EXECUTIVE SUMMARY

Introduction

RPS Australia West Pty Ltd (RPS) in partnership with Wood Public Limited Company (Wood) (RPS/Wood) was engaged by the Department of Defence (Defence) to undertake a Detailed Site Investigation (DSI) at the Lavarack Barracks (the “Base”), located in Townsville, Queensland. The DSI at Lavarack Barracks included investigation of the Base and surrounding off-Base areas, including the suburbs of Annandale, Wulguru, Idalia, and Oonoonba (north and east of the Base, respectively), as presented on Figure A (Below and Appendix A) and collectively termed the Investigation Area (IA).

Figure A: Investigation Area location and boundary

DSI data collection was undertaken in field mobilisation events occurring between July 2018 and October 2018. Surface water discharge sampling was also undertaken in December 2018 to determine the influence of wet season precipitation on PFAS migration via the surface water drainage channels on-Base, which discharge into the residential suburbs of Annandale and Idalia and ultimately the Ross River.

Site setting

The IA is located within the dry tropics of Queensland. The topography of the IA is characterised by a hillslope profile descending from the Mount Stuart massif to the south to the Ross River floodplain terraces. On-Base surface water drainage channels feeds into a system of drainage channels that criss-cross the residential suburbs north and east of the Base and ultimately feed into the Ross River.

Climate conditions and flood impacts

Townsville’s climate is dominated by a wet season (November through April) and a dry season (May through October). The wet season is typically hot and humid with a long-term average precipitation of 1,005mm while dry seasons are generally warm with a long-term average precipitation of 120mm (BoM 2018). During high intensity rainfall events (typically during the wet season) soil and sediments within the drainage channels are mobilised resulting in deposition of sediments at lower velocity locations downstream within the catchment and
within the Ross River and in areas of localised inundation within the floodplain. This wet/dry seasonality is considered the primary influence on contaminant transport pathways within the IA.

Distinct from the annual localised inundation, was the one in one hundred-year, major flooding event which occurred in January/February 2019 (BoM 2019). In the seven days to 4 February 2019, the Bureau of Meteorology site at Townsville Aero recorded 1052.8 mm and 1259.8 mm in the ten days to 8 February 2019. Prior to this event, the Townsville record for a 7-day period was 886.2 mm (January 1998) and for a 10-day period was 925.5 mm (January 1953), (BoM 2019). This event resulted in widespread flooding within the IA as shown in the figure below. Inundation by potentially PFAS impacted waters and redistribution of PFAS impacted soils and sediments may therefore have occurred within the IA.

![Figure B: January / February 2019 flood extent](image)

**Detailed Site Investigation Summary**

The DSI identified key source areas on-Base where the historical use of AFFF for firefighting and training purposes has contributed to PFAS impacts in soil, groundwater, sediment, and surface water. Based on a qualitative assessment of the source areas the following primary source areas were identified:

- Former Fire Station (PSC-4: CSR_QLD_000536)
- Monocell (PSC-5: CSR_QLD_000315)
- Former Fire Training Area (PSC-6: CSR_QLD_000313),

The following secondary sources were also identified;

- Golf Course (PSC-13: CSR_QLD_000537)
- Sporting Fields (PSC-14: CSR_QLD_000537)
- Top Dam (PSC-15: CSR_QLD_000539)
Middle and Lower Dams (PSC-16: CSR_QLD_000539)

Diffuse secondary impacts to groundwater and surface-water were also identified across the Base during the DSI.

The DSI concluded that further investigation was required to confirm the findings of the DSI in the form of Seasonal Monitoring Events. The DSI identified low levels of risk to on-base personnel and recommended completion of a Human Health Risk Assessment to assess to on and off base surface and groundwater users.

Further assessment of the risk to ecological receptors was also recommended owing to the impact identified to surface water, groundwater and soils in the form of a separate Ecological Risk Assessment.

The risk assessments have commenced and are ongoing. This report presents the findings of the first SME.

