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Greenacre Facility
PFAS Management Options Assessment

1 Introduction

Fire and Rescue NSW (FRNSW) engaged GHD Pty Ltd (GHD) to undertake a management options assessment (MOA) for the FRNSW Greenacre site, located 1 and 1A Amarina Avenue, Greenacre NSW 2190 (the 'site'). The MOA was required to provide a discussion document for a remediation workshop to be held in Sydney in 2018.

The MOA was in response to identified contamination from per- and poly-fluorinated alkyl substances (PFAS) which were derived from the former use of specific aqueous film forming foams (AFFF) at the site.

2 Purpose

The purpose of this report is to provide FRNSW with an understanding of the potential management options to address onsite and offsite contamination of soil, groundwater and surface water.

The document first summarises the site setting and constraints, potential remedial/management options and then some suggested management scenarios for discussion.

3 Approach

The approach used to develop the MOA comprised:

- Assessment of the results of previous investigations at the site;
- A data gap analysis to identify where further data might be needed;
- A qualitative risk assessment to inform the level of remediation required;
- Assessment of the volumes and extents of contamination;
- A remediation options assessment to select the most suitable remedial and/or management technology to address the contamination issues;
- Selection of remediation and or management options for discussion.

3.1 Previous analytical results

A preliminary site investigation (PSI) was undertaken by GHD in 2016 to identify potential sources of contamination and areas of potential concern and develop a sampling and analytical plan for further intrusive investigations on the site. The findings of the PSI are reported in:

- GHD (2016) *Fire & Rescue NSW, Greenacre PFAS Investigation, Preliminary Site Investigation and Sampling and Analysis Quality Plan*. August 2016 (the PSI).

Following the PSI, an environmental site assessment (ESA) was undertaken by GHD in 2016. The aim of the investigation was to characterised impacts from PFAS on the site and the surrounding environment. The findings of the ESA are reported in:

- GHD (2017a) *Fire & Rescue NSW, Greenacre Facility, Environmental Site Assessment - PFAS.* April 2017.

A further ESA was undertaken in May 2017. The findings of the May 2017 ESA are reported in:

- GHD (2017b) F*ire & Rescue NSW, Greenacre Facility, Phase 2 Environmental Site Assessment - PFAS.* July 2017.

The key findings of the two ESAs are summarised as follows:

- The inferred groundwater flow is complicated by an apparent groundwater 'sink'. Groundwater appears to flow towards this sink from the north and south with a component of flow towards the eastern boundary. Groundwater depths range from approximately 2 m to 4 mTOC.
- Groundwater was generally brackish
- All soil PFAS results were generally less than the laboratory limit of reporting (LOR) and/or several orders of magnitude below the nominated screening levels under a commercial/industrial land use scenario (20 mg/kg). The highest PFAS concentration in soil was 2.05 mg/kg (total PFAS) reported in onsite location MW05 at a depth of 0.16-0.25 m.
- Sediment samples from site drains reported low PFAS concentrations, with the highest being 8.9 mg/kg total PFAS. This was recovered from a main warehouse and workshop building in the north of the site.
- Groundwater PFAS exceeded the adopted drinking water and freshwater ecological guidelines in most wells and surface water samples. It is noted that drinking water is not a beneficial use given the brackish nature of the groundwater.
- Two water tanks were also sampled. They consisted of a large retention tank for recycled truck water was identified during the PSI (GHD, 2016) on the eastern site boundary (designated as FW01) and a second underground tank (FW02) adjacent to FW01 to the north. Both water tanks reported detectable PFAS.

3.2 Site setting and constraints

The main features of the Greenacre site setting and their relevance to determining appropriate management options are provided in Table 1.

Table 1 Site setting and contaminant issues

Aspect	Summary	Issues
Site location	Located in an urban setting with little or no groundwater extractive use.	Location and land uses may largely restrict exposure scenarios to onsite.
Geology and hydrogeology	The site is underlain by Bringelly Shale near the interface with the Ashfield Shale and further underlain by the Hawksbury Sandstone. Groundwater flow is complicated by site features but appears to have an easterly component. Groundwater quality is brackish. There is three registered groundwater bore within 500 m of the site although they are registered for monitoring rather than extractive use.	Groundwater flow will be controlled by fractures in the underlying geology and yields may be limited. Salinity precludes a number of potential beneficial uses including drinking water.
Hydrology	The closest receiving water body is Coxs Creek, located approximately 1 km south-east of the site. This flows into Cooks River, located approximately 1.2 km east of the site. It is expected that the stormwater systems will intercept surface water flowing from the site before it reaches either of these receptors. However, stormwater drains leaving the site could potentially drain to either of these receptors.	Surface drains may be a significant PFAS migration pathway offsite
Contaminants of concern	PFAS – notably PFOS, PFHxS, PFOA. Identified in soil, sediment, groundwater and surface water onsite and offsite. Water soluble, can sorb to soil and sediments, leachable, resistant to degradation, possibly toxic to animals and humans, bioaccumulate in the food chain, long half-lives in humans and high adverse profile in the media.	The physico-chemical characteristics of PFAS make these chemicals very hard to remove from the environment and to destroy. PFOS_PFHXS exceed screening criteria for drinking water and fresh water ecological in surface water and groundwater. However, these beneficial uses are either not relevant or not likely to be impacted. PFAS have received very negative reporting in the media and have a high perception of risk to the community.

