Williamtown Sand Syndicate – Per- and Polyfluoroalkyl Substances Annual Risk Review

398 Cabbage Tree Road, Williamtown, New South Wales, 2318

25003700.001A

20 March 2025

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Integrated Environmental Management Solutions
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Attention: Kristen McMahon

Subject: Williamtown Sand Syndicate – Per- and Polyfluoroalkyl Substances Annual Risk Review
398 Cabbage Tree Road, Williamtown, New South Wales, 2318

EXECUTIVE SUMMARY

Kleinfelder Australia was engaged by Integrated Environmental Management Australia (IEMA), on behalf of the Williamtown Sand Syndicate (WSS), to undertake a review of the 2024 quarrying activities at Newcastle Sand and determine whether these activities have changed the potential for local residents to be exposed to per- and polyfluoroalkyl substances (PFAS). Regional PFAS contamination in the quarry area is related to contamination at and from the Department of Defence (DoD) Williamtown Royal Australian Air Force Base ("the Base"). PFAS has been identified in soil, sediment, surface water, groundwater and biota (terrestrial and aquatic) within and surrounding the Base.

The Newcastle Sand quarry is located at 398 Cabbage Tree Road, Williamtown ("the Site") and is situated partially within the New South Wales Environment Protection Authority (EPA) defined Williamtown Management Area (WMA). The Site is located within the WMA broader management zone, defined as an area where PFAS could be identified at the current time and into the future. EPA precautionary advice, to minimise PFAS exposure within the broader management zone, includes avoiding the use of groundwater and surface water and consuming home-grown produce.

This report addresses the requirement of Schedule 3 Condition 48, in the Development Consent SSD-6125, which requires an assessment of whether quarrying operations are increasing the risk of PFAS exposure for local residents and the environment.

Since 2007, the DoD has been investigating the PFAS presence in various media at and surrounding the Base. The investigations have included multiple rounds of soil, sediment, surface water and groundwater sampling within the EPA defined WMA. Off-Base PFAS surface water and groundwater, PFAS fate and transport models and human and ecological health risk assessments have also been conducted. The human health risk assessment identified four "risk zones", designated Zones A through D, corresponding with a risk hierarchy such that Zone A is the highest risk and Zone D is the lowest. Part of the Site is situated within the low-risk Zone C, with the north-western Site area located outside the defined risk zones. Zones C and D broadly correspond with the WMA broader management area.

Currently, the principal PFAS of concern within the Base and WMA is PFOS, which generally comprises >60% of the PFAS present.

A review of the publicly available information, that includes the Site setting, PFAS sampling and analysis undertaken at the Site and those conducted by the DoD at the Base and surrounding area, leads to the following conclusions:

- PFAS migration from primary or secondary Base sources is unlikely to reach the Site during the quarry's operational lifetime.
- Pre-operational site investigations report that PFAS are not present in Site soil.

- In surface water, PFAS was not found to be present during this monitoring period. Past detections were mainly at SW4 along the easternmost boundary. The likely source of PFAS in this area is from an irrigation channel that is at or near the level of the major channel to the east.
- PFAS are considered unlikely to be currently present in groundwater beneath the site. PFAS was not detected in groundwater at concentrations above the laboratory LOR during 2024 monitoring.
- In 2024 PFAS in the wash plant water and wash plant fines were assessed as part of monthly monitoring activities, in accordance with the site Soil and Water Management Plan (SWMP) (2021):
    - Concentrations of PFAS (PFOA, PFOS and PFHxS) were reported at similar concentrations to previous years with concentrations below the site-specific trigger values.
    - PFAS concentrations (PFOS) were reported in wash plant fines (silt and organic material) in three of four samples. The reported concentrations are similar to previous results and do not exceed the site-specific trigger values.
    - Based on the wash plant sample results, it is probable that a minor PFAS source is present in the wash plant or within the silt and organic material.
- The floor of the quarry is based on maintaining a 0.7m buffer above the maximum predicted ground water level. The ground water elevation (GWE) across the Site reported an average peak of 2.95 m AHD, in July 2024, before decreasing towards the end of the year. Groundwater elevations did not exceed the inferred maximum levels this year.
- At the highest groundwater table levels, 5.051mAHD at BH11 in July 2024, quarry floor levels always remained above the groundwater table and did not intercept groundwater. The nearest groundwater sampling point to the current quarry floor is located at BH10 adjacent to current quarrying activities in Sector 5 and 6.
- Given there was no interception of groundwater and groundwater is unlikely to be PFAS contaminated, this is unlikely to have resulted in any increased risk to on-, or off-Site receptors.

The DoD-commissioned human health risk assessment (HRA) (AECOM, 2017) determined that the Site is within PFAS Risk Zone C for impacts originating from the Base. This quarry PFAS risk assessment review for 2023 compared the upper exposure scenario (i.e., highest concentration) for Risk Zone C, detailed within the DOD HRA, with potential exposures from the quarry and concludes:

- The only product produced onsite where repeatable PFAS detections have occurred and presents a potential risk to nearby residents and ecological receptors is the wash plant fines (silt and organic material), where the stockpiled fines could be transported from the Site via dust dispersion. This is unlikely as:
    - Dust mitigation measures undertaken by Newcastle Sand are likely to reduce this risk, and the fines form an agglomerated matrix, more consolidated and bound than existing silts and clays on site.
    - The PFAS concentrations are below the human and ecological health screening criteria and the risk is therefore currently low and acceptable.
    - The PFAS Risk Review addendum (Kleinfelder, 2024) identified that based on currently reported concentrations within the wash plant fines materials, below adopted criteria, PFAS leachability testing is not required. Additional investigations into the source and leachability of potential PFAS should be undertaken in the event that concentrations exceed the site-specific criteria and trigger additional investigations (SWMP, 2021).
    - Fines are approved for use within onsite rehabilitation or to be blended for use as a landscaping product. With the repeated detections of PFAS, prior to offsite removal and sale of the material under the applicable NSW Environmental Protection Authority (EPA) Resource Recovery Order (RRO) it will be necessary to assess concentrations of PFAS within this material to ensure it is suitable for use and consistent with relevant criteria.

Other quarrying operations are not likely to increase the PFAS risk to residents because:

- PFAS was not detected in any surface water samples in 2024 (WSS January - September Monthly Monitoring reports, Kleinfelder, 2024 and Client provided data October – December 2024).

- PFAS was not detected in any groundwater samples in 2024 (WSS January - September Monthly Monitoring reports, Kleinfelder, 2024 and Client provided data October – December 2024)
- Quarrying operations could result in the establishment of a short-term groundwater mound, however, this is unlikely to change the current groundwater flow regime, noting that groundwater extraction and dewatering is not permitted or undertaken at the site.
- The Base PFAS groundwater plumes are unlikely to intersect the eastern Site boundary prior to 2050, by which time quarrying operations will have ceased and any complete PFAS migration pathways will be unlikely.
- Historical prevailing wind directions and dust mitigation measures undertaken by the quarry operator will not result in additional PFAS impacts to nearby residents.