Objectives and scope

The primary objective of the Seasonal Monitoring Event (SME) was to determine the PFAS related impacts of the 2019 flood event on the IA, confirm the findings of the Detailed Site Investigation (DSI), and provide information on the seasonal variability of PFAS concentrations within the IA. The results from the SME will be used to inform decision-making in the PFAS Area Management Plan (PMAP) and in development of the timing and extent of sampling in the Ongoing Monitoring Plan (OMP).

To achieve this the following sampling regime was undertaken within the IA. Broadly, the locations sampled were chosen to be consistent with the DSI SAQP and in consideration of Defence’s Outside-In approach to PFAS Management, and the SME Scoping document (RPS/Wood 2019b).

Table 1: Seasonal monitoring event scope summary

<table>
<thead>
<tr>
<th>Scope Item</th>
<th>July 2019</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lavarack Barracks boundary monitoring wells</td>
<td></td>
<td>Sampling at 17 Base boundary groundwater monitoring wells, to determine changes in PFAS migration downstream and (potentially) off-Base.</td>
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<tr>
<td>On-Base monitoring wells</td>
<td></td>
<td>Sampling at the groundwater monitoring well within each Potential Source of Contamination where the highest PFAS concentrations were recorded (eight wells) to confirm the concentrations of PFAS in these locations.</td>
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<td></td>
<td></td>
<td>Sampling at groundwater monitoring wells downgradient of key PFAS source areas (PSC-4, PSC-5, PSC-6) to determine changes in the migration of PFAS from these locations.</td>
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<tr>
<td>Off-Base monitoring wells</td>
<td></td>
<td>Sampling at eight off-Base monitoring wells to confirm the concentrations of PFAS in groundwater within the suburban residential areas.</td>
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<td>Assessment of the suitability of groundwater monitoring wells suspected to have been impacted by the 2019 flood event.</td>
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<tr>
<td>On-Base surface water sampling</td>
<td></td>
<td>Surface water sampling at seven on-Base surface water locations including Base boundary discharge points (four samples) and Top, Middle and Lower dams (three samples).</td>
</tr>
<tr>
<td>Off-Base surface water sampling</td>
<td></td>
<td>Surface water sampling at 12 targeted off-Base surface water locations including the eastern and western perimeter of the IA, the surface water drainage channels within the suburb of Annandale (six samples) and the system of man-made lakes within the suburb of Idalia (six samples).</td>
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<tr>
<td>Delineation of surface soil impacts near drainage channels</td>
<td></td>
<td>Collection of 16 soil samples from key areas within the Annandale drainage channels to determine the extent of observed PFAS detections identified during monitoring well installation during the DSI.</td>
</tr>
</tbody>
</table>

Summary of seasonal monitoring event findings

Sampling undertaken during the SME typically confirmed the findings of the DSI with respect to PFAS sources, pathways for migration off-Base and relevant on-Base and off-Base receptors. The findings relating to the scope items as highlighted in Table 1 are outlined below:
**Lavarack Barracks boundary monitoring wells**

The SME sampling confirmed the DSI finding that PFAS is migrating off-Base via groundwater in a northerly and north-easterly direction. PFAS concentrations at the Base boundary were typically noted to have increased relative to DSI sampling conducted in September/October 2019. However, overall SME results typically reflected those collected during the DSI sampling, with exceedances of adopted criteria primarily located within sub-catchments F and G towards the centre of the northern Base boundary, and sub-catchments J and K located towards the north-east corner of the Base.

**On-Base monitoring wells**

PFAS concentrations in July 2019 exceeded human health recreational water (NHMRC 2019) and ecological freshwater 95% (HEPA 2018) criteria in all locations where exceedances were observed during the DSI. Reductions in PFAS concentrations were observed at four of the seven PSCs sampled during the SME; PFAS concentrations were noted to have increased in three of the seven PSC locations:

- Former Fire Station PSC-4
- Monocell PSC-5
- Former Fire Training Area PSC-6
- Former B Squadron PSC-11

Groundwater sampling results downgradient of PSC-4 also increased, indicating that PFAS may be migrating from the Former Fire Station and impacting downgradient receptors within sub-catchment G. Concentrations of PFAS in groundwater at the fire station were identified as the highest on base during the DSI and this finding was confirmed by this SME.

