Interim Human Health and Ecological Risk Assessment

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

Prepared for:
Department of Defence
26 Brindabella CCT
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Distribution

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Executive Summary

Senversa Pty Ltd (Senversa) has been engaged to undertake a Human Health and Ecological Risk Assessment (HHERA) of per- and poly-fluoroalkyl substances (PFAS) impacts which have been identified on and in the vicinity of RAAF Base East Sale (the site). The HHERA forms part of the Department of Defence's response to the detection of PFAS in the environment which may be associated with the historic use of aqueous film-forming foam (AFFF) at the site. The overall objective of the HHERA is to assess risk to human health and the environment due to the presence of PFAS at the site, and in the surrounding area (the Investigation Area, as presented in **Figure 3**). The HHERA was conducted in accordance with guidance provided in the National Environment Protection (Assessment of Site Contamination) Amendment Measure ('the NEPM') (NEPC, 2013). The first phase of the detailed environmental investigation, the Preliminary Site Investigation (PSI) was completed by Senversa in October 2016 (Senversa, 2016) and provided a review of historical contamination sources and activities at the site and the site's environmental setting. The PSI identified areas of potential interest and data gaps in the understanding of the preliminary conceptual site model (CSM) for further environmental investigation both on and off-site which were addressed in the Detailed Site Investigation (DSI), completed by Senversa in June 2017. The DSI identified a number of PFAS exposure pathways for which additional assessment was required, due to exceedance of adopted screening criteria (or because no relevant screening criteria are available). On this basis, the DSI recommended that a HHERA be undertaken to provide a detailed evaluation of risks to receptors via the pathways identified as requiring further assessment.

The HHERA is based on currently available data, and it is acknowledged that further investigation works may assist with refining the findings of the current risk assessment (specifically where potentially elevated risks are identified), and the requirement for management measures. Therefore, this HHERA is considered to be an interim assessment, which will be updated should additional data become available that allows the assessment to be refined.

This HHERA has assessed risks both on-site, and for the off-site Investigation Area as a whole. The on-site area is considered separately, as the concentrations of PFAS are higher on-site, and the nature of the potential exposures is different. For off-site areas, the HHERA assessed whether there are potentially elevated risks across the Investigation Area as a whole (rather than on specific properties). The aim of this approach is to allow broad conclusions to be drawn for the Investigation Area as a whole, with recommendations made to Defence if specific properties require further assessment. For the assessment of human health risks, the HHERA has adopted health based guidance values as derived by FSANZ (2017).

Additional screening has been undertaken as part of this HHERA. As part of this additional screening, key pathways associated with the greatest potential for exposure were automatically selected for inclusion in the HHERA. For all other pathways, additional screening assessment was conducted to either exclude pathways associated with low and acceptable risk, or include pathways for which further, detailed assessment was required as part of the HHERA. Where risks are assessed to be low and acceptable, no specific additional precautions are required.

Based on the results of additional screening the risks associated with the following pathways were assessed to be low and acceptable:

Recreational water contact in The Heart Morass (people and pets)

- Primary contact (e.g. swimming)
- Secondary contact (e.g. boating or during hunting / fishing from within the water)
- Passive contact (during land based activities at The Heart Morass e.g. nature visits and walks)
- Risks are low and acceptable both for people visiting The Heart Morass, and also for their pets (e.g. dogs who may swim within the Heart Morass)

Incidental contact with soil (on-site and off-site)

- During gardening
- During agricultural work

Incidental contact with water (off-site)

- Risks are low and acceptable for contact with groundwater and surface water
- During gardening with bore water or surface water (e.g. from dams or irrigation lines)
- During agricultural work (e.g. from dams or irrigation lines)

Consumption of home-grown fruit and vegetables (on-site and off-site)

- The assessment conservatively considered the consumption of home-grown produce making up to 100% of produce in the diet (off-site rural properties), or 10% of produce in the diet (for on-site receptors)
- The assessment considered uptake from soil and water used for watering home-grown produce (e.g. tank, bore or irrigation water

Consumption of chicken eggs (off-site)

- Assessment considers potential PFAS uptake into chicken eggs based on soil and water concentrations in the broader Investigation Area, and also for specific properties on which chickens are currently raised

Commercial fisheries pathways (excluding human consumption)

- Carp as crayfish bait
- Carp as fertiliser

Drinking water (on-site and off-site)

- Drinking water supplies on-site off-site are unimpacted by PFAS from the site, and pathways of drinking water ingestion have therefore not been considered further

Terrestrial ecosystems (on-site and off-site)

- Concentrations off-site were below conservative screening levels. A further screening assessment was conducted for on-site soils, and considered the potential risks to terrestrial ecological receptors (including soil microorganisms, invertebrates and plants, and higher order predators)