Considering the information reviewed, the following is concluded:

- Base-sourced PFAS is and has historically been unlikely to be transported to the Site via wind, surface water or groundwater – the Site does not appear to have received PFAS from the Base and does not appear to be acting as a local tertiary PFAS source based on the currently reported PFAS analytical data.
- PFAS was not detected in surface waters during 2024.
- PFAS detections in wash plant water and wash plant fines sampled in 2024 were all reported below the site-specific trigger levels
- The above average rainfall during the first half of 2024 increased groundwater levels during the middle of the year.
- The water table did not exceed the maximum inferred water level at any of the locations this year. Thus, the groundwater level remained at least 0.7 m below the base of quarry operations meaning that any potentially contaminated groundwater did not breach the surface.
- Given the low concentrations of PFAS reported at the site, which have consistently been reported below site specific trigger levels and below applicable human health criteria, the potential risks to health from identified PFAS within the wash plant is considered to be low and acceptable.
- Based on the Addendum PFAS Annual Risk Review (Kleinfelder, 2024), the development of a numerical groundwater flow model is not required at this time, as PFAS concentrations in groundwater are sporadic and are consistently reported below the site-specific trigger level and below applicable health criteria, therefore presenting a low risk.
- In addition, the addendum investigation (Kleinfelder, 2024) has confirmed that wash plant fines material is suitable for onsite reuse for rehabilitation of processed areas or offsite reuse in accordance with the applicable NSW EPA RRO as stipulated by the Biodiversity and Rehabilitation Management Plan version 4.2 (Newcastle Sand, 2024).

Based on the Addendum PFAS Annual Risk Review (Kleinfelder, 2024) the following is recommended:

- Further investigations would be required to determine the exact source of PFAS, however, given the analytical results obtained, this is not considered to be required for the Site at this time.
- Additional investigations into the source and leachability potential of PFAS within the wash plant should only be required in the event that PFAS concentrations exceed the site-specific trigger levels and trigger the requirement for additional investigations, as per Section 8.6.3 of the Soil and Water Management Plan (SWMP, 2021).

1 INTRODUCTION AND OBJECTIVES

Integrated Environmental Management Australia (IEMA) commissioned Kleinfelder to undertake a review of Department of Defence (DoD) and the NSW EPA information regarding PFAS contamination that originated from the Williamtown Royal Australian Air Force (RAAF) Base ("the Base"). The Site is within the NSW EPA declared Williamtown Management Area (WMA).

The WMA was established by the NSW EPA, following DoD commissioned testing of sediment, soil, groundwater, surface water and aquatic and terrestrial biota which identified a large area affected by PFAS contamination originating from the Base (**Figure 1**). The EPA management area comprises four risk zones A through D, with A being the highest risk and D being the lowest risk:

Part of the Site is situated within the low-risk Zone C, with the north-western Site area located outside the defined risk zones. Zones C and D broadly correspond with the WMA broader management area.

In accordance with Condition 48 of the quarry approval note, an annual review of the currently available PFAS information relating to PFAS exposure pathways, for contamination originating from the Base, is required to be conducted. The review is to assess if the quarrying activities have resulted in an increased PFAS exposure for local residents. Condition 48 states the following:

> *"In conjunction with preparation of each Annual Review, unless otherwise agreed with the Secretary, the Applicant shall engage a suitably qualified and experienced independent expert, approved by the Secretary, to review the currently available information on exposure pathways for PFAS contamination originating from the Williamtown RAAF Base, as may be applicable to local residents and the development. This report must assess whether or not quarrying operations are increasing the risk of PFAS exposure for local residents and/or the environment, to the satisfaction of the Secretary. The Applicant must ensure that the Review of PFAS Exposure Pathways reports are placed on its website and are available to the CCC and any interested person on request."*

1.1 OBJECTIVE

The objective of this review is to assess if the quarrying activities have resulted in an increased PFAS exposure for local residents.

2 SITE SETTING

The site is located approximately 1.4 km to the southwest of the Base's western boundary at 398 Cabbage Tree Road, Williamtown NSW. The general land use in the vicinity of the Site is large-lot residential and farming. Residential properties are located to the Site's east, west and south with larger conservation reserves on the northern boundaries. The Tilligerry Habitat Reserve forms part of the western and northern Site boundaries.

The Williamtown area receives a mean annual rainfall of 1,126.8 mm, with the highest rainfall months typically between January and June, where the monthly mean rainfall typically exceeds 100 mm (Bureau of Meteorology weather station 061078). Mean monthly temperatures range between 12.5 ^{o}C and 23.2 ^{o}C, indicating the climate is warm temperate. The prevailing 9 AM wind directions at the Base are north-westerly (25%) and westerly (22%), i.e., away from the Site. Calm is the third most common observation (14%). Wind directions toward the Site are north-easterly (7%) and easterly (5%). Predominant 3 PM wind directions are south-easterly (8%) and southerly (9%). Afternoon wind directions toward the Site are easterly (5%) and north-easterly (6%).

Geologically the Site is located within the Tomago Sandbeds, a linear series of shallow sand dunes that cover approximately 200 km^2 between Newcastle and Lemon Tree Passage, that have a mean thickness of 20 metres[1]. The beds were deposited from the Hunter and Karuah rivers during a period of high sea level and overlie clay and rock. The aquifer is the Tomago Sandbeds, with the underlying clay and rock generally acting as a barrier to vertical groundwater migration. Groundwater hydraulic gradients detailed in the DoD 2022 report (www.defence.gov.au/environment/pfas/Williamtown/publications.asp) indicate a potential southerly groundwater flow direction and with a groundwater mound present to the south of the onsite stormwater retention basin known as Lake Cochran (**Figure 1** and **Figure 2 below**).

[1] Crosbie, R.S., 2003. Regional scaling of groundwater recharge. PhD Thesis, University of Newcastle.

