for bioaccumulation via all potential pathways relevant to this HHRA. The identification of chemicals of potential concern (CoPC) for this HHRA was therefore based on the availability of toxicity reference values (TRV) either released by an authoritative Australian body, such as the Department of Health (DoH), or derived in a manner consistent with relevant Australian guidelines, for those PFAS detected above the laboratory LOR.

It is noted that there is currently no consistent evidence that exposure to the PFAS assessed in this HHRA causes adverse human health effects (FSANZ, 2017b). However, because these chemicals have been shown to have health effects in animals and because these chemicals persist in humans and the environment, enHealth (2016b) recommended '*that human exposure to these chemicals is minimised as a precaution*'. The TRV adopted in this HHRA were the tolerable daily intakes (TDI) sourced from FSANZ (2017a) for PFOS, PFHxS and PFOA, and from ToxConsult (2016) for PFHxA.

The TDI is a daily intake which, over a lifetime, is considered to be without appreciable adverse health effects, based on toxicological studies and incorporating a range of uncertainty (safety) factors. It is noted that exceeding the TDI does not necessarily mean that health effects will occur.

Risk Characterisation

The potential for adverse threshold effects resulting from exposure to an individual CoPC has been evaluated by comparing the intake for each exposure pathway, expressed as daily chemical intake, with the threshold TRV (adjusted to account for background exposure). The resulting ratio is referred to as the hazard quotient (HQ) (ASC NEPM 2013). To assess the overall potential for adverse health effects posed by exposure to multiple pathways, the hazard quotients for each chemical and exposure pathway relevant to a receptor are summed to calculate a hazard index (HI).

The threshold TRV assumes that there is a level of exposure below which it is unlikely for humans to experience health effects, based on the available toxicological studies. If the exposure level does not exceed the threshold, i.e. if HI is equal to or less than 1, then it is reasonable to conclude that no adverse health effects are likely to be realised (ASC NEPM 2013). These low levels of exposure are considered acceptable from a health perspective because they are not likely to be associated with adverse effects, and as such, the risk estimate is referred to herein as 'low and acceptable'.

Conclusions

The following conclusions are provided with respect to the potential for PFAS exposure to identified people as a result of PFAS in environmental media (soil, groundwater, surface water and sediment), eggs, vegetables, fruit and finfish. These conclusions should be read in conjunction with the data gaps presented in **Section 4.2.3** and sensitivity assessment presented in **Section 8.0**. It is stressed that the risk assessment process involves a number of assumptions regarding Site conditions, human exposure and chemical toxicity. Further, there is unavoidable uncertainty that the algorithms used in the models provide a reliable approximation of reality. As such, conservative assumptions have been made in the selection of parameters for use in the HHRA based on available information. These assumptions will continue to evolve as additional data are collected that will provide verification or further refine the model input parameters.

Overall the outcomes of this HHRA suggest:

- Typical exposure to PFAS for most people in the Study Area is unlikely to result in cumulative PFAS intakes that exceed the TDI, and therefore is associated with a low and acceptable health risk. This includes:
  - Residents who do not consume home-grown eggs
  - Horticultural / agricultural workers
  - Recreational users of local waterways who do not live in the Study Area
  - Council workers.
- For a small number of people who live within the Study Area, and who eat a large proportion of their diet sourced from home-grown eggs from backyard poultry (equivalent to 24 eggs sourced from the Study Area per month for an adult and 14 eggs per month for a child), home-grown red meat from cattle (equivalent to 50 servings of red meat sourced from the Study Area per month for an adult and 26 servings of red meat per month for a child), and / or fish caught from local waterways (equivalent to an annual average of approximately 12 standard servings of finfish sourced from the Study Area per month for adults and seven standard servings of finfish per month for children) there is potential for elevated PFAS exposure to occur. It is suggested that these people reduce their intake of these foods sourced from the Study Area in order to minimise future PFAS exposure. Consideration should also be given to any dietary advice that may be issued by relevant authorities based on the outcomes of this HHRA or subsequent investigations.

Limiting the off-Site discharge of PFAS-impacted water from the sewage treatment plant (STP) / trade waste plant (TWP) to Bakers Lagoon would likely result in reduced surface water and sediment PFAS concentrations in the Lagoon over time. This, in turn, would reduce PFAS exposure for receptors within and adjacent to Bakers Lagoon.

While it is understood that groundwater is not currently used as a source of potable supply in the Study Area, an assessment has been undertaken based on the groundwater data available within this report to examine suitability for future use. It concludes that the concentrations of PFAS measured in a number of off-Site wells (in particular monitoring wells) would suggest that consumption of groundwater is not carried out in the Study Area.

The HHRA conclusions are summarised in **Table ES-1** and **Table ES-2** for residents, **Table ES-3** for commercial agriculture / horticultural workers, **Table ES-4** for recreational users of publicly accessible areas and **Table ES-5** for Council Workers.