The following were identified as the key pathways for further consideration in the HHERA:

Agriculture, fishing and game hunting

- Consumption of livestock and dairy products from the area
- Livestock health
- Consumption of recreationally hunted ducks
- Consumption of recreationally caught fish, or fish from commercial fisheries

Incidental contact with water

- Shallow groundwater by intrusive workers on-site
- Drain water by intrusive workers on-site
- Drain water by workers off-site

Aquatic Ecosystems

- Risks to aquatic plants and animals
- Risks to higher order predators consuming aquatic plants and animals

It is noted that there are multiple key pathways for which further assessment has been undertaken in the HHERA. It is however considered unlikely that individual receptors within the Investigation Area would be exposed to PFAS via more than one of these key pathways. In particular, local residents who may be exposed via the home consumption of livestock and dairy products did not indicate (in surveys) that they consume fish and ducks recreationally hunted from The Heart Morass. It is additionally unlikely that visitors to the area (e.g. recreational users of The Heart Morass) or public consumers of livestock, dairy products or fish would be exposed via multiple pathways. On this basis, each of these key pathways has been assessed separately for the purposes of assessing risks.

Overall summary of elevated risks

The HHERA has identified potentially elevated risks associated with the following pathways:

- Home-consumption of meat, offal and milk raised on-site. It is noted that the grazier does not currently consume beef raised on-site, and there are currently no dairy cows on-site, and so a pathway of home-consumption of cattle meat, offal and milk raised on-site is currently inactive. It is however noted that sheep are raised on-site for home consumption, and there are considered to be elevated risks associated with home-consumption of lamb raised on-site. However, it should also be noted that there are uncertainties inherent in estimating produce concentrations from measured concentrations in soil, grass and water upon which this conclusion is currently based, and further assessment is warranted.
- Public consumption of meat, milk or offal raised on-site. It is not considered possible to exclude potentially elevated risks associated with the public consumption of meat, milk or offal raised on-site based on the available data, however more data is required. It is noted that there are currently no dairy cows on-site, and so a pathway of home-consumption of cattle meat, offal and milk raised on-site is currently inactive. The results of the assessment do not necessarily indicate that risks to public consumers are elevated, merely that further investigation and assessment is warranted to assess the level of risk to public consumption of meat, milk or offal raised on-site.
- Home consumption of duck meat and duck liver recreationally hunted from The Heart Morass even at low consumption rates (i.e. 1 serve of duck/month).
- Home consumption or public consumption of fish caught from The Heart Morass
- Exposure to aquatic ecological receptors in surface waters in the Investigation Area, and to higher-order predators consuming biota from these areas as part of their diet.

The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

The risks associated with other pathways considered in detail in the HHERA was assessed to be low and acceptable. Where risks are assessed to be low and acceptable, no specific additional precautions are required. This includes pathways of:

- home consumption or public consumption of meat, milk or offal raised off-site
- incidental groundwater contact on-site, or contact in drains on-site or off-site
- livestock health (on-site and off-site)

Further detail regarding the risk findings (for the key pathways considered in detail in the HHERA) is presented below.

Risk associated with the consumption of livestock and dairy products from the area, and risk to livestock health

On-site Risk

There is considered to be a potentially elevated risk associated with the home-consumption of meat, offal and milk raised on-site. It is noted that there is a single grazier raising livestock on-site. This grazier does not currently consume beef raised on-site, and there are currently no dairy cows on-site, and so a pathway of home-consumption of cattle meat, offal and milk raised on-site is currently inactive. It is however noted that sheep are raised on-site for home consumption, and elevated risks associated with home-consumption of lamb raised on-site cannot be excluded based on the available data. The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted. Further assessment is warranted to assess the potential risks associated with this pathway.

A potentially elevated risk to public consumers (of meat, offal and milk raised on-site and entering the public food supply) cannot be ruled out, noting the uncertainties inherent in estimating produce concentrations from measured concentrations in soil, grass and water upon which this conclusion is currently based, and also noting further assessment is warranted. This result is discussed in more detail below:

- For meat, risks are assessed to be low and acceptable, based on a scenario where 1 kg of meat, or 0.5 kg for a child (around 3% of meat in the diet for a mean consumer) is sourced annually from the Investigation Area for the sole consumption by an individual. This scenario is considered appropriate and conservative for where meat enters a broader regional or national market. The risk assessment also considers (as part of the sensitivity analysis) a scenario where a larger proportion of meat in an individual's diet (10%) is sourced from the Investigation Area; this is protective of a scenario where there is a local sales channel, such that multiple purchases of meat from the investigation area by a single purchaser are plausible. The risks were potentially elevated for this scenario.
- For offal, risks are assessed to be marginally elevated, based on a scenario where 0.25 kg of offal (around 2% of offal in the diet for a mean consumer) is sourced annually from the Investigation Area for the sole consumption by an individual. This scenario is considered appropriate and conservative for where meat enters a broader regional or national market. The risk assessment also considers (as part of the sensitivity analysis) a scenario where a larger proportion of meat in an individual's diet (10%) is sourced from the Investigation Area; this is protective of a scenario where there is a local sales channel, such that multiple purchases of meat from the investigation area by a single purchaser are plausible. The risks were potentially elevated for this scenario.
- For milk, it is noted that there are currently no dairy cows on-site, and so a pathway of public consumption of milk raised on-site is currently inactive.