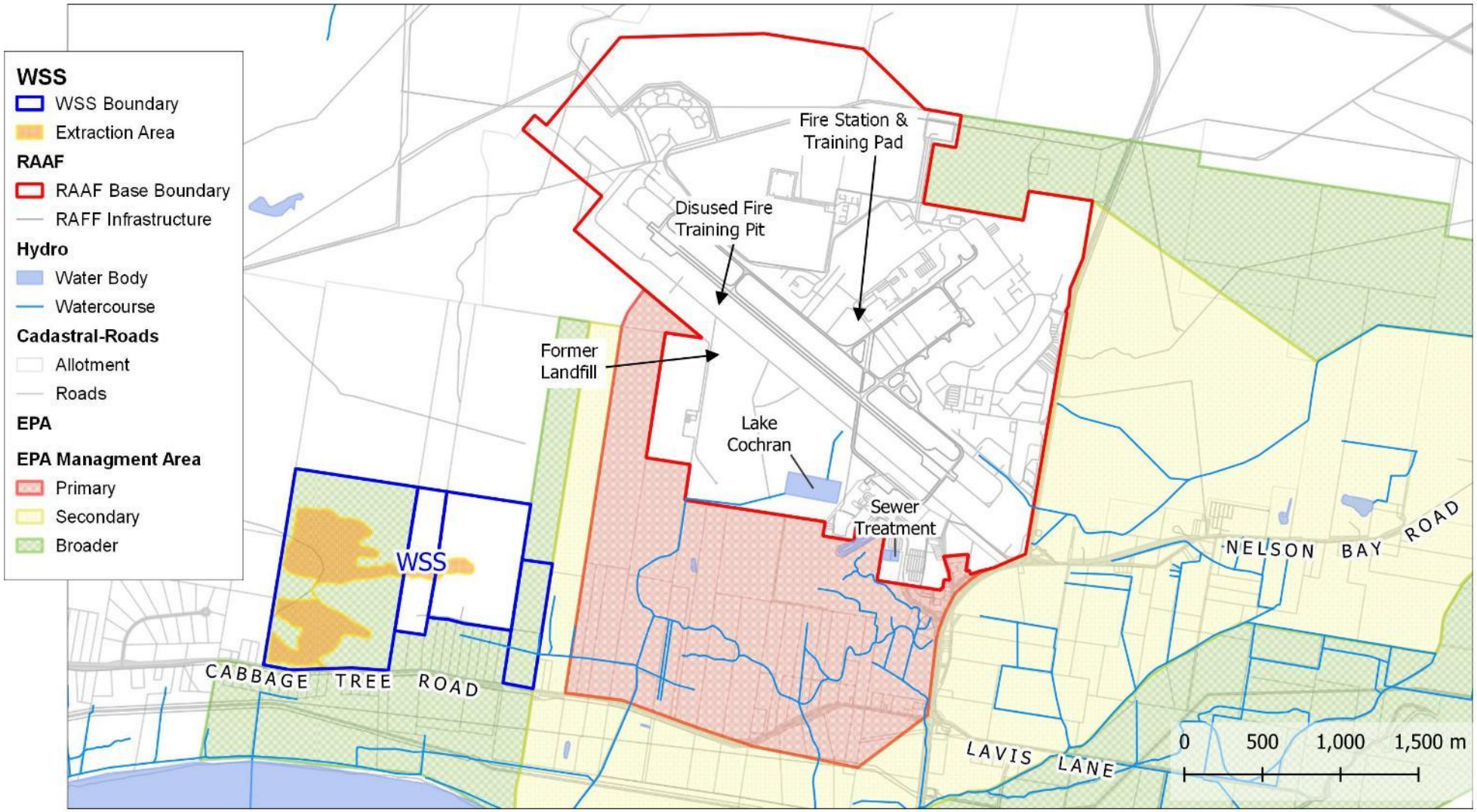

Figure 1. Site regional context.

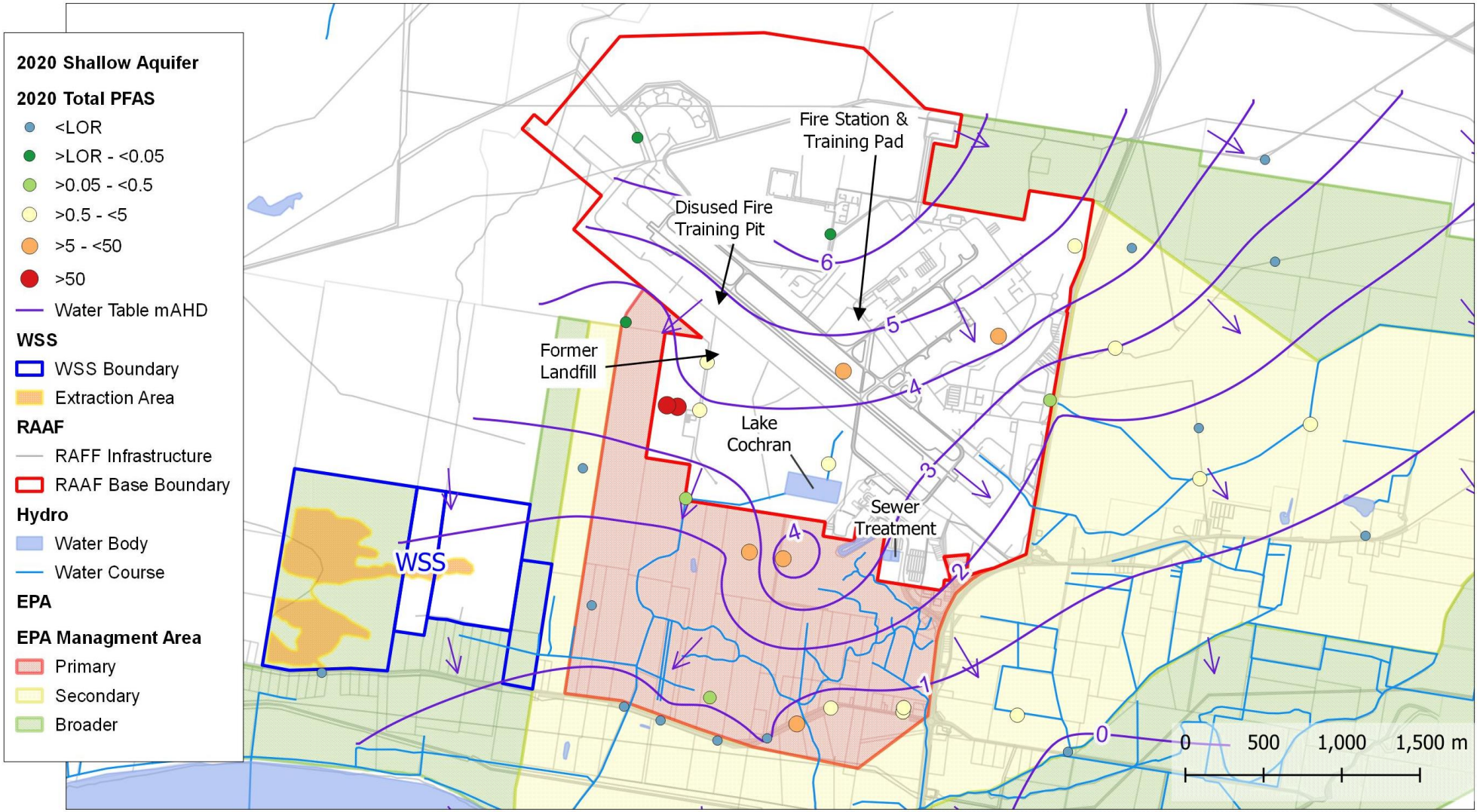

Figure 2. May 2020 shallow aquifer water table elevations, potential groundwater flow direction and total PFAS concentrations.

The Tomago Sandbeds aquifer forms an important water resource in the area. The low salinity groundwater, combined with relatively shallow water table depth (mean depth 1.5 m below ground level) have, historically resulted in the extensive use of the resource as a stock watering, irrigation and drinking water supply.