Aspect	Summary	Issues
Contaminant sources	AFFF products containing PFAS are no longer used on the site so no primary sources exist. Significant secondary sources of PFAS contamination include drain contents, soil, groundwater and water storage tanks. Potential sources not yet assessed include the site washdown bay and contaminated trucks entering the site for maintenance.	The site remains a potential source of PFAS contamination to offsite receptors. Trucks entering the site may be a n ongoing source of PFAS to the site if they have legacy PFAS in their tanks.
Contaminant fate and transport	PFAS can leach from soil into groundwater and migrate offsite – however, the site is largely covered by building sand hardstand so leaching may be minimal. . PFAS can migrate offsite in drains. It is currently unclear where groundwater would discharge offsite.	PFAS can migrate considerable distances in groundwater although this is restricted by hydraulic gradients and permeability. Permeability in the fractured rock aquifer may be low so migration from the site via groundwater may be somewhat restricted. A significant mass of PFAS may have migrated via stormwater and sewer discharge from the site. Migration via drains may be more significant that in groundwater.
Regulatory constraints	Currently no accepted waste disposal criteria for PFAS Screening criteria for ecological receptors tend to be very low. The criteria protective of human consumption of impacted biota is generally below laboratory LORs.	Offsite disposal to a landfill is not a currently available option. Offsite disposal to a treatment facility is a potential option
Remedial constraints	PFAS can be destroyed thermally but at very high temperatures i.e. >1400^{o}C. Many other technologies have been tested at bench scale but not full scale. There are method that can remove PFAS from water including filtration methods and reverse osmosis.	Remedial methods are not well established and may be cost-prohibitive if volumes of water and/or soil are large..

3.3 Summary

The information presented above indicated that the site media (soil, sediment, surface water and groundwater) are impacted to varying extents by PFAS. The most likely source of the PFAS is from trucks visiting the site and discharging waste water and from maintenance of the trucks. PFAS may discharge from the site via stormwater and sewers.

4 Management drivers

Based on the data set, there appears to be a mass of PFAS in the site drains and groundwater. It is possible that this mass could migrate offsite via drains and groundwater advection. The ultimate discharge sites for these is not established.

GHD concludes that:

- Impacted PFAS sources include the drains and groundwater onsite. The extent of soil contamination has not been systematically assessed, however, exposure to soils is unlikely due to the site covering (building and hardstand).
- Groundwater contamination may extend offsite as it has been identified in wells close to the eastern site boundary. Whilst groundwater extractive use is considered unlikely in the vicinity of the site, further assessment of the extent of off-site impact is required to further understand potential off-site risks.
- PFAS in drains could migrate offsite in stormwater and sewers and this may be the main immediate risk to offsite receptors.
- Vehicles entering the site for maintenance may continue to discharge PFAS-contaminated products.

5 Management options approach

At this stage the options for PFAS management at the Greenacre site include:

- Reassessment of the trade waste and stormwater system for the site. This may include interception of potentially contaminated stormwater and sewer water leaving the site and/or a more sophisticated waste treatment system.
- Assessment of all FRNSW trucks for PFAS in water tanks and foam tanks (both A and B Class foam tanks).
- Further assessment of offsite groundwater impact.

Until it can be shown that the site would not be recontaminated from truck maintenance activities, the clean up of site drains and groundwater is not recommended.

6 Indicative cost estimates

The review of the site's waste and stormwater system would be the subject of considerable research and planning. No cost is provided at this stage for this process.

Assessment of the FRNSW vehicles would require three samples per truck – one each from the water tank, Class A and Class B foam tanks. Laboratory analysis would be in the order of **$** per vehicle for an extended PFAS suite of 28 PFAS species. A limited analytical suite of PFOS, PFOA, 6:2FtS and 8:2FtS would cost if the order of **$** per vehicle. This does not include costs for sampling, laboratory liaison and reporting.

7 Limitations

This report has been prepared by GHD for FRNSW and may only be used and relied on by FRNSW for the purpose agreed between GHD and the FRNSW as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than FRNSW arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

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The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

Sincerely

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