**Off-Base monitoring wells**

A total of seven groundwater monitoring wells were resampled with two of these returning PFAS concentrations above the human health (drinking water) criteria. PFAS concentrations were typically consistent with results from the DSI sampling conducted in September 2018.

**Off-Base surface water sampling**

Surface water sampling conducted within the Annandale drainage channels indicated that PFAS concentrations in surface waters to the northwest of the Base had typically reduced when compared with results from sampling conducted in December 2018. However, PFAS concentrations in surface water to the north and north-east of the Base had increased relative to results from September 2018.

PFAS concentrations within Fairfield lake were noted to have increased when compared to results from August 2018; however, PFAS concentrations remained below all human health (drinking water) and ecological freshwater criteria in all other lake samples analysed.

**Delineation of surface soil impacts near drainage channels**

PFAS were detected in soil samples collected from the Annandale drainage channels however these remained below the relevant ecological (public open space) criteria. The sampling results indicate that soils at these locations are contaminated with low levels of PFAS and are likely to be representative of other areas of low energy flow and infiltration within the off-Base drainage channels.

**Seasonal variability**

This SME was conducted during the dry period, while sampling reported in the DSI was typically undertaken at the start of the wet season. Overall, the results from the SME indicate an increase in PFAS concentrations within relevant media compared to results from the DSI, however the overall the number and locations of guideline exceedances corresponded broadly to those identified in the DSI, and on this basis can be considered to confirm the findings of the DSI.
While some variability in concentration would be expected as a result of increased water input in the wet season when compared to the dry season, it is noted that in general concentrations of PFAS have increased relative to the DSI data. This is not considered evidence of a trend as this SME was conducted in the dry season following extreme weather event, i.e. a one-in-100-year flood when the yearly mean Townsville rainfall was exceeded in a two-week period. The results are therefore not considered to be reflective of what would be expected from typical seasonal variation.

**Conceptual Site Model review**

The source-pathway-receptor linkages outlined in the CSM were reviewed following completion of the SME. Based on the results, there is evidence of PFAS migration from existing on-Base sources to off-Base receptors. The primary mechanism for PFAS migration off-Base was identified as surface runoff during seasonal rainfall events, typically occurring during the wet season (November to April).

Off-Base soil sampling within the surface drainage channels indicates that soils within the drainage channels at key low-energy locations receive PFAS contamination from surface water and sediments mobilised during seasonal flow events and may be considered a sink of PFAS off-Base. However, the finding does not significantly alter the source-pathway-receptor linkages identified within the CSM.

Based on a comparison of the findings of the DSI and SME, RPS/Wood consider the existing CSM provides an appropriate assessment of the valid and potentially valid pollutant linkages. Further assessment as part of the HHRA, ERA, PMAP and OMP will permit refinement of the CSM. The CSM is summarised in Figures C and D.

**Figure C: Conceptual site model including catchments G, F, R, S, & T (RPS/Wood 2019a)**
Figure D: Conceptual site model including catchments J, K, V (RPS/Wood 2019a)

Conclusions

Based on the results of the SME, there is evidence of PFAS migration from existing on-Base sources to off-Base receptors. The primary mechanism for PFAS migration off-Base was identified as surface runoff during seasonal rainfall events, typically occurring during the wet season (November to April).

Soil and groundwater contamination associated with the Former Fire Station (PSC-4 located within sub-catchment G) were identified as the largest key point sources of PFAS on-Base during the DSI investigation. The findings of SME support the findings of the DSI and confirm that this location remains the key source area contributing to the off-Base PFAS pollutant linkages identified in the CSM. PSC-4 and sub-catchment G are therefore considered key targets for any future response actions to be developed as part of the PMAP.

Comparison of the data collected in this SME with that collected and reported on in the DSI has not identified a significant change to the source-pathway-receptor linkages presented within the CSM. Results from this SME are therefore considered to support the findings of the DSI.

Although an assessment of the impact of seasonal variability in PFAS concentrations on and off base within the IA was considered, variation in results from samples collected pre and post the 2019 flood, are not considered to be reflective of typical seasonal variation. On this basis ongoing seasonal monitoring to permit comparison of PFAS concentrations within the IA is recommended and will be presented in the PMAP and OMP currently being developed.