There is a well-developed man-made surface waterway network within the Williamtown area. Site surface water runoff may discharge to two unnamed surface water channels; one channel discharges directly to Fullerton Cove and the other joins Dawsons Drain, approximately 650 metres from the Site's eastern boundary. Within the Base, Lake Cochran acts as a stormwater collection point which also discharges to the off-Base Dawson's Drain and ultimately Fullerton Cove to the South. An extract from the Soil and Water Management Plan (SWMP) has been included as **Figure 3** below and shows the current mapping of the drainage network.

3 2024 QUARRYING ACTIVITIES SUMMARY

The subject land where the quarry is located occupies four land titles and has an area of 175 hectares (ha), with the quarry disturbance area occupying approximately 43 ha. Approximately 3.25 megatonnes of sand is planned to be quarried from elevated areas over a period of up to 15 years. Sand will be excavated from an elevation of 24 mAHD to an elevation no less than 0.7 metres above the highest estimated water table elevation. The anticipated minimum excavation elevations are approximately 5.6 m AHD in the north and 3.8 m AHD in the south.

Groundwater is not being extracted by the Site operators for quarrying operations, which rely on water sourced from Hunter Water. WSS has commenced a comprehensive groundwater and surface water monitoring program to monitor water levels and quality from the Site and to ensure that sand is not extracted from an elevation less than 0.7 metres above the maximum estimated water table elevation.

Various works have occurred at the Site throughout 2024 (see **Figure 3).** Quarrying operations proceed in pre-determined Sectors, which are mined sequentially based upon the scheduled mining operations procedures. Sectors are shown on **Figure 3** below. Mining operations area preceded by vegetation clearing of these areas and the sequential rehabilitation of previously mined Sectors. An initial wash plant was constructed within the central area of Sector 1 in July 2021. Construction of a second sand wash plant was completed in Sector 3 prior to the February 2023 annual monitoring round, with sand washing operations beginning in March 2023. Subsequently, the original wash plant has since been decommissioned and deconstructed. Monthly PFAS monitoring has continued at the new wash plant since it commenced operations.

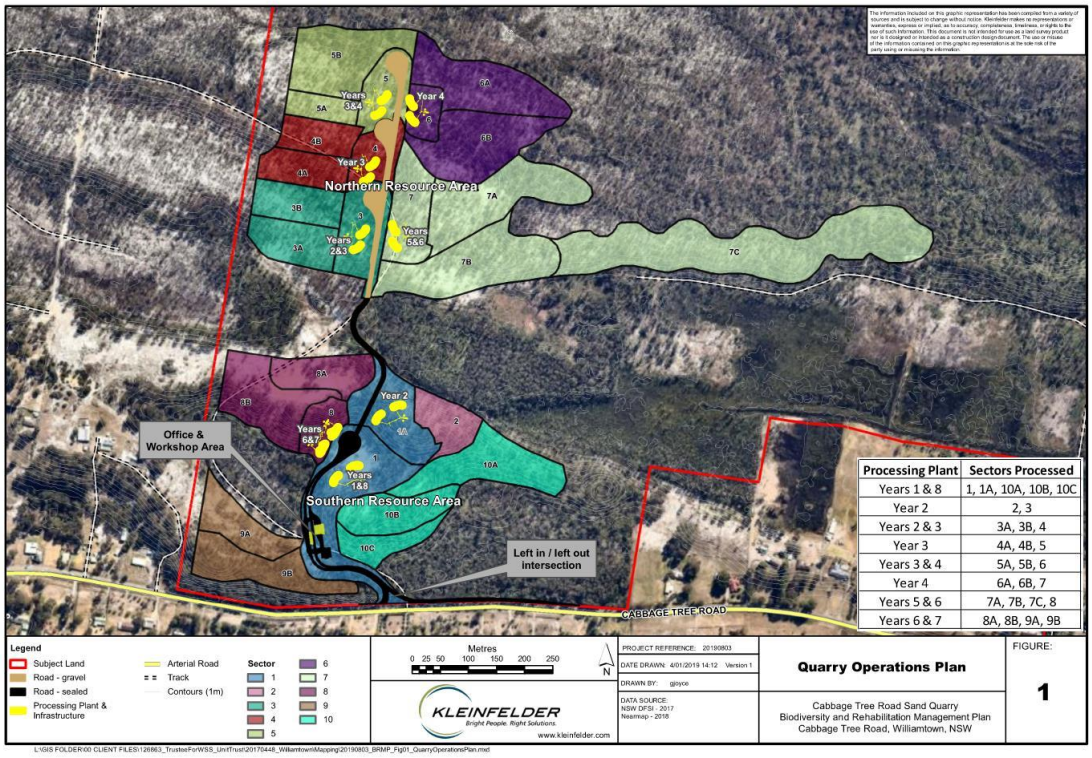

Figure 3: Quarry operations Plan

4 SUMMARY OF PFAS INVESTIGATIONS IN THE WMA

PFAS contamination of surface water, groundwater, sediment, soil and aquatic and terrestrial biota within and surrounding the Base has been reported by both the NSW EPA and DoD. A list of reports is available at www.defence.gov.au/environment/pfas/Williamtown/publications.asp.

The contamination is understood to have been the result of the use of aqueous film-forming foam used during firefighting and emergency response training. The known PFAS contamination sources at the Base are:

- Primary sources – Fire station, two landfills and a disused fire training pit.
- Secondary sources – Lake Cochran, the trade waste treatment plant (eastern Base area) and sewage treatment plant.
- The trade waste treatment plant is not considered a possible source for PFAS contamination that may occur at the Site.

The surface soil samples collected outside the Base boundaries have been predominantly collected across the southern boundary, south of Lake Cochran and the sewerage treatment area. The PFOS + PFHxS concentrations, which generally make up approximately 90% of the total PFAS concentrations in the Williamtown Management Area, in the off-Base surface soil samples range between the laboratory limit of reporting (LOR), 0.2 and 375 micrograms per kilogram (µg/kg). Two soil samples were collected between the Site and the Base's western boundary. The PFOS + PFHxS concentrations in soil were 0.5 and 0.7 µg/kg, with the closest sample to the Site 350 metres northeast (1.3 km from the disused fire training pit (i.e., a primary PFAS source) and 1.1 km from a former landfill (i.e., a secondary PFAS source).

PFOS + PFHxS concentrations above the laboratory LOR (>0.2 to <10 µg/L) have been observed in all surface water samples collected from channels that receive discharge from the Base. Based on the local drainage network, surface water is not considered a likely pathway for PFAS from the Base to the Site under normal flow conditions. However, backwash flooding is considered likely during high rainfall events and could impact upon the Site.

On- and off-Base PFAS groundwater investigations have focused on the Tomago Sandbeds aquifer, with shallow and deep groundwater samples collected and analysed. This review focusses on PFAS concentrations in the shallow aquifer.

The 2020 groundwater Base PFAS monitoring results are summarised in **Figure 2** (above). PFOS + PFHxS concentrations above the laboratory LOR were observed to the south of Lake Cochran, beneath the disused fire training burn-pit, former landfill and current fire station and training pad. From the data reviewed it is evident that there is a groundwater mound to the south of Lake Cochran, suggesting the lake is providing groundwater recharge and is consistent with high PFOS + PFHxS concentrations observed down-gradient from the Lake.