Table ES- 1 Summary of HHRA conclusions for residents based on Scenario 1 (cattle access to Bakers Lagoon and surrounding waterways)

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Soil			
Incidental ingestion of soil as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with soil as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Inhalation of dust as a result of outdoor activities or dust tracked back into the home	Low & Acceptable	Low & Acceptable	No precaution suggested
Locally sourced food (for finfish refer to Table ES-4)			
Ingestion of eggs from home-grown backyard poultry that have grazed in areas irrigated or flooded with water containing detectable PFAS	Elevated[1]	Low & Acceptable[2]	Minimise intake of eggs from home-grown backyard chickens that have been exposed to water or soil containing detectable PFAS

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Ingestion of home-grown green vegetables that have been irrigated with water containing detectable PFAS, or have been grown in soil that has been irrigated or flooded with water containing detectable PFAS	Low & Acceptable	Low & Acceptable	No precaution suggested
Ingestion of home-grown red meat from sheep or cattle that have consumed water containing detectable PFAS, or have grazed in areas irrigated or flooded with water containing detectable PFAS in the vicinity of Bakers Lagoon and surrounding surface water network	Elevated[3]	Low & Acceptable[4]	Minimise intake of home-grown red meat that have been exposed to water or soil containing detectable PFAS in and around Bakers Lagoon and surround surface water networks

Notes: [1]Assumes consumption of food sourced from the Study Area equivalent to 24 eggs per month for an adult and 14 eggs per month for a child.
[2] Assumes consumption of food sourced from the Study Area equivalent to three to four eggs per month for an adult and two eggs per month for a child.
[3] Assumes consumption of food sourced from the Study Area equivalent to 50 standard servings of beef per month for an adult and up to 26 standard servings per month for a child.
[4]Assumes consumption of food sourced from the Study Area equivalent to two standard servings of beef per month for an adult and up to one standard servings per month for a child.

Table ES- 2 Summary of HHRA conclusions for residents based on Scenario 2 (no animal access to Bakers Lagoon and surrounding surface water networks)

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Soil			
Incidental ingestion of soil as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with soil as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Inhalation of dust as a result of outdoor activities or dust tracked back into the home	Low & Acceptable	Low & Acceptable	No precaution suggested
Locally sourced food (for finfish refer to Table 36Table ES-4)			
Ingestion of eggs from home-grown backyard poultry that have grazed in areas irrigated or flooded with water containing detectable PFAS	Elevated[1]	Low & Acceptable[2]	Minimise intake of eggs from home-grown backyard chickens that have been exposed to water or soil containing detectable PFAS

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Ingestion of home-grown green vegetables that have been irrigated with water containing detectable PFAS, or have been grown in soil that has been irrigated or flooded with water containing detectable PFAS.	Low & Acceptable	Low & Acceptable	No precaution suggested.
Ingestion of home-grown red meat from sheep or cattle that have consumed water containing detectable PFAS, or have grazed in areas irrigated or flooded with water containing detectable PFAS excluding Bakers Lagoon and the surrounding surface water networks.	Elevated[3]	Low & Acceptable[4]	Minimise intake of home-grown red meat that have been exposed to water or soil containing detectable PFAS in the Study Area.

Notes: [1]Assumes consumption of food sourced from the Study Area equivalent to 24 eggs per month for an adult and 14 eggs per month for a child.
[2] Assumes consumption of food sourced from the Study Area equivalent to three to four eggs per month for an adult and two eggs per month for a child.
[3] Assumes consumption of food sourced from the Study Area equivalent to 50 standard servings of beef per month for an adult and up to 26 standard servings per month for a child.
[4]Assumes consumption of food sourced from the Study Area equivalent to two standard servings of beef per month for an adult and up to one standard servings per month for a child.

Table ES- 3 Summary of HHRA conclusions for commercial horticultural / agricultural workers

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Soil			
Incidental ingestion of soil as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with soil as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Inhalation of dust as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Surface Water and Groundwater			
Incidental ingestion of water as a result of outdoor agriculture / horticultural use	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with groundwater as a result of outdoor agriculture / horticultural use	Low & Acceptable	Low & Acceptable	No precaution suggested

Table ES- 4 Summary of HHRA conclusions for recreational users of publicly accessible areas

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Soil and Sediment			
Incidental ingestion of soil and sediment as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with soil and sediment as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Inhalation of dust as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Surface Water			
Incidental ingestion of surface water as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with surface water as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Locally sourced food			
Consumption of finfish from local waterways by recreational fishers.	Low & Acceptable[1]	Low & Acceptable[2]	No precaution suggested for recreational users of local waterways who does not live within the Study Area. If a recreational fisher lives within the Study Area they may consider minimising their consumption of locally caught finfish and home-grown produce, because cumulative exposure by additional pathways may result in elevated PFAS intakes.

Notes: [1]Assumming an equivalent to an annual average of approximately 12standard servings of finfish sourced from the Study Area per month for adults and seven standard servings of finfish per month for child.
[2]Assuming an equivalent to an annual average of approximately one standard serving of finfish per month sourced from the Study Area for adults and one standard serving of finfish per month for a child.

Table ES- 5 Summary of HHRA conclusions for council workers

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Soil and Sediment			
Incidental ingestion of soil and sediment as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with soil and sediment as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested

Exposure Pathway	Potential PFAS Exposure		Suggested Precautions to Minimise Future PFAS Exposure
	Upper	Typical	
Inhalation of dust as a result of outdoor activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Groundwater and Surface water			
Incidental ingestion of water as a result of maintenance activities	Low & Acceptable	Low & Acceptable	No precaution suggested
Dermal contact with water as a result of maintenance activities	Low & Acceptable	Low & Acceptable	No precaution suggested