Overall, while risks were assessed to be low and acceptable based on a scenario where meat or offal enters a broad regional or national market, the risk assessment indicates potentially elevated risks based on a more conservative scenario where there is a local sales channel. Given the uncertainty in the assessment (including the nature of the sales market for produce, and the uncertainties inherent in estimating produce concentrations from measured concentrations in soil, grass and water), it is not considered possible to exclude potentially elevated risks associated with the public consumption of meat, milk or offal raised on-site based on the available data, however more data is required. The results of the assessment do not necessarily indicate that risks to public consumers are elevated, merely that further investigation and assessment is warranted to assess the level of risk to public consumption of meat, milk or offal raised on-site.

Risks to livestock health on-site are assessed to be low and acceptable.

Off-site Risk

Potential risks to home consumers (of meat, offal and milk raised off-site) are assessed to be low and acceptable.

Potential risks to public consumers (of meat, offal and milk raised off-site and entering the public food supply) are assessed to be low and acceptable. The estimated risks for all off-site pathways to public consumers are at least 30 times below the acceptable level. Given this large margin of safety, there is therefore a relatively high level of confidence that risks to public consumers of meat, offal and milk raised off-site are low and acceptable.

Risks to livestock health off-site are assessed to be low and acceptable

Consumption of recreationally hunted ducks

Based on the assessment, there is concluded to be an elevated risk associated with the home consumption of duck meat and duck liver recreationally hunted from The Heart Morass even at low consumption rates (i.e. 1 serve of duck/month). The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

It is noted that there is no known commercial duck hunting from The Heart Morass. As such the HHERA focusses on assessing the risks associated with consumption of recreationally hunted duck.

Consumption of recreationally caught fish, or fish from commercial fisheries

Recreational fishing

Based on the assessment, there is concluded to be an elevated risk associated with the home consumption of fish caught from the area of the Eastern Main Drain Outlet where it enters The Heart Morass, even at low consumption rates (i.e. 1 serve of fish/month). It is noted that there is limited public access to this area of The Heart Morass, as it adjoins privately held land.

There is concluded to be an elevated risk associated with the home consumption of fish caught from the area of the Latrobe River Drain Outlets from The Heart Morass, when moderate-to-high consumption rates (1 -3 serves/week) are assumed. However, the estimated risks are low and acceptable for less frequent consumption (i.e. 1 serve/month).

These conclusions indicate that the risk profile varies between different species and locations. It is not clear if the variation in concentrations represents spatial differences across The Heart Morass, or age, size or species differences or a combination of variables. On this basis, the overall conclusion is that potentially elevated risks cannot be excluded for consumers of recreationally caught fish from the Heart Morass. Based on the available data, potential risks associated with a pathway of home

consumption of recreationally caught fish may extend beyond The Heart Morass. The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

Commercial fisheries

Risks are assessed to be marginally elevated based on the concentrations in eel and tupong measured at the Eastern Main Drain Outlet. It is at least plausible that an assessment of risks from eel and tupong consumption which is based on concentrations measured at the Eastern Main Drain Outlet is likely to be conservative for The Heart Morass as a whole, given the elevated surface water concentrations measured in this area. However, It is understood that larger fish (including eels and carp) than those currently sampled are taken commercially. Based on the available data, it cannot be excluded that PFAS concentrations in these larger, older fish (given their increased lifespan and increased PFAS exposure potential) could be higher than those currently measured. Additional data from such fish would be required to better undertstand the range in concentrations in fish caught for consumption, and the level of risk.

Risks are approximately 20 – 100 times below the acceptable level based on the concentrations measured in carp at the Latrobe River Drain Outlets. Even based on a limited dataset, there is therefore a relatively high level of certainty that the potential risks associated with public consumption of commercially caught fish carp from this area of The Heart Morass are low and acceptable. However, further data would be required to undertake a conclusive assessment of the potential risks associated with public consumption of carp from other areas of the Heart Morass (where PFAS water concentrations are higher), or other species in this area of The Heart Morass. Therefore, while the current data for carp from this area indicates potential risks from public carp consumption are likely to be low and acceptable, it is not possible to extrapolate this conclusion more broadly (in terms of location or species), and potentially elevated risks for carp in other areas of The Heart Morass, or other species in this area, cannot be excluded.