The Site is not directly down-hydraulic gradient from any known primary or secondary Base PFAS source, as shown below on **Figure 4**.

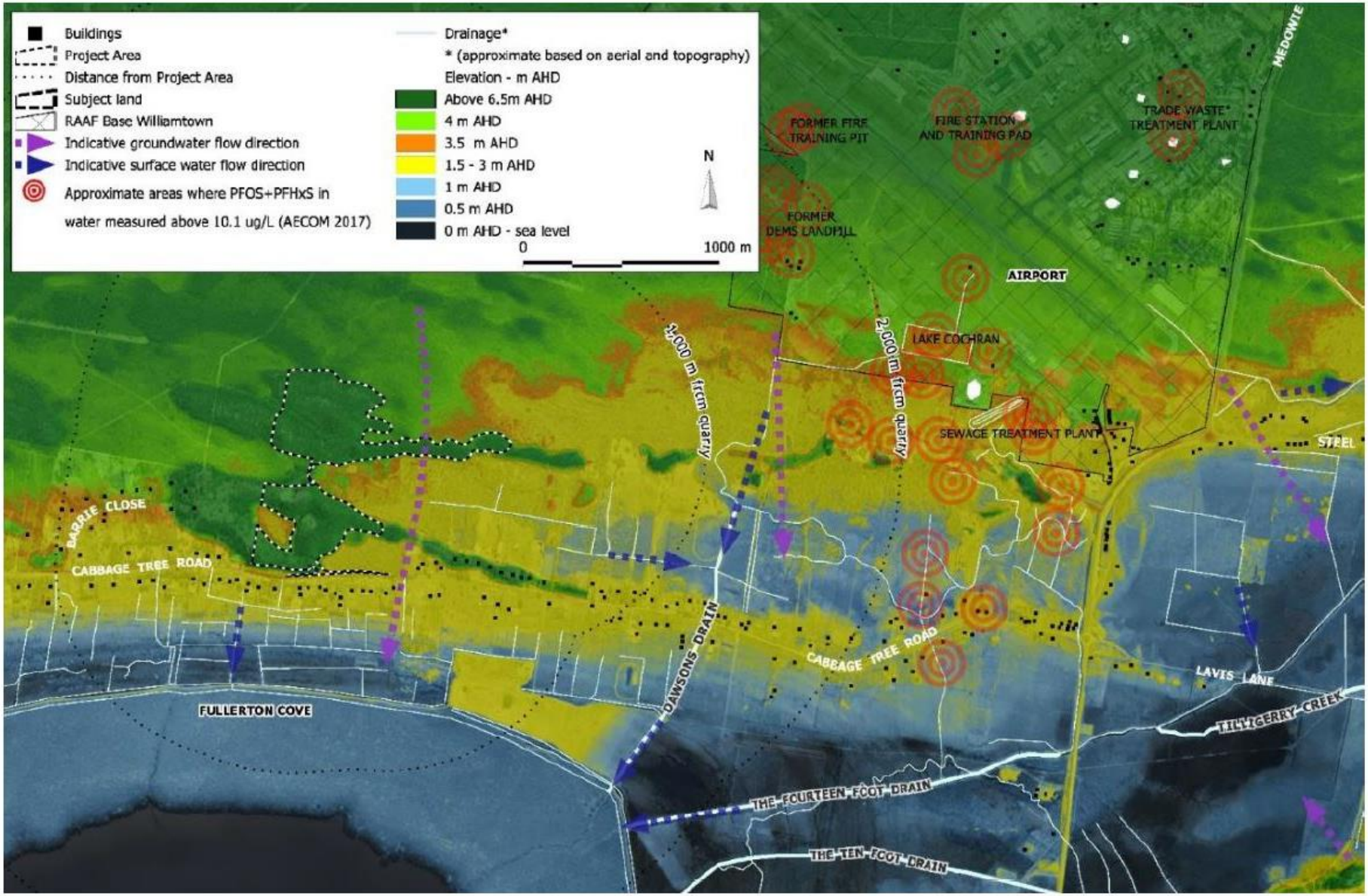

Figure 4: Elevation and drainage network of the project area and subject land in relation to surrounding lands.

With regards to the Base groundwater fate and transport model, four “unconfirmed” PFAS sources (surface water, soil and/or groundwater) located to the Site’s south were identified. It is possible that one of these sources, located near the Cabbage Tree Road Dawsons Drain bridge, is associated with the Lake Cochran discharge.

The other three low PFAS concentration occurrences are located to the Base’s south and cannot be directly linked to the source at the Base.

These locations are:

- One Base groundwater monitoring well and three residential monitoring wells located on Cabbage Tree Road, directly south of the Site.
- Groundwater from a residential well located 550 metres to the Site’s south.
- Groundwater from a residential well located to the south of lot DP629503. It is noted PFAS were not present above the laboratory LOR in a 2019 groundwater sample from MW139 located approximately 75 metres up-hydraulic gradient from the residential well.

The PFAS groundwater fate and transport model (WaterShed Hydrogeo, 2022) estimated the Base PFAS groundwater plume areas may expand through PFAS dispersion and diffusion. In addition, it indicated that by 2050:

- The disused fire training pit and former landfill plumes may merge, although it is noted that the merged plume is unlikely to intersect the Site’s eastern boundary.
- The Lake Cochran PFAS plume should not intersect the Site’s eastern boundary.
- The probable Lake Cochran sourced off-Base groundwater “unidentified” PFAS occurrence is beneath the Site’s DP814078 parcel (eastern Site area) and has total PFAS concentrations between 0.01 and 0.07 µg/L.

5 SITE PFAS INVESTIGATIONS REVIEW

PFAS investigations commissioned by WSS at the Site have involved submission of soil, surface water and groundwater samples to a laboratory that has National Association of Testing Authorities (NATA) accreditation to determine PFAS concentrations in the submitted media. All laboratory results discussed in this report have been compared to the site-specific trigger values established in the Soil and Water Management Plan (SWMP, 2021). A QAQC schedule was also conducted as per PFAS NEPM guidelines for PFAS (HEPA, 2020), where one duplicate and triplicate sample was taken for every ten primary samples.

Surface and groundwater sampling locations are shown on **Figure 5** below.

5.1 SURFACE WATER

Surface water is monitored at four Site locations (SW01, SW02, SW03 & SW04), with 15 surface water samples collected from the four locations between January and December 2024 and submitted for PFAS analysis. During the 2024 monitoring period there were no reported results of PFAS compounds detected above the laboratory LOR in any surface water samples.

5.2 GROUNDWATER

Groundwater samples were collected using high-density polyethylene (HDPE) HydraSleeves, with the samples transferred directly into laboratory supplied PFAS specific sample containers. This method is considered suitable for the collection of water samples, as outlined in approved methods for the sampling and analysis of water pollutants in NSW (EPA 2022).

