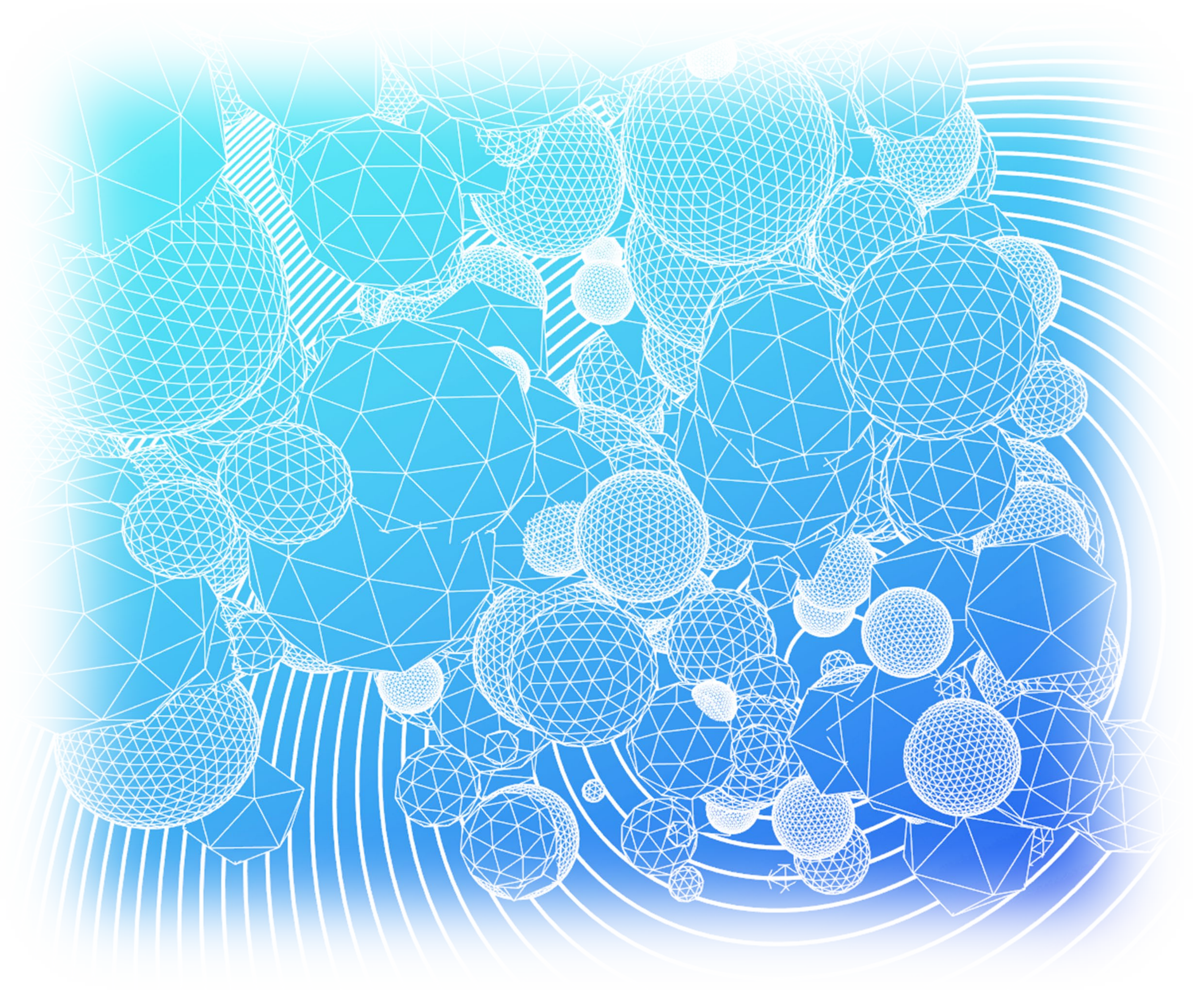

2021 Human Health and Ecological Risk Assessment for PFAS: Parafield Airport

Prepared for: Parafield Airport Limited

13 August 2021

Document History and Status

Report Reference	AALPA/17/R001
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Limitations

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It is prepared in accordance with the scope of work and for the purpose outlined in the Section 1 of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences Pty Ltd has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports for use in this assessment was false.

This report was prepared from April to July 2017, updated in August 2018, December - January 2021 and May 2021, and finalised in August 2021, and is based on the information provided and reviewed at that time. Environmental Risk Sciences Pty Ltd disclaims responsibility for any changes that may have occurred after this time.

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Table of Contents

Appendices:

Glossary of Terms

AAL	Adelaide Airport Limited
PAL	Parafield Airport Limited
Additive Effect	An additive effect is where two or more substances act together to produce a total effect that is the same as the sum of the individual effects
Adsorption	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.
Adverse Health Effect	A change in body function or cell structure that might lead to disease or health problems
ANZECC	Australia and New Zealand Environment and Conservation Council
ASLP	Australian Standard Leaching Procedure
AT	Averaging Time
Background Level	An average or expected amount of a substance or material in a specific environment, or typical amounts of substances that occur naturally in an environment.
BW	Body weight
Carcinogen	A substance that causes cancer.
CF	Unit Conversion Factor
Chronic Exposure	Contact with a substance that occurs over a long time (more than 1 year) (compare with acute exposure and intermediate duration exposure)
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Detection Limit	The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
ED	Exposure Duration
EF	Exposure Frequency
EFSA	European Food Safety Authority
ET	Exposure time
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).
Exposure Assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure Pathway	The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as chemical leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
FSANZ	Food Standards Australia New Zealand
FTG	Fire Training Ground

Guideline Value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organisation (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter- and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines will have different names, such as investigation level, trigger value, ambient guideline etc.
HHERA	Human Health and Ecological Risk Assessment
HI	Hazard Index
HIL	Health Investigation Level
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure).
Inhalation	The act of breathing. A hazardous substance can enter the body this way (see route of exposure).
LOAEL	Lowest-observed-adverse-effect-level: The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals
LOR	Limit of Reporting
MDH	Minnesota Department of Health
NAFP	Northern Adelaide Food Park
No effect level	The tested dose of a substance that does not cause adverse effects in people or animals. See also NOAEL and LOAEL
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NOAEL	No-observed-adverse-effect-level: The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals
PEF	Particulate Emission Factor: The potential concentration of a chemical in dust that might be in air as a result of wind erosion
PFAS	**Per- or Poly-fluoroalkyl Substances**
PFBA	*Perfluorobutanoic Acid*
PFPeA	*Perfluoropentanoic Acid*
PFHxA	*Perfluorohexanoic Acid*
PFHpA	*Perfluoroheptanoic Acid*
PFOA	*Perfluorooctanoic Acid*
PFNA	*Perfluorononanoic Acid*
PFDA	*Perfluorodecanoic Acid*
PFUdA	*Perfluoroundecanoic Acid*
PFDoA	*Perfluorododecanoic Acid*
PFBS	*Perfluorobutanesulfonic Acid*
PFHxS	*Perfluorohexanesulfonic Acid*
PFOS	*Perfluorooctanesulfonic Acid*
6:2 FtS	*1H.1H.2H.2H-Perfluorooctansulfonic Acid*
8:2 FtS	*1H.1H.2H.2H-Perfluorodecanesulfonic Acid*
PFOSA	*Perfluorooctanesulfonamide*
Point of Exposure	The place where someone can come into contact with a substance present in the environment (see exposure pathway).

Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Receptor Population	People who could come into contact with hazardous substances (see exposure pathway).
Risk	The probability that something will cause injury or harm.
RME	Reasonable maximum exposure: The RME represents exposure scenario based on a set of exposure parameters that is representative of expected maximum exposure for that receptor and activity. The RME would not be expected to be exceeded except under highly specific and exceptional circumstances.
Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin (dermal contact)
SWL	Standing Water Level
TDS	Total Dissolved Solids
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicity Data	Characterisation or quantitative value estimated (by recognised authorities) for each individual chemical for relevant exposure pathway (inhalation, oral or dermal), with special emphasis on dose-response characteristics. The data is based on available toxicity studies relevant to humans and/or animals and relevant safety factors.
Toxicological Profile	An assessment that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
Toxicology	The study of the harmful effects of substances on humans or animals.
TRV	Toxicity Reference Value, e.g. an RfD, ADI, TDI, or PTWI. A guideline toxicity value that incorporates uncertainty or safety factors to identify a safe dose assuming daily lifetime exposure to a substance that is unlikely to cause harm in humans.
Uncertainty Factor	Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people (also sometimes called a safety factor).
USEPA	United States Environmental Protection Agency
VPCZ	Vernal Pools Conservation Zone
WHO	World Health Organisation

Executive Summary

Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Parafield Airport Limited (PAL) to review available data and undertake a human health and ecological risk assessment (HHERA) in relating to the presence of per- and polyfluoroalkyl substances (PFAS) at Parafield Airport, South Australia (the “airport”; refer to plans in **Appendix A**).

Previous investigations conducted on-airport have detected concentrations of some PFAS in soil, groundwater and stormwater. PFAS are a family of fluorine-containing compounds with unique properties to make materials stain- and stick-resistant. PFAS are often described as being “ubiquitous in the environment”. They have been widely used in man-made products such as paints, roof treatments, hardwood floor protectant, surface protection products (e.g. carpet and clothing treatments) and coatings for cardboard and packaging. Some PFAS are, or were also historically used in, fire-fighting foams (also known as aqueous film-forming foams; AFFF). PFAS are not found in the environment from natural sources, only from anthropogenic sources. The unique properties of PFAS make them persistent in the environment and highly mobile in soil and water (ATSDR 2018).

Firefighting services were provided by former commonwealth agencies at Parafield Airport until 1986. Since that time, fire fighting services have been provided externally by the Metropolitan Fire Service. Firefighting foam used at the airport by aviation rescue firefighting services since the early 1970s contained PFAS and included commercial products such as 3M LightWater™ and Ansulite™. The use of this foam at Parafield Airport was discontinued more than 30 years ago in 1986 when there ceased to be an active fire fighting service based at Parafield Airport.

PAL took over operations of Parafield Airport in 1998 in a leasehold arrangement with the Australian Government. While PAL has never been responsible for fire fighting services, it is pro-actively managing and coordinating the response to PFAS-related investigations based on guidance from Federal and State regulators, including the Environment Protection Authority (EPA).

A number of activities that may lead to exposure to PFAS have been identified on- and off-airport, and this report presents an assessment of potential risks following these exposures. A qualitative assessment of risks to on- and off-airport environments has also been undertaken. It is understood from PAL (and as discussed in the Environmental Projects July 2020 assessment) that PFAS concentration at location P61 are likely to be from a separate off-airport source. Given this, PFAS concentrations at this location have not been considered further in the HHERA.

Objectives

The objectives of the HHERA presented in this report are:

- To undertake an evaluation of the potential risks to human health associated with direct contact exposures from PFAS compounds in soil, groundwater and stormwater on-airport, in the context of the ongoing use of the area as an airport;
- To undertake a qualitative evaluation of the potential risks to the on-airport environment;
- To undertake an evaluation of the potential risks to human health associated with direct contact exposures from PFAS compounds in groundwater and surface water in off-airport areas, in the context of the existing land uses;

- To undertake a qualitative evaluation of the potential risks to the off-airport aquatic environments of Gulf St Vincent and Dry Creek; and
- Based on the HHERA, identify any additional data that may be required to assist in refining the assessment of risk or in considering additional risk management measures that may be needed.

This assessment has been undertaken to evaluate potential risks to human health and the environment based on the information available up to 21 January 2021 and as described in **Section 1.4**. The HHERA has addressed human health and environmental risk issues relevant to PFAS in soil, groundwater and/or stormwater at Parafield Airport and off-airport. The assessment has not addressed human health or environmental risk issues associated with other chemicals or any other environmental media. The assessment of human health and ecological risk issues relating to PFAS and firefighting activities (including training) and PFAS and the use of the south-west corner of the airport as part of the Northern Adelaide Food Park (NAFP), is outside the scope of this HHERA. Similarly:

- No data for water harvested as part of the Managed Aquifer Recharge (MAR) scheme has been provided for review; and
- Investigations undertaken to date have not identified that stormwater or surface water downgradient of the airport is extracted and used.

Hence, potential health and environmental risks associated with the MAR scheme of the off-airport use of stormwater or surface water are not assessed in this HHERA.

It is understood that Adelaide Airport Limited (AAL) policies also apply to PAL, and AAL procedures are reviewed annually.

Conclusions

Table ES.1 provides an overview of the ways in which on- and off-airport human receptors (including members of the community) may be exposed to PFAS, derived from the airport, and the conclusions and recommendations relevant to these areas. The conclusions and recommendations are made based on the available data, and with consideration of the available information on the existing land use patterns on-airport and off-airport, and the uncertainties identified in this assessment.

Table ES.1: Conclusions and Recommendation, Risks to Human Health from PFAS

How the Community May be Exposed	Potential Risks to Human Health and the Environment[1]	Areas where Potential Risk Issues Identified[1]	Recommendations[1]
Human Health – On-Airport, Current Exposures			
Direct contact with PFAS in soil by Airport Workers	Low and acceptable.	NA	Management measures outlined in the AAL Guideline for PFAS Work Health and Safety are supported and should be applied to all potential PFAS source areas at the airport. If works may intercept groundwater or stormwater, the list of required personal protective equipment should be expanded to include long sleeves and long trousers, and waterproof boots if workers may get their feet wet in the course of activities.
Direct contact with PFAS in groundwater by Airport Workers.	Low and acceptable.	NA	
Direct contact with PFAS in stormwater by Airport Workers.	Low and acceptable.	NA	
Human Health – Off-Airport, Current Exposures			
Non-potable use of groundwater with PFAS where exposures occur via direct contact	Low and acceptable.	NA	NA
Recreational use of Dry Creek where exposures to PFAS in water occur via incidental direct contact	Low and acceptable.	NA	NA
Consumption of fish with PFAS caught from Dry Creek	Low and acceptable based on the results of the preliminary fish sampling undertaken in Patawalonga Creek adjacent to Adelaide Airport.	NA	NA
Human Health – Off-Airport, Potential Future Exposures			
Use of groundwater with PFAS for filling swimming pools where exposures occur via direct contact	Low and acceptable.	NA	NA
Consumption of eggs from chickens on properties where PFAS is present in groundwater used for stock watering	Low and acceptable.	NA	NA
Ingestion of homegrown fruit and vegetables on properties where water containing PFAS is used for irrigation	Low and acceptable.	NA	NA

Notes:

1 = The conclusions of the HHERA are based on the available sampling and analysis results.

The findings of the ecological risk assessment component of the HHERA were as follows:

- On-airport: sampling and analysis for PFAS near and within the VPCZ has been limited to date. Further information is therefore required to confirm if the exposure pathways between PFAS impacts and terrestrial and aquatic receptors in the VPCZ is currently complete and/or would be complete or potentially complete following airport re-development works (e.g. the construction of a development similar to that of the proposed NAFP); and
- Off-airport: it is recommended that PAL initiate discussions with SA EPA to confirm the relevant protection level for aquatic ecosystems within Dry Creek and Gulf St Vincent (understood to be 80%, 90% or 95%):
    - There are no ecological risk issues of concern at the 80% and 90% species protection levels
    - Maximum concentrations of PFOS in groundwater off-airport exceed the 95% species protection level at 3 locations, however concentrations are delineated to below this protection level before Gulf St Vincent
    - Maximum concentrations of PFOS in stormwater on-airport exceed the 95% species protection level, however average PFOS concentrations are below this protection level
    - Based on fish data for Patawalonga Creek adjacent to Adelaide Airport, there are no risk issues of concern in relation to bioaccumulation.