On this basis, it is not considered possible to exclude elevated risks based on a pathway of public consumption of fish from The Heart Morass, however more data is required. The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

PFAS concentrations have only been measured in fish collected from The Heart Morass. While the concentrations in carp measured at the La Trobe River Drain Outlets are associated with low and acceptable risks to public consumers, there is insufficient data to extrapolate this results to draw broad conclusions regarding the potential risks associated with public consumption of commercially caught fish from downstream surface waters.

Incidental contact with groundwater and drain water on-site, or drain water off-site

It is concluded that the potential risk to on-site intrusive workers (maintenance and construction) associated with PFOS, PFHxS and PFOA in groundwater is low and acceptable. However, if large scale construction takes place on site then reasonable precautions to limit construction workers contact with groundwater should be employed, consistent with Defence's management systems and procedures for PFAS management to be implemented by Defence personnel and Contractors. These conclusions are also considered to apply for on-site (Base) personnel undertaking training exercises, as the potential exposure frequency and duration is likely to be lower for Base personnel than for intrusive or construction workers.

As the maximum concentrations measured in shallow groundwater are higher than the concentrations measured in the open drainage network, and the potential for exposure by workers is considered to be similar in nature, these conclusions are also considered applicable for on-site or off-site workers entering the open drainage network. It is additionally noted there is limited data for temporal variability

of drain concentrations, but that shallow groundwater is likely to be discharging into the open drain network; this further indicates the appropriateness of using the shallow groundwater concentrations to assess the likely levels of risk associated with both shallow groundwater contact, and also water contact within the open drainage network.

These conclusions are also considered to apply for on-site (Base) personnel undertaking training exercises, as the potential exposure frequency and duration is likely to be lower for on-site (Base) personnel than for intrusive or construction workers.

Pathways to aquatic ecological receptors, including higher order predators consuming aquatic biota

The ecological risk assessment made the following conclusions:

- Reported surface water PFOS concentrations in The Heart Morass were above the screening level for assessment of adverse effects due to direct contact exposure by aquatic species and bioaccumulation within aquatic ecosystems (draft revised ANZECC/ARMCANZ water quality guidelines).
- Reported PFOS concentrations in aquatic biota (including plants, invertebrates and fish/eels) and ducks exceeded relevant dietary screening concentrations for the protection of a range of relevant bird receptors (Environment Canada (EC) avian diet screening levels, and adjusted levels for different representative bird species).

Overall, it is not considered possible to exclude potential adverse effects to ecological receptors within The Heart Morass, although it is emphasised that for species which source only a portion of their diet from within the Investigation Area, risks may be lower than indicated in this assessment, however more data is required. The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

The measured PFAS concentrations in ducks exceed avian diet screening levels; however, it is noted that these ducks themselves are migratory and are likely to source their diet widely (not just from The Heart Morass); as such, while the measured concentrations pose elevated risks to predators eating these ducks as part of their diet, there is a level of uncertainty around whether the measured PFAS concentrations in ducks relate solely to exposure in The Heart Morass, or to other potential sources in the area.

There is currently insufficient data to fully assess potential risks to aquatic ecosystems in natural surface waters up-stream or down-stream of The Heart Morass, or to provide a full assessment of the variation in concentrations within The Heart Morass. This is because the assessment focussed on assessing the risks from those areas where the potential for exposure is highest. While risks were elevated for all biota collected from The Heart Morass, the concentrations in fish collected from drains between The Heart Morass and the Latrobe River were lower than in other locations of The Heart Morass; the risk to avian predators remained elevated for these fish, but only marginally so for certain receptor types (e.g. eagles). The most elevated concentrations were identified in biota collected from the vicinity of the site's main surface water discharge outlet, the Eastern Main Drain. These results provide some indication that the potential ecological risks may be variable within The Heart Morass and may reduce downstream of The Heart Morass. This could be further understood as part of wider ecological investigations and assessment.

Next Steps

The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted. Potentially elevated risks cannot be excluded for a number of pathways, based on the currently available data. The collection of additional data, including further assessment of extent and temporal variability, may assist with refining the current assessment of the potentially elevated risks, and the requirement for management measures.

Given the understanding of the risks, it is understood that Defence has committed to identify and prioritise management actions to address health, environmental and community issues arising from the identified PFAS impacts that can be implemented in the short, medium and long term. This is the next step in the investigations program and management actions will be presented in a site specific Strategic Management Plan (SMP) to be developed for the site.

This executive summary must be read in conjunction with the full report.

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