Fourteen groundwater monitoring wells have been installed and either gauged or sampled at the Site (BH1 to BH12A). BH1 and BH12 were decommissioned in June and July of 2022, being replaced with BH1A and BH12A respectively in August 2022. Baseline results and inferred ground water elevations for these locations are taken from their respective predecessor wells until a baseline can be set. Gauging of BH1A and BH12A was carried out monthly since installation, with an annual sampling in February and quarterly sampling beginning from August 2023 onwards. Gauging of BH5 is carried out quarterly, with annual sampling in February.

MW239S, located within the DP629503 land parcel, was installed during the DoD investigations. Groundwater from the well was reported to have 0.03 µg/L PFOS in March 2017, however, during WSS monitoring 29 samples have been collected from 2019 to December 2024, with all samples returning PFAS concentrations below the laboratory LOR.

During the 2024 monitoring period, PFAS was sampled quarterly/annually, with samples taken in February, May, August and December at wells as outlined in **Table 1**.

Table 1: Monitoring Well locations Sampled for PFAS (2024)

Monitoring Well ID	February	May	August	December
BH1A	✓	✓	✓	✓
BH2	✓	✓	✓	✓
BH4	✓	✓	✓	✓
BH5	✓	*	*	*
BH6	✓	✓	✓	✓
BH7	✓	✓	✓	✓
BH8	✓	✓	✓	✓
BH9A	✓	✓	✓	✓
BH11	✓	✓	✓	✓
BH12A	✓	✓	✓	✓
MW239S	✓	✓	✓	✓

Note: * Gauging only

5.3 WATER TABLE ELEVATION

During the 2024 monitoring period, groundwater elevations showed a stable to decreasing trend following on from the groundwater elevation trends reported between 2023 and March 2024 (Monthly Water Quality Monitoring reports, Kleinfelder, 2024) From April 2024 onwards, groundwater elevations reported a generally increasing trend across the site, peaking in July then falling during the latter part of the year (Monthly Water Quality Monitoring reports, Kleinfelder, 2024) There was an average increase of 0.12 m in groundwater elevation recorded when compared to the previous 2023 levels. The water table elevation contours indicate a southeasterly groundwater flow direction, as presented in **Figure 5**, consistent with the 2019 to 2023 contours.

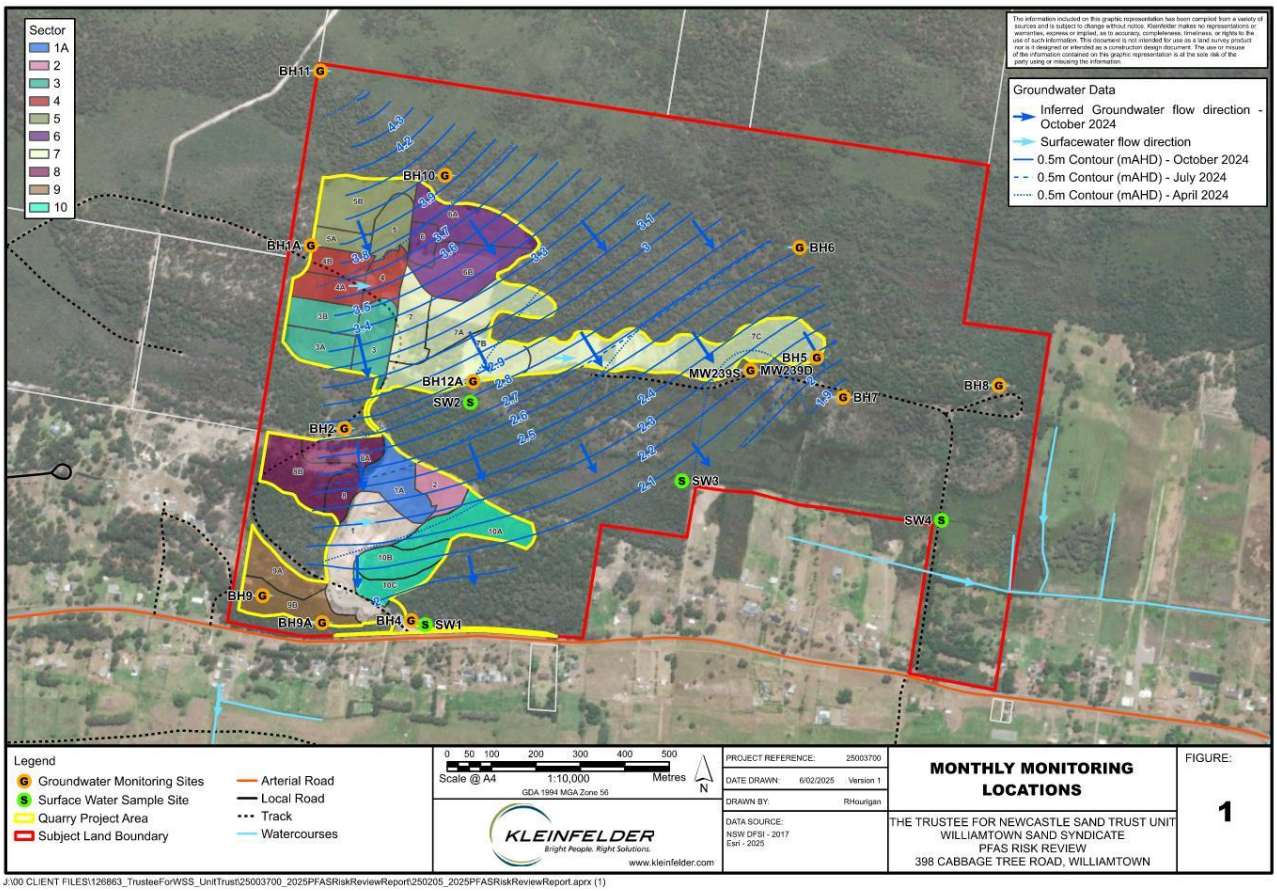

Figure 5: Inferred Groundwater flow direction through the Site during April, July and October 2024

The floor of the quarry is stabilised by maintaining a 0.7m buffer above the maximum predicted ground water level, as per the Maximum Extraction Depth Management Plan (Watershed Hydrogeo, 2019) in accordance with the limit of consent *Condition 6*. Due to this 0.7m buffer above the inferred maximum groundwater level, dewatering due to quarrying activities is not required. During the 2024 monitoring period there were 7 recorded instances of Trigger Action and Response Plan (TARP) trigger level exceedances. The following TARP exceedances were reported between June and September 2024 and coincide with the higher rainfall reported during the latter half of the year

- BH1A reported four TARP exceedances, one being Level 1 in September and three being Level 2 in June, July and August 2024
- BH2 reported two TARP exceedances, both Level 1 in June and July 2024
- BH11 reported one TARP exceedance, Level 1 in July 2024

In the long-term, groundwater rainfall recharge within the sands is likely to be relatively rapid. The removal of sand above the Site aquifer may result in short-term groundwater mounding, due to increased infiltration and lower evapotranspiration, with the mound dissipating due to the high effective porosity of the sands. If a groundwater mound does form beneath the quarried areas, it would be unlikely to significantly change the groundwater flow direction and is more likely to result in producing a steeper off-site hydraulic gradient. The likelihood that the quarrying would lead to increased groundwater flow from the Base to the Site area is very low.