Section 1. Background

1.1 Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Parafield Airport Limited (PAL) to review available data and undertake a human health and ecological risk assessment (HHERA) in relating to the presence of per- and polyfluoroalkyl substances (PFAS) at Parafield Airport, South Australia (the “airport”; refer to plans in **Appendix A**).

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PAL took over operations of Parafield Airport in 1998 in a leasehold arrangement with the Australian Government. While PAL has never been responsible for fire fighting services, it is pro-actively managing and coordinating the response to PFAS-related investigations based on guidance from Federal and State regulators, including the Environment Protection Authority (EPA).

A number of activities that may lead to exposure to PFAS have been identified on- and off-airport, and this report presents an assessment of potential risks following these exposures. A qualitative assessment of risks to on- and off-airport environments has also been undertaken. It is understood from PAL (and as discussed in the Environmental Projects July 2020 assessment) that PFAS concentration at location P61 are likely to be from a separate off-airport source. Given this, PFAS concentrations at this location have not been considered further in the HHERA.

1.2 Objectives

The objectives of the HHERA presented in this report are:

- To undertake an evaluation of the potential risks to human health associated with direct contact exposures from PFAS compounds in soil, groundwater and stormwater on-airport, in the context of the ongoing use of the area as an airport;
- To undertake a qualitative evaluation of the potential risks to the on-airport environment;

- To undertake an evaluation of the potential risks to human health associated with direct contact exposures from PFAS compounds in groundwater and surface water in off-airport areas, in the context of the existing land uses;
- To undertake a qualitative evaluation of the potential risks to the off-airport aquatic environments of Gulf St Vincent and Dry Creek; and
- Based on the HHERA, identify any additional data that may be required to assist in refining the assessment of risk or in considering additional risk management measures that may be needed.

This assessment has been undertaken to evaluate potential risks to human health and the environment based on the information available up to 21 January 2021 and as described in **Section 1.4**. The HHERA has addressed human health and environmental risk issues relevant to PFAS in soil, groundwater and/or stormwater at Parafield Airport and off-airport. The assessment has not addressed human health or environmental risk issues associated with other chemicals or any other environmental media. The assessment of human health and ecological risk issues relating to PFAS and firefighting activities (including training) and PFAS and the use of the south-west corner of the airport as part of the Northern Adelaide Food Park (NAFP), is outside the scope of this HHERA. Similarly:

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Hence, potential health and environmental risks associated with the MAR scheme of the off-airport use of stormwater or surface water are not assessed in this HHERA.

It is understood that Adelaide Airport Limited (AAL) policies also apply to PAL, and AAL procedures are reviewed annually.

1.3 Methodology

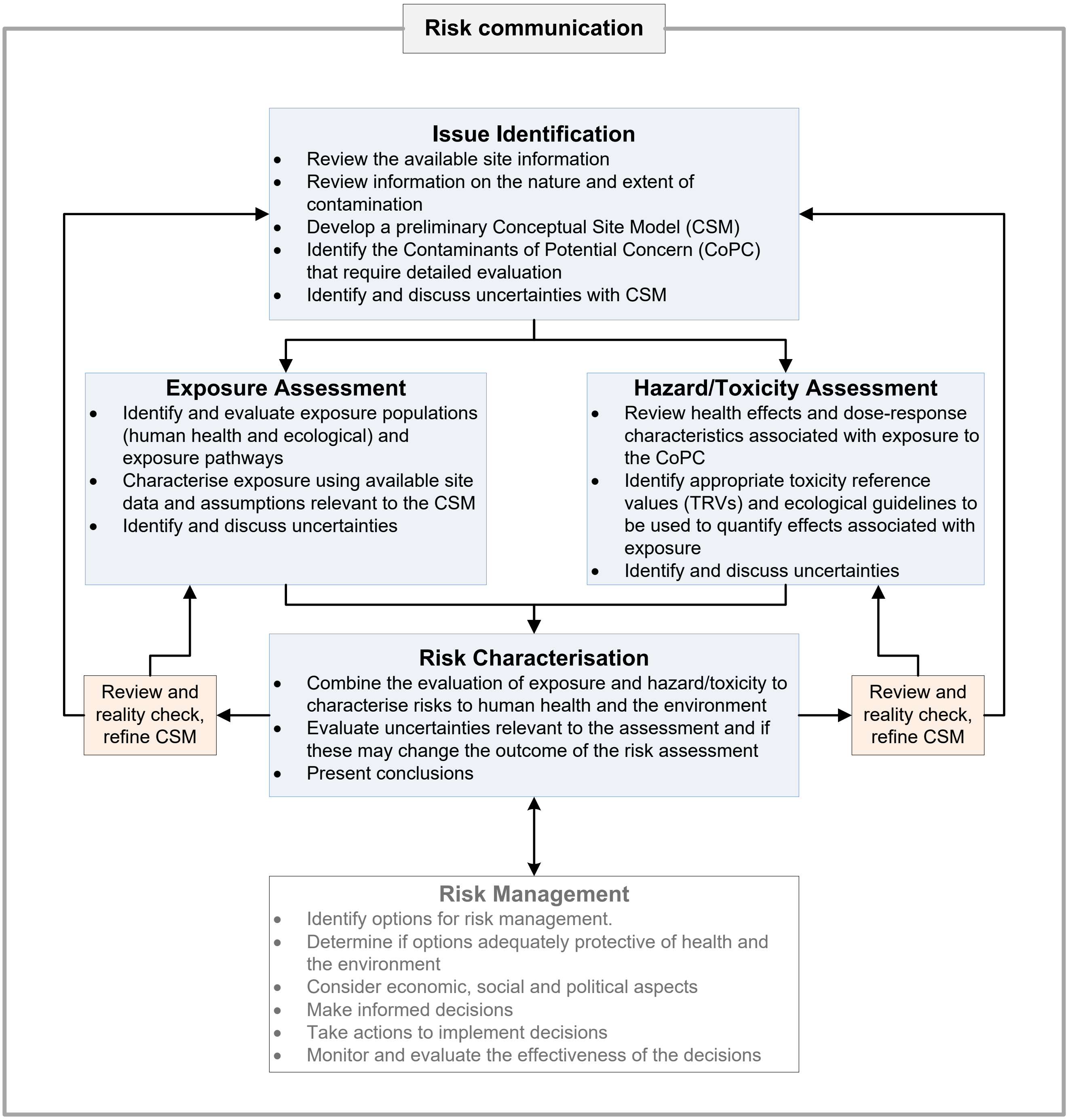
In general, the approach taken for the assessment of human health and environmental risks is in accordance with guidelines / protocols endorsed by Australian regulators, including:

- enHealth Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a);
- enHealth Australian Exposure Factor Guide (enHealth 2012b);
- Food Standards Australia New Zealand (FSANZ) guideline Perfluorinated Chemicals in food (FSANZ 2017a), and associated supporting documents:
  - Supporting Document 1 Hazard assessment report – Perfluorooctane sulfonate (PFOS), Perfluorooctanoic acid (PFOA), Perfluorohexane sulfonate (PFHxS) (FSANZ 2017b)
    - Critical review of pharmacokinetic modelling of PFOS and PFOA to assist in establishing HBGVs for these chemicals (FSANZ 2017c)
    - Immunomodulation by PFASs: a brief literature review (ToxConsult 2017)
  - Supporting Document 2 Assessment of potential dietary exposure to PFOS, PFOA and PFHxS occurring in foods sampled from contaminated sites (FSANZ 2017d)

    - Occurrence of and dietary exposure to PFOS, PFOA and PFHxS reported in the literature (FSANZ 2017e)
    - Occurrence of PFOS, PFOA and PFHxS in foods and water sampled from contaminated sites (FSANZ 2017f)
  - Supporting Document 3 Summary of other controls for perfluorinated chemicals (FSANZ 2017g)
  - Supporting Document 4 Criteria for the establishment of maximum levels in food (FSANZ 2017h)
- National Environmental Protection Measure – Assessment of Site Contamination (ASC NEPM) including:
  - Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013a)
  - Schedule B4 Guideline on Health Risk Assessment Methodology (NEPC 1999 amended 2013c)
  - Schedule B5 Guideline on Ecological Risk Assessment (NEPC 1999 amended 2013d)
  - Schedule B6 Guideline on Risk Based Assessment of Groundwater Contamination (NEPC 1999 amended 2013c)
  - Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013d)
- Australian Government National Health and Medical research Council (NHMRC) Guidance on Per and Polyfluoroalkyl substances (PFAS) in Recreational Water, 2019 (NHMRC 2019); and
- PFAS National Environmental Management Plan (the “PFAS NEMP”), Version 2.0, January 2020 (HEPA 2020).

In addition, protocols and guidelines developed by international agencies have been used (and referenced) to provide supplementary guidance where required. International guidance has not been adopted where it is inconsistent with the Australian regulatory or policy setting.

The overall approach for the HHERA is outlined in the following (modified from enHealth 2012):



The overall approach adopted in this assessment is as follows:

- Summary of relevant information and available data relevant to the development of a Conceptual Site Model (CSM) for PFAS in environmental media on- and off-airport as relevant to the assessment of health and environmental risks (**Section 2**);

- Issue identification for human health risk assessment, including comparison of concentrations of PFAS in environmental media with screening level guidelines for on-airport (**Section 3**) and off-airport (**Section 4**);
- Identification of an appropriate dose-response relationship and quantitative values (toxicity reference values; TRV) for the assessment of potential human health effects associated with exposures to PFAS (**Section 5**);
- Quantification of likely exposures by human receptors to PFAS for on-airport (**Section 6**) and off-airport (**Section 8**);
- Characterisation of human health and environmental risks on the basis of the above for on-airport (**Section 7**) and off-airport (**Section 9**). The characterisation of risk will present conclusions in relation to risk with consideration of the uncertainties identified in the assessment and any requirements to undertake risk management measures;
- Screening level ecological risk assessment for on-airport (**Section 10**) and off-airport (**Section 11**); and
- Conclusions (**Section 12**).

1.4 Available Information

This assessment has been conducted on the basis of information and data presented in the reports identified below which have been provided by AAL/PAL. Eleven additional reports are available since the last revision of the HHERA in August 2018 (Reports numbered 6 to 16 below).

PFAS Assessment Reports and Information:

1. Golder Associates (May 2016), Site History and Qualitative Risk Assessment of Perfluorinated Chemical Sources – Parafield Airport (no data);
2. LBW Environmental Projects (August 2016), Adelaide and Parafield Airports PFAS Investigation;
3. GHD (December 2016, 2016a) Proposed Northern Adelaide Food Park Groundwater Investigation;
4. GHD (September 2016, 2016b) Parafield Airport, Groundwater Well Installation and Sampling Report;
5. GHD (September 2016, 2016c) Proposed Northern Adelaide Food Park Contamination Site Investigation;
6. GHD (January 2018, 2018a), Proposed Northern Adelaide Food Park Well Installation and Groundwater Monitoring Report;
7. GHD (March 2018, 2018b), Parafield Airport Commercial Estate Environmental and Geotechnical Investigation;
8. Environmental Projects (December 2018), Re: Parafield Airport Review of Off-site Residential Land Use (no data);
9. Environmental Projects (April 2019), Parafield Airport Groundwater Monitoring Event;
10. GHD (September 2019, 2019a), Parafield Airport Off-Site Groundwater Use Survey and Groundwater Investigation;
11. GHD (August 2019; 2019b), Parafield Airport Additional Groundwater Investigation;
12. GHD (September 2019, 2019c), Parafield Airport Additional Groundwater Investigation;
13. GHD (November 2019; 2019d), Parafield Airport Additional Groundwater Investigation (October/November 2019);

14. GHD (January 2020; 2020a), Parafield Airport Additional Groundwater Investigation (December 2019);
15. GHD (April 2020; 2020b), Parafield Airport Additional Groundwater Investigation (February 2020);
16. Environmental Projects (July 2020), Re: Parafield Off-airport PFAS sampling - Desktop Review;
17. Tabulated data for water samples collected from the stormwater drains at the Airport;
18. NMI Analysis Report No. RN1107974 (March 2016; groundwater); and
19. Site plans showing Potential PFAS contamination sources and sampling locations.

Flora and Fauna Surveys:

20. BUSH-ANEW (January 2001), Remnant Indigenous Vegetation Survey, Area A: Proposed Gerard Industries Site, Parafield Airport; and
21. Coleman and Cook (May 2002), PAL vernal pools – assessment of their ecological health.

Parafield Airport Guidance Documents:

22. AAL (2016a), Adelaide Airport Guideline: PFAS – Work Health and Safety (Per- and Poly-fluorinated Alkyl Substances), Adelaide Airport Limited, June 2016;
23. AAL (2016b), Adelaide Airport Guideline: Construction Dewatering, Adelaide Airport Limited January 2016; and
24. AAL (2016c), Vernal Pool Creek Conservation Zone Management Plan, February 2016.

Parafield Airport Documents:

25. PAL (2017), Parafield Airport Master Plan 2017[1].
26. AAL (2013), Stormwater Quality, A review – August 2013, Adelaide Airport Limited.

[1] https://www.parafieldairport.com.au/community/publications/parafield-airport-master-plan-2017

Section 2. Airport Setting and Conceptual Site Model

2.1 Airport Location

The Parafield Airport Master Plan (PAL 2017) indicates that Parafield Airport (the "airport") is in the City of Salisbury in the Adelaide metropolitan area, 18 km north of the Adelaide CBD. The airport is one of the busiest General Aviation airports in Australia with four runways. Activities at the airport are dominated by pilot training and recreational activities with other activities including crop dusting, aerial photography, search and rescue, fire-fighting, policing and charter services to mines in South Australia.

Land uses surrounding the airport are predominantly residential, with some commercial and industrial land uses to the north and east/south-east (Golder 2016).

2.2 Geology, Hydrogeology, Hydrology and Groundwater Use

The following summary has been prepared from a review of the information presented in Golder (2016), GHD (2016a) and information provided by AAL/PAL unless otherwise noted:

2.2.1 Hydrology

The nearest surface water bodies to the airport are:

- The Mawson Lakes – an artificial lake system located immediately south-west of the airport;
- Dry Creek, located approximately 700 m south-west of the airport; and
- The Little Para River, located approximately 2.5 km north of the airport.

Parafield Airport lies at the downstream end of several regional catchments. Stormwater at the airport is collected into a network of drainage channels that take water runoff to the Salisbury Council draining system both abutting the airport or within drainage easements.

All drains that receive stormwater runoff from the airport, including Airport Drain, Railway Drain and Bennetts Road Drain all flow into Dry Creek (refer to **Figure 1**).:

- Airport Drain (East) collects water from the majority of the airport and runs into the Railway Drain near the Parafield Gardens Railway Station. The Railway Drain directs flows from the suburb of Salisbury South, with most water (from Salisbury South, not from the airport) being diverted into a wetland on airport land which is managed by the Salisbury Council; and
- The Main North Road Diversion Drain collects flows from the urban catchment to the east of Main North Road and the commercial precinct (including Bunnings) through several stormwater drains. Stormwater from the airport also enters this drain. This drain discharges to Bennett Drain, which runs along the south-western property boundary, before merging with the Railway Drain.

Dry Creek travels approximately 3.5 km before meeting the tributaries of Barker Inlet, a mangrove estuarine environment.

The Parafield Stormwater Harvesting Scheme diverts stormwater from catchments around the airport into capture basins and reedbeds constructed under birdproof netting. Water from the Parafield Stormwater Harvesting Scheme is pumped to a tank in Greenfields, where it is mixed with treated wastewater, after which it is pumped into Mawson Lakes via a separate (purple coloured) reticulation system. Recycled water from Mawson Lakes is used for local industry and community facilities (not drinking water). It is understood that no stormwater from Parafield Airport flows into this system.

Figure 1. Parafield Airport Stormwater Drainage System (blue lines) (AAL 2013)

2.2.2 Geology

The airport is underlain by the Pooraka Formation which comprises pale re-brown sandy clays. Intrusive investigations at the airport by LBW (2016) and GHD (2016a) have identified silty and sandy clays with some gravels present throughout shallow soils.

2.2.3 Hydrogeology

Groundwater beneath the airport is generally present at around 2 to 4 metres below ground level (m bgl) (AAL 2016a). Groundwater levels as shallow as 0.7 m bgl have been reported following periods of high rainfall in 2016 (GHD 2016a).

Groundwater is generally inferred to flow to the south-west, eventually discharging to Gulf St Vincent. Golder (2016) notes that there is likely to be some aquifer recharge associated with leakage from stormwater drains at and in the vicinity of the airport, which will vary based on drain construction and gradient and geology.

2.2.4 Use of Groundwater

PAL has indicated that groundwater is not used for any purpose on-airport.

In general terms, PAL has indicated that potable water at the airport, and in all areas surrounding the airport, is sourced from the reticulated water supply. No licenses are issued for the extraction of groundwater from the shallow aquifer for potable use off-airport. In Section 2.8.2 of the SA EPA Guidelines for the Assessment and Remediation of Groundwater Contamination (SA EPA 2009) it is noted that groundwater in metropolitan Adelaide is not to be considered for potable use because of the salinity of the water and the presence of a town water supply.

In relation to the off-airport area, 2 further reviews have been undertaken in 2016 (Golder 2016) and 2019 (GHD 2019) to determine the potential uses of groundwater at, and to the south and west of the airport where residential and recreational areas are present. These reviews indicate that the Parafield Gardens residential area is located to adjacent to the western boundary of the airport and the Bridges Estate residential area (within the suburb of Mawson Lakes) is located adjacent to the southern boundary of the airport (GHD 2019). The University of South Australia (Mawson Lakes Campus) is located to the south of the airport. Residential development commenced in 1955 to the west of the airport and post 1997 to the south. The Mawson Lakes Campus of the University of South Australia opened in 1971 (Environmental Projects 2018).

The reviews undertaken are discussed further below.

Golder, 2016

A groundwater database search undertaken by Golder (2016) identified 239 registered bores within a 2.5 km radius of the centre of the airport. Based on a depth to groundwater of 2 to 4 m bg, 42 of the identified bores were concluded to be installed within the shallow aquifer underlying the airport. Thirty-eight of these bores were registered for monitoring/observation, however 8 bores, all located to the south-west of the airport, were registered for general/unknown use. According to Figure 3 in Golder (2016), the closest general/unknown use bore is located approximately 200 m from the airport boundary, adjacent to a bore registered for MAR/Aquifer Storage and Recovery. The closest bores registered for domestic use (2 bores) were located approximately 800 m to the south-west of the airport and are screened between 27.4 to 39.6 m bgl, within a deeper aquifer than the shallow aquifer investigated at the airport.

Based on this review, there are general/unknown use bores located downgradient of the airport where water could be extracted for domestic use. There is also the potential that unregistered bores could be present downgradient of the airport or that that bores could be installed downgradient of the airport in the future, and water extracted for domestic or recreational use.

The total dissolved solids (TDS) concentrations in the registered wells was reported by Golder (2016) to be in the range 175 to 3,517mg/L. TDS concentrations reported in on-airport groundwater wells by GHD (2016a) were in the range 1,087 to 24,708 mg/L. In accordance with the Australian Drinking Water Guideline (NHMRC 2011 updated 2018), water with a TDS of less than 600 mg/L is regarded as good quality drinking water.

GHD, 2019

Based on the findings of the Golder (2016) review, a groundwater use survey in the residential areas to the south and west of the airport was completed by GHD (2019a) in late 2018/early 2019. The survey was split into 3 areas:

- South of the airport: Area 1 comprising properties to the north of Elder Smith Road and Mawson Lakes;
- West of the airport:
    - Area 2 comprising properties along the Bardsley Avenue
    - Area 3 comprising the Parafield Gardens Soccer and Sports Club to Kellaway, Mailey and Woodfull, and Bradman Streets to Hilditch Drive.

A total of 122 survey responses were received from 637 properties within the investigation areas. A response was received from the Parafield Gardens Soccer and Sports Club with the remaining responses from residential properties. The survey indicated the following:

- All properties (including the Sports Club) have mains water plumbed into buildings and utilise mains water for potable water supply;
- Twenty-two residents have a rainwater tank connected to the house;
- Except for 2 properties, all properties utilise recycled water, mains water or tank water for non-potable uses:
    - One property uses groundwater for irrigating lawn areas (from 1 groundwater bore);
    - Groundwater (from 2 bores) is used to irrigate the sporting areas at the Soccer and Sports Club
- The bores at the Soccer Club are installed within the deeper (tertiary) aquifer associated with the City of Salisbury MAR scheme and not the shallow groundwater aquifer which was the subject of off-airport investigations undertaken (refer below);
- The groundwater bores at the above 2 properties were not plumbed into buildings and tanks (that could be used to store groundwater) were not identified at either property; and
- Groundwater was not used for the irrigation of fruit or vegetables at any property.

The extent of the groundwater use survey is shown on **Figure 2**.

Figure 2. Off-Airport Groundwater Use Survey Area (GHD 2019a)

A more recent groundwater database search was also completed by GHD (2019a), with 173 registered bores identified within a 2 km radius of the airport. Listed purposes included investigation/observation, irrigation, MAR, drainage and domestic/irrigation/stock watering. TDS concentrations below 1,200 mg/L were reported in 16 operational bores, however, these bores were installed at deeper than 120 m below ground level (m bgl) (associated with the MAR) or installed prior to 1985 (and considered unlikely to be operational). A further review of available information indicated that it was unlikely that active bores used for were present within 800 m downgradient of the airport.

Twenty-one off-airport groundwater locations have also been investigated by GHD and Environmental Projects (refer to **Section 4.2.1** for further information). TDS concentrations reported in these wells, as well as relevant wells on the airport boundary, are summarised in **Table 2.1**, alongside the information provided in relation to the suitability of water for irrigating fruit/vegetables or watering chickens (ANZECC 1992) (refer to **Table 2.2**).

Table 2.1: Summary of Groundwater TDS Concentrations in Off-Airport and Boundary Wells

Water Class Based on TDS Concentration	South		West	
	Boundary	Off-Airport	Boundary	Off-Airport
Class 3 (TDS = 500 -1,500 mg/L)			✓	✓
Class 4 (TDS = 1,500 – 3,500 mg/L)	✓	--	✓	✓
Class 5 (TDS = >3,500 mg/L)	--	✓	--	--

Notes:

✓ = Based on TDS concentration, groundwater falls into this water class

1 = ANZECC (1992) has since been revised (in 2018) however the revised guidance does not include all the information available in ANZECC (1992) in relation to this issue. Hence, ANZECC (1992) has been referred to.

A summary of the ANZECC (1992) water classes for fruit and vegetables is provided in **Table 2.2**.

Water with a TDS concentration of 0 to 2,000 mg/L is suitable for watering chickens, and chickens should be able to adapt without loss to water with TDS concentrations of up to 3,000 mg/L. Hence, Class 3 and 4 water is generally suitable for watering chickens.

Table 2.2: Summary of Water Class Based on TDS (ANZECC 1992)

Class (Well ID)	TDS Concentration (mg/L)	Description	Fruit/Vegetable Suitable For:
Class 3	500-1,500	High salinity, requires adequate drainage and salinity control, and salt tolerant plants	**Fruit:** Mulberry, apple, pear, raspberry, quince **Vegetables:** Cauliflower, bell pepper, cabbage, broccoli, tomato, beans, sweet potato, artichoke
Class 4	1,500-3,500	Very high salinity, not suitable for use under ordinary conditions	**Fruit:** Olive, fig, pomegranate, cantaloupe **Vegetables:** Spinach, asparagus, kale, beets, gherkin
Class 5	>3,500	Extremely high salinity and can be used only on permeable, well-drained soils under good management and for salt tolerant crops or occasional emergency use	**Fruit:** None. ANZECC guidance lists water as suitable for dates however the TDS concentrations are over double the threshold and unlikely to be suitable. **Vegetables**: None

Review of **Table 2.1** indicates that the groundwater quality on the boundary and to the south and west of the airport generally falls into Classes 3 and 4, and hence, may be suitable for growing some fruit and vegetables and watering chickens. The exception is off-airport wells P38 and P39, located to the south in Mawson Lakes. These wells reported TDS concentrations in the range 4,400 to 13,052 mg/L when sampled in November/December 2018. This water is unsuitable for use for chickens and is categorised as Class 5 water for irrigation of fruit and vegetables.

The future use of groundwater for filling swimming pools is also considered possible.

2.2.5 Use of Stormwater

PAL (2017) notes that recent drought, uncertainty with respect to South Australia's long-term water availability and rising supply costs has led to water emerging as a priority issue for PAL. Stormwater harvested by the City of Salisbury from local drains and treated in a series of wetlands on the airport has been a supplementary source of non-potable water to off- and on-airport facilities and residential areas for several years. This is the City of Salisbury MAR scheme referred to above.

Aquifers are natural storage mechanisms that can store large quantities of water. Storing water within aquifers has numerous benefits – including lower losses than surface storages subject to evaporation and improved water quality through water percolating through the aquifer. This process can also be used as a beneficial means of artificially recharging depleted groundwater reserves. The MAR scheme (also known as Aquifer Storage Recover; refer to **Figure 3**) pumps recycled stormwater from wetlands into designated groundwater aquifers under pressure. The recycled stormwater injected is continually monitored via online sampling to ensure water quality criteria are met. The pressure in the aquifer is also continually measured to protect the integrity of the clay formations above the limestone aquifer (confining layer). Recycled stormwater is then recovered from the aquifer using submersible bore pumps before being distributed to customers. The MAR scheme includes several sites in addition to the airport, including Edinburg Parks South and Greenfield Wetlands.[2]

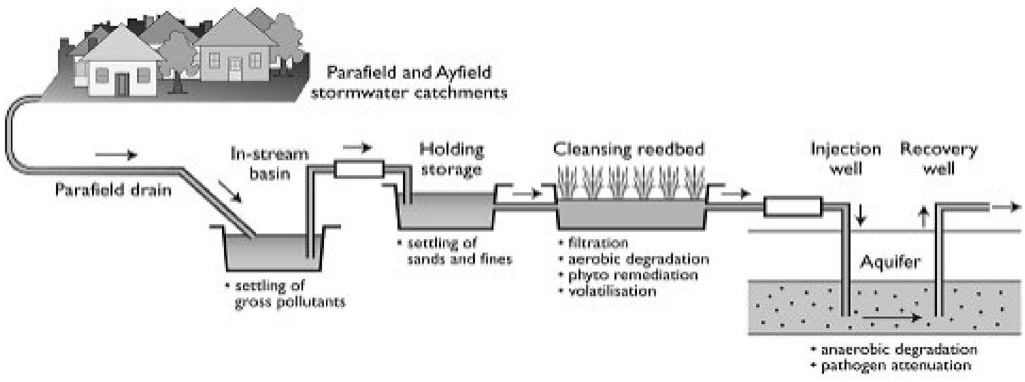


Figure 3. Schematic of Aquifer Storage Recovery Process[3]

No data for water harvested as part of the MAR scheme has been provided for review, hence, potential health and environmental risks associated with the scheme are not assessed in this HHERA. GHD (2019) indicates that Salisbury Water has provided results to PAL indicating that

[2] https://www.salisbury.sa.gov.au/Live/Environment_and_Sustainability/Wetlands_and_Water/Water_Recycling/Aquifer_Storage_Recovery
[3] https://www.salisbury.sa.gov.au/Live/Environment_and_Sustainability/Wetlands_and_Water/Water_Recycling/Aquifer_Storage_Recovery

concentrations of PFAS in stormwater harvested from the deeper (tertiary aquifer) by the MAR scheme are below the drinking water guidelines.

Investigations undertaken to date have not identified the use of stormwater or surface water for any other purposes (on- or off-airport).

2.3 Introduction to PFAS

This section is an introduction to PFAS chemicals that has been compiled based on enRiskS' experience in undertaking human health and ecological risks assessments for PFAS in Australia.

As indicated in **Section 1**, PFAS do not occur naturally in the environment. They are man-made chemicals with unique properties that make materials stain- and water-resistant because the compounds repel oil, grease and water. These unique properties also make them persistent in the environment and highly mobile in soil and water i.e. they readily leach into groundwater.

Most environmental investigations for contaminated sites involve chemicals that break down over time, and this is considered when assessing the fate of the chemical. Many of the chemicals in the PFAS family do not break down over time in the environment due to the strength of the carbon fluorine bond. As a result, investigations of sites which may be contaminated with PFAS chemicals are focused on where the chemicals are and how and where they may travel, over longer timeframes and usually with less (or no) attenuation.

Not only are PFAS chemicals extremely difficult to break into their component parts in the environment, but organisms cannot easily metabolise them. They are readily absorbed into the body for most organisms given their water solubility. Also, unlike most water-soluble chemicals, they are difficult to remove from the body once taken in, at least for some organisms including humans. This combination means that they can build up inside organisms that are exposed – i.e. they bioaccumulate and biomagnify. Bioaccumulation is the gradual build-up of a chemical, such as PFOS, in an organism over time. Biomagnification is the increase in the concentration of a chemical as you move up the food chain. Both these processes occur when an organism absorbs the chemical faster than it is removed. The potential for PFAS to bioaccumulate and biomagnify is a characteristic of these chemicals that makes them more likely to pose a risk to human health or the environment.

PFAS also behave differently to other chemicals where bioaccumulation is of concern, such as organochlorine pesticides like DDT and polychlorinated biphenyls (PCBs). Chemicals such as DDT or PCBs are not water soluble and so do not easily travel from where they were used. Such chemicals also accumulate in the lipids in organisms and tend to take quite some time to accumulate to high levels. For PFAS, their water solubility means they can easily move from areas where they have been used into off-airport areas. They accumulate by attaching to proteins in blood and other organs and this can occur quite rapidly, especially for aquatic organisms (days to weeks instead of years or decades for the other types of bioaccumulative chemicals discussed above).

There are a large number (thousands) of PFAS compounds, however, most reviews in the scientific literature have focused on perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA) and, more recently, perfluorohexane sulfonate (PFHxS). The reasons why these PFAS have been the focus include:

- Many of the other PFAS compounds break down into one or more of these 3;

- These 3 PFAS are extremely difficult to break down any further and so are persistent;
- These 3 PFAS are found in the highest concentrations in the environment;
- These 3 PFAS are known to be bioaccumulative, with PFOS usually of most concern from a bioaccumulation perspective; and
- Due to the above, these 3 PFAS are usually of most concern from a regulatory perspective.

Studies have investigated whether PFAS can be found in organisms (plants, animals and people). These studies have found that PFOS, PFOA and PFHxS are the PFAS chemicals most commonly reported to be present in organisms that people consume as food (e.g. fish).

On this basis, PFOS, PFHxS and PFOA have been identified as the chemicals of potential concern (CoPCs) for this HHERA.

Site investigations in the USA, Europe and Australia have shown that the main exposure pathway in both humans and animals for PFAS is the oral (also known as the ingestion or consumption) pathway. This pathway normally drives the evaluation of risk issues. Potential ingestion pathways include consumption of water (drinking, cooking, showering, swimming, boating, cleaning, etc.) and ingestion of soil. For PFAS, consumption of food also needs to be evaluated. Aquatic biota (fish and other aquatic organisms) can be exposed to these chemicals via direct uptake from the water in which they live or consuming water, or in food that has been affected.

PFAS are not volatile at environmental (neutral) pH, so the vapour inhalation/vapour intrusion pathway does not require assessment in a PFAS HHERA. Although the data is limited, there is scientific evidence to suggest that the dermal absorption is limited in comparison to the ingestion pathway.

2.4 Identified Potential PFAS Source Areas

Golder (2016) identifies nine areas of interest in relation to PFAS contamination issues:

- The Aeroservices Pty Ltd, Flight Training Adelaide and Stark Aviation tenancies in the northern portion of the airport;
- The North Former Fire Training Ground (FTG), located near the above tenancies in the norther portion of the airport;
- The West Former FTG, located in the central portion of the airport to the south-west of the runways;
- The South-East FTG, located in the south-east corner of the airport;
- The Former Fire Station, located on the northern airport boundary;
- The Former Landfill Bunker, located adjacent to the south-western runways; and
- The Former Landfill, located in the south-western corner of the airport.

Golder (2016) concludes that the potential for the areas of interest to be impacted by PFAS is Very Low for the tenancies in the northern portion of the airport, Low for the West Former FTG and the Former Landfill Bunker and Moderate for the North Former FTG, South-East Former FTG, Former Fire Station and Former Landfill.

The potential for industrial properties to the north-east and south-east of the airport to be impacted by PFAS is also concluded to be Low.

Potential PFAS source areas are not discussed by LBW (2016), however the location of the North Former FTG, West Former FTG, South-East Former FTG and Former Fire Station are indicated on the figures appended to the report as “Former firefighting training ground”.

The location of the potential PFAS source areas is shown on the plans in **Appendix A**.

Section 3. HHRA, Issue Identification: On-Airport

3.1 General

This section of the report provides a more detailed review of the exposure pathways and individuals or groups of individuals relevant to PFAS compounds identified in environmental media on-airport, and if the PFAS concentrations are sufficiently elevated to require a detailed assessment of human health risk. The review presented here has considered data collected on-airport for the purpose of characterising PFAS risk issues.

The relevant data and plans have been extracted from the available investigation reports (where possible) and provided in **Appendix A**.

3.2 Potential for Exposure

The following human receptors have been identified in the context of the ongoing use of the airport.

- Airport workers;
- Other tenants; and
- Members of the general public (i.e. visitors).

Exposures by visitors will be less than for workers (including contractors) and tenants as visitors will be present for less time on-airport. Hence, this assessment has focused on risks to workers and tenants with the view that this will also be protective of visitors.

Further discussion of the relevant exposure pathways for airport workers and tenants is provided below.

PFAS are readily absorbed via the oral route of exposure, however they are not volatile at environmental pH and there is scientific evidence to suggest that the dermal absorption is limited in comparison to the ingestion pathway. Regardless, the potential for dermal exposure has been considered in the HHERA.

No edible products are grown and consumed on-airport and a reticulated (i.e. mains) water supply is available at the airport.

Airport Workers

Airport workers may encounter PFAS impacted soil, groundwater and stormwater during operational activities including excavation works that extend into groundwater or maintenance of stormwater collection structures. Where there are no exposures to PFAS in soil and/or water, there are no health risks from PFAS. This means there are no health risks from PFAS to office workers and workers who are not involved in activities where contact with PFAS in soil and/or water may occur.

With respect to potential exposures to PFAS by workers, the AAL Guideline for PFAS Work Health and Safety specifies that PFAS exposures should be considered, and where necessary, included in JSAs, SWIs and Take 5 risk assessments prior to the commencement of works. Suggested control measures include dust control, the use of personal protective equipment (PPE) comprising gloves, dust masks and protective eyewear and the appropriate decontamination of PPE following works.

The Guideline notes that these control measures form part of controls already in place to manage existing risks.

In addition, the Adelaide Airport Guideline for Construction Dewatering indicates that dewatering may be required if excavations associated with development works extend below the depth of the shallow groundwater aquifer or into stormwater. Dewatering is only implemented when other controls (e.g. up-slope stormwater management measures) are not adequate to allow for the safe and effective completion of works. Where dewatering is required, contractors are required to submit a Dewatering Management Plan (DWMP) and Construction Environment Management Plan (CEMP) to AAL as part of the Building Approval Application.

As noted in **Section 1.2**, AAL policies also apply to PAL, and AAL procedures are reviewed annually.

Tenants

Sampling for PFAS in non-operational areas of the airport has not been undertaken to date. Exposures to PFAS in non-operational areas of the airport are likely to be incomplete due to the following reasons:

- Access to all operational areas of the airport is restricted. Hence, except for AAL/PAL employees or contractors, tenants are unlikely to come into direct contact with soil that may be impacted with PFAS;
- Dust suppression measures are implemented to minimise exposure of aircraft to dust. Hence it is unlikely that tenants will be exposed to dust impacted with PFAS;
- No sensitive tenancies are present at the airport (all tenancies can be categorised as non-sensitive commercial/industrial land uses);
- There are no playground or general recreational areas at the airport; and
- A reticulated (i.e. mains) water supply is available at the airport and groundwater is not used for any purpose at the airport.

Hence, potential risks to tenants do not required further consideration in this HHERA.

Table 3.1 presents a more detailed overview of the exposure pathways relevant to the assessment of human exposure on-airport. The table also outlines the data that is relevant to the assessment of these exposures and outcomes of the screening level assessment undertaken. Text shown in **blue** indicates that risks have been concluded to be acceptable while text shown in **purple** indicates that further assessment is required or recommended. Where data is available this further assessment has been presented in the HHERA.

Table 3.1: Summary of Key Exposure Pathways – On-Airport

Exposure Pathway/Media	Potentially Significant Pathway?	Comments	Screening Assessment
Airport Workers			
Incidental ingestion of PFAS in soil	✓	Direct contact exposures (including incidental ingestion, dermal contact with soil and the inhalation of dust) may occur during above and below ground excavation activities that involve contact with soil. This may include works required for the installation of services or re-surfacing of paved areas.	Soil screening guidelines are available for commercial/industrial workers, based on the protection of ingestion, dermal contact and inhalation exposures. These criteria are also protective of exposures that may occur during excavation works.[2] The screening level assessment is presented in **Section 3.5.** **No PFAS concentrations of concern identified in soil.**
Dermal contact with PFAS in soil[1]	✓		
Inhalation of PFAS in dust generated from the airport	✓		
Incidental ingestion of PFAS in stormwater[3]	✓	Direct contact exposures (including incidental ingestion and dermal contact) may occur during excavation activities that intercept shallow groundwater and/or stormwater. These activities may include the installation of services or the re-alignment of drains. Airport workers are unlikely to spend a significant amount of time wading or walking in water as part of the works as dewatering activities are undertaken where works may intercept shallow groundwater or stormwater. Inhalation exposures will not occur as PFAS are not volatile. In addition, while the irrigation of water may generate aerosols, these will be large enough to be swallowed (and ingested) rather than inhaled into the lungs.[3]	No current potable or recreational use of water on-airport. Hence the screening level assessment has considered guidelines more relevant to incidental contact. The screening level assessment is presented in **Section 3.6.** **No PFAS concentrations of concern identified in stormwater.**
Dermal contact with PFAS in stormwater[1]	✓		
Incidental ingestion of PFAS in ground water[3]	✓		No current potable or recreational use of water on-airport. Hence the screening level assessment has considered guidelines more relevant to incidental contact. The screening level assessment is presented in **Section 3.6.** **Groundwater concentrations on-airport exceed the adopted guidelines relevant to direct contact exposures by Airport Workers. Further assessment of potential exposures by Airport workers is required to be undertaken and is presented in Sections 5 to 7.**
Dermal contact with PFAS in ground water[1]	✓		

Notes for Table 3.1:

"✓"	= Exposure pathway is considered to be potentially complete and has been assessed further in this HHERA.
"✓"	= Exposure pathway is considered to be limited, however has been assessed further in this HHERA for completeness.
1	= Dermal uptake of PFAS in soil and water is understood to be limited in comparison to the incidental ingestion pathways (refer below for further information) however further assessment has been provided in this HHERA for completeness
2	= The soil screening guidelines for commercial/industrial workers are protective of all exposures that would occur by excavation workers. For example, the health screening level for direct contact with non-volatile total recoverable hydrocarbons (TRH C16-C34) in soil is 27,000 mg/kg for a commercial/industrial worker and 85,000 mg/kg for an excavation worker (CRC CARE 2011). This is because although excavation workers may have a higher exposure to soil than commercial/industrial workers, this only occurs for a short period of time and on an infrequent basis.
3	= Potential risks associated with the generation of fine aerosols, that may be inhaled instead of ingested, have not been assessed in this HHERA. If activities that may generate fine aerosols from PFAS impacted water are proposed, a further assessment should be undertaken prior to the commencement of the activity. This further assessment should consider all relevant exposure pathways.

Other Issues – Proposed Northern Adelaide Food Park

GHD (2016a; 2018a) indicates that investigations were undertaken in the southern and south-western portion of the airport to inform the master planning of the proposed NAFP. GHD (2018a) was focused in the vicinity of the proposed distribution centre building, in Allotment A of the proposed Enterprise Precinct. GHD (2016a) notes that the NAFP is an initiative of the South Australian Government in conjunction with the Economic Development Board and Food SA. It will be the catalyst for the growth of food production and sales through the co-location of food and beverage manufacturers and processors on a common site with supporting infrastructure and access to transport networks.

No further information relating to the proposed land uses within the NAFP are indicated in GHD (2016a) although reported concentrations of PFOS and PFOA in soil at the airport have been compared to health and ecological screening levels for a commercial/industrial land use. Information was provided by the Government of South Australia Primary Industries and Regions SA on the proposed project and based on this information, it was agreed that the land use within the NAFP was likely to be characterised as a commercial/industrial setting.

The assessment of human health and ecological risk issues relating to PFAS, and the use of the south-west corner of the airport as part of such a development as the NAFP, is outside the scope of this HHERA. It is noted that the South Australian Government changed the scope of their Food Park project and made the decision not to proceed with their Food Park project at Parafield Airport.

3.3 Available Data

3.3.1 General

PAL has commissioned several investigations to assess potential receptors and exposure pathways to PFAS on- and off-airport and inform the need for further assessment, remediation and management. Results from automated stormwater sampling are also available for review.

The available information is summarised in **Section 1.4**. Some of the reports listed in this section did not include any sampling and analysis for PFAS. These reports have not been included in the review provided below but have been considered in the development of the CSM.

Relevant extracts from the assessment reports where data were collected are provided in **Appendix A**.

3.3.2 2016 Investigations

In 2016, on-airport investigations were undertaken by LBW (2016) and GHD (2016a; 2016b; 2016c).

Investigation works undertaken by LBW (2016) comprised:

- The sampling of three existing groundwater wells - BGW1, BGW2 and P8. BGW1 and BGW2 were located on the eastern boundary of the airport and well P8 is located in the south-west corner of the airport. Groundwater sampling was undertaken in March 2016; and
- The installation and one round of sampling of four new groundwater wells - GWP1-PFC, GWP2-PFC, GWP3-PFC and GWP4-PFC. Three of these wells were installed along the

western airport boundary with the remaining well installed at the central southern airport boundary. Groundwater sampling was undertaken in May 2016.

Collected groundwater samples were analysed for an extended PFAS suite by the Australian National Measurement Institute (NMI). The adopted laboratory limits of reporting (LORs) were in the range <0.005 to <0.01 µg/L for groundwater, with the exception of analysis for PFPeA where the LOR was <0.5 µg/L.

One duplicate groundwater sample was collected and analysed as part of the LBW (2016) investigation. The LBW report provides a review of the quality assurance/quality control (QA/QC) procedures undertaken as part of the groundwater sampling and concludes that the overall data quality is adequate for the purpose of the assessment, with the caveat that inter-laboratory duplicates should be collected and analysed in future sampling events.

Investigation works undertaken by GHD (2016a, 2016b) in August and November 2016 comprised:

- The installation of 15 groundwater wells – including well BGW3, located on the eastern airport boundary (to the south of BGW1 and BGW2) and wells GWP6-PFC and P9 to P21, located in the south-western corner of the airport in the proposed NAFP;
- Collection of soil samples during the installation of the new wells; and
- Two rounds of groundwater sampling of selected new and existing wells in or adjacent to the NAFP area:
    - August 2016: sampling of P6, P8, P9 to P11, BGW3 and GWP6-PFC
    - November 2016: sampling of P1, P3, P6, P8 to P21, BGW3, GWP3-PFC and GWP6-PFC

Samples collected in August 2016 were analysed for an extended suite of PFAS compounds by ALS Laboratories. Samples collected in November 2016 were analysed for an extended PFAS suite by ALS Laboratories and Eurofins MGT. The adopted laboratory LORs were in the range <0.0002 to <0.001 mg/kg for soil and <0.01 to <0.1 µg/L for groundwater.

Two duplicate and two split groundwater samples were collected and analysed as part of the GHD (2016a) investigation, with one duplicate and one split sample collected and analysed for soil. Split samples were analysed for a reduced set of four PFAS. The GHD report provides a review of the QA / QC procedures undertaken as part of the soil and groundwater sampling and concludes that the data is reasonable and of sufficient quality to meet the data quality objectives for the investigation.

GHD (2016c) conducted soil sampling from 65 test pit locations within the Proposed Northern Adelaide Food Park area of the site, with groundwater sampled from three wells (PP2, P3 and P6). Analysis of selected soil samples (5 samples) included PFOS, PFOA and 6:2 FtS, adopting a LOR in the range 0.005 to 0.01 mg/kg. Groundwater samples were analysed for an extended suite of PFAS, with a LOR in the range <0.01 to 0.05.

3.3.3 2018 Investigations

In 2018, on-airport investigations were undertaken by GHD (2018a; 2018b).

GHD (2018a) comprised a further investigation of the NAFP area, specifically that in the vicinity of the proposed distribution centre within Allotment A, in November 2017. Works undertaken comprised the following:

- The installation of 11 groundwater wells (P22 to P32);
- Collection of analysis of soil samples during the installation of the new wells (soil leachate samples were also analysed); and
- One round of groundwater sampling of new wells P22 to P32 and 13 selected existing wells (P1, P6, P10, P12 to P14, P16, P18 to P21 and GWP6-PFC).

Collected soil and groundwater samples were analysed for an extended suite of PFAS compounds by Eurofins mgt. The adopted laboratory LORs were in the range <0.0005 to <0.001 mg/kg