5.4 RAINFALL

Rainfall data was obtained from the Bureau of Meteorology (BOM) website for the Williamtown RAAF Base (Station Number 061078), approximately 4km from Site. The total rainfall recorded for 2024 (1,214.4mm) was found to marginally exceed the annual average rainfall for this station (1,127.5 mm).

During the consecutive months of April, May, June and July 2024, higher than average rainfall was reported, 351.2 mm greater than usually observed during these months.

Conversely, in the latter half of the year, during the months of August, September October, November and December 2024, the recorded rainfall totals were reported at or below the usual monthly averages, 102.8 mm less than usually reported during these months.

The above-average rainfall (351.2 mm greater than average) during the first half of the year, particularly between April and June, elevated the groundwater table across the site during the middle of the year leading to TARP level exceedances as discussed above, followed by a steady decreasing trend due to below average rainfall reported in the second half of the year.

5.5 PFAS

During the baseline 2016 and 2017 monitoring period, seven groundwater samples were analysed for PFAS with all concentrations reported below the laboratory LOR.

From the 2019 WSS monitoring, a concentration of Perfluorodecanesulfonic acids (PFDS) equal to the LOR (0.02 µg/L) was reported for BH4 groundwater, however, the concentration was below the laboratory LOR in follow-up samples.

Table 2: Historical Groundwater PFAS Sampling (2020-2024)

Year	Wells sampled	Number of samples	Analyte above LOR (Location)
2020	10	68	6:2FTS (BH9)
2021	10	87	6:2FTS (BH4)
2022	10	34	6:2FTS (BH4 and BH12)
2023	11	40	6:2FTS (BH4)
2024	11	42	None

5.6 GROUNDWATER SUMMARY

In summary:

- The changes in water table elevation are a consequence of the above average rainfall between April and July of 2024 and lower than average rainfall reported during the final four months of 2024.
- 2024 water table elevations reported some elevated levels during the middle of the year, whilst the remainder of the year was generally in line with historical monitoring pre-2022.

The potential groundwater flow direction, as depicted in **Figure 5**, is consistent with the observed 2020, 2021, 2022 and 2023 directions, from the northeast to the southeast through the site.

5.7 WASH PLANT SAMPLES

Following the Wash Plant addition to the quarry, a condition of the approval included monitoring for PFAS within the wash plant water and sediment. To provide a greater understanding of PFAS distribution at the Site, the wash plant water (WPW) and wash plant sediment fines (WPF) were submitted to the laboratory for PFAS analysis on a quarterly basis. The laboratory results are summarised below in **Table 3**:

Table 3: Wash Plant Water PFAS (January to December 2024)

Month	PFAS Concentrations Above LOR
January	PFOS (0.01 µg/L)
February	ND
March	All <LOR
April	All <LOR
May	ND
June	All <LOR
July	PFOS (0.04 µg/L)
August	PFOA (0.02 µg/L), PFHxS (0.03 µg/L) and PFOS (0.02 µg/L)
September	All <LOR
October	All <LOR
November	All <LOR
December	All <LOR

Notes:
LOR = 0.01 µg/L
ND = No Data

Four wash plant fines samples (comprising silt and organic particles) were collected from the plant between May and December 2024. A wash plant fines sediment sample could not be taken during the February monitoring event due to the removal of the old wash plant and pre-operational testing of the new system being still underway at the time of visiting the site.

- PFOS was detected in three samples March, June and August 0.0009 mg/kg, 0.0013 mg/kg and 0.001 mg/kg respectively, remaining below the site-specific trigger values.

Based on the wash plant waste (fines) sample results, a minor PFAS source within the wash plant could be considered. However, it is also possible that PFAS within wash plant inputs are concentrated within the silt and organic material (Monthly Water Quality Monitoring reports, 2024)

6 ADDENDUM PER- AND POLYFLUOROALKYL SUBSTANCES ANNUAL RISK REVIEW

Following the 2023 PFAS Risk Review (Kleinfelder, 2024a) which was completed for the site, an addendum assessment was undertaken to assess the requirements for the 2023 recommendations to be implemented. The *Addendum per-polyfluoroalkyl substances annual risk review* (Kleinfelder, 2024b) was undertaken to investigate whether there is sufficient risk of increased PFAS exposure, due to Site operations, to warrant the implementation of the 2023 PFAS Risk Review recommendations.

The Addendum Investigation reviewed available site information and PFAS sampling and analysis results undertaken at the site, which led to the following conclusions:

- PFAS concentrations in groundwater and surface water are low and have consistently been reported below site-specific trigger levels and below applicable human health criteria.
- It is noted that 92% of all surface water samples and 98.7% of all groundwater samples have been reported below the laboratory limit of reporting since sampling commenced in February 2019.
- No notable spikes in PFAS concentrations within groundwater, surface water, or the wash plant have been reported at the site since sampling commenced in February 2019.
- Statistical analysis of PFAS concentrations within wash plant fines and wash plant water were determined to present no discernible trend since sampling commenced in February 2019.
- PFAS detections within the wash plant have been investigated and several minor sources have been indicated as potential sources, further investigations would be required to confirm any findings.
- Based on the assessment, the potential for increased risks to health from identified PFAS at the site and within the wash plant is considered low and acceptable.

In summary, additional investigations into the source of PFAS, the development of a numerical groundwater flow model and PFAS leach testing would not be required for current PFAS concentrations at the site. Based on the results obtained, fines material is considered suitable for onsite reuse within the rehabilitation of site as per the biodiversity and rehabilitation management plan (Newcastle sand, 2024) or offsite reuse in accordance with the applicable NSW EPA RRO. The requirement of additional investigations should be considered in the event that PFAS concentrations exceed the site-specific trigger levels and trigger the requirement for additional investigations, as per Section 8.6.3 of the SWMP (2021).

7 DOD HUMAN HEALTH RISK ASSESSMENT REVIEW

In 2016 the DoD engaged AECOM to undertake an off-Base human health risk assessment (HHRA). The off-Base HHRA was updated in 2017. A summary of the findings of the updated HHRA and relevance to the Site area are provided below.

The HHRA evaluated the potential health risks in the Williamtown area to residents (including recreational and commercial fishers and beef farmers) and non-residents (commercial fishers, council workers and visitors) from exposure to PFAS under both typical and upper exposure scenarios. The exposure scenarios are:

Typical exposure scenario:

- Representative of PFAS concentrations that a general or average receptor is likely to be exposed to. This is applicable to the majority of the population.

Upper exposure scenario:

- Calculated based on the PFAS concentration upper 95th percentile in the relevant media and is applicable for receptors that may be in close proximity to media with elevated PFAS concentrations, within a localised area, such as a residential groundwater well.
- The upper exposure scenario is considered suitable for quarry workers who would have a generally high risk though ingestion (incidental and via inhalation) and residents near the quarry.

Based on the Stage 2B investigation outcomes the HHRA divided the off-Base areas into zones based on the potential risk that PFAS posed. The Site's local area was designated Risk Zone C (low risk), with the risk zone

encompassing the entire eastern Site area and the southern proposed extraction area. For reference the northern extraction area is not within an identified risk zone.

The HHRA determined risks for Risk Zone C upper exposure scenarios (pathways) are:

Ingestion and contact with groundwater – acceptable.
Dermal contact with soil and Ingestion of soil and dust – acceptable.
Consumption of homegrown eggs – **elevated**.
Consumption of locally grown fruit and vegetables – acceptable.
Incidental ingestion of surface water – **elevated**.
Surface water contact – acceptable.
Incidental ingestion and contact with sediment – acceptable.
Consumption of beef and milk – **elevated**.

7.1 Relevance of Potential On- and Off-Site Exposures

The HHRA determined potential exposure pathways listed above are considered suitable for off-Site residents and on-Site quarry personnel. For nearby residents and quarry personnel, the comparison of the HHRA upper exposure scenario is considered conservative:

For dust inhalation/soil ingestion because:

- PFAS have not been reported above the laboratory limit of reporting in soil samples.
- Dust mitigation measures are required during quarrying activities.

For groundwater exposure because:

- The quarry base will not extend to a depth within 0.7 metres of the highest estimated water table elevation, hence, groundwater management will not be required and groundwater discharge to surface water as a result of quarrying activities will not occur.
- PFAS have essentially not been identified above the laboratory LOR in Site groundwater, hence, PFAS present in groundwater from nearby residential wells is unlikely to have been sourced from the Site.
- The designation of Risk Zone C in the Site area was partially based on a very low PFOS concentration from one well, a concentration that was not subsequently observed.
- Groundwater migration from the Base is unlikely to reach the eastern property before 2050 (AECOM, 2016), by which time quarrying operations will have ceased, and any complete PFAS migration pathways will be unlikely.

Based on the above, the potential for increased PFAS exposure to residents resulting from quarrying activities is considered unlikely.

8 CONCLUSIONS

A review of the currently available information regarding the PFAS contamination originating from the Base and assessed Site derived soil, groundwater and surface water data was undertaken to determine whether quarrying operations will increase the PFAS exposure to nearby residents.

During 2024, sand quarrying activities were ongoing at the Site and expanded further into the northern Site area.

Considering the information reviewed, the following is concluded:

- Base-sourced PFAS is and has historically been unlikely to be transported to the Site via wind, surface water or groundwater – the Site does not appear to have currently received PFAS from the Base and does not appear to be acting as a local tertiary PFAS source based on currently reported PFAS analytical data.
- PFAS was not detected in surface waters during 2024.
- PFAS detections in wash plant water and wash plant fines sampled in 2024 were all reported below the site-specific trigger levels
- The above average rainfall during the first half of 2024 increased groundwater levels during the middle of the year.
- The water table did not exceed the maximum inferred water level at any of the locations this year. Thus, the groundwater level remained at least 0.7 m below the base of quarry operations meaning that any potentially contaminated groundwater did not breach the surface.

- Given the low concentrations of PFAS reported at the site, which have consistently been reported below site specific trigger levels and below applicable human health criteria, the potential risks to health from identified PFAS within the wash plant is considered to be low and acceptable.
- Based on the Addendum PFAS Annual Risk Review (Kleinfelder, 2024), the development of a numerical groundwater flow model is not required at this time, as PFAS concentrations in groundwater are sporadic and are consistently reported below the site-specific trigger level and below applicable health criteria and therefore present a low risk.
- In addition, the addendum investigation (Kleinfelder, 2024) has confirmed that wash plant fines material is suitable for onsite reuse as part of site rehabilitation works in accordance with the Biodiversity and Rehabilitation management plan (Newcastle sand, 2024) or offsite reuse in accordance with the applicable NSW EPA RRO.

8.1 RECOMMENDATIONS

Based on the Addendum PFAS Annual Risk Review (Kleinfelder, 2024):

- Further investigations would be required to determine the exact source of PFAS, however, given the analytical results obtained, this is not considered to be required for the Site at this time.
- Additional investigations into the exact source and leachability potential of PFAS within the wash plant should only be required in the event that PFAS concentrations exceed the site-specific trigger levels or RRO quality requirements and trigger the requirement for additional investigations, as per Section 8.6.3 of the Soil and Water Management Plan (SWMP, 2021).

9 REFERENCES

AECOM, 2016, Off-site Human Health Risk Assessment (RAAF Base Williamtown)

Australian Department of Defence, 2016, Human Health Risk Assessment -Key Findings and Next Steps

Kleinfelder Australia Pty. Ltd., 2024, Monthly water Quality Monitoring Reports (January, February, March, April, May, June, July, August and September)

Newcastle Sand Pty. Ltd., 2024, Biodiversity and Rehabilitation Management Plan, as amended 23 February 2024

Newcastle Sand Pty. Ltd., 2024, Monthly Water Quality Monitoring Reports (October, November and December)

Newcastle Sand Pty. Ltd., 2021 Soil and Water Management Plan, as produced 7 July 2021

WaterShed Hydrogeo, 2019, Maximum Extraction Depth Management Plan, as produced May 2019

WaterShed Hydrogeo, 2022, Numerical Groundwater Model Update, as produced September 2022

If you require additional information or clarification, please contact the undersigned at +61 2 4092 8066. This report should be read in conjunction with the Kleinfelder Statement of Limitations (attached).

Sincerely,

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Attachments

Attachment 1: Statement of Limitations

ATTACHMENT 1: STATEMENT OF LIMITATIONS

STATEMENT OF LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data known to date. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided. The science of climate change and translating climate risks into design criteria are new and evolving practices, involving many uncertainties. The projections made in this report only reflect the professional judgment of the Project Team applying a standard of care consistent with the level of care and skill of other professionals undertaking similar work in the same locality under similar conditions at the date the services are provided. For these reasons, the recommendations, predictions, and projections made within this report provide guidelines based on the knowledge available to Kleinfelder as of the date provided based on Kleinfelder's review of the resources [identified below]. Any predictions or projections made in this report are not guaranteed predictions or projections of future events. The nature and climate impacts may differ significantly from predictions based on currently available data. Kleinfelder recommends that the results of these evaluations be updated over time as science, data, and modelling techniques advance. Unless so engaged, Kleinfelder disclaims any undertaking to update these predictions in the future. Any reliance upon maps or data presented herein used to make decisions or conclusions is at the sole discretion and risk of the user. This information is provided with the understanding that the data is not guaranteed to be accurate, correct, or complete and assumes no responsibility for errors or omissions. This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report. The work performed was based on project information provided by Client. If Client does not retain Kleinfelder to review any plans and specifications, including any revisions or modifications to the plans and specifications, Kleinfelder assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from Kleinfelder's engineer that such changes do not affect our recommendations. Failure to do so will vitiate Kleinfelder's recommendations. In addition to the above, the footer of letters and letter reports must indicate the Kleinfelder copyright, and the bottom front page of a bound report must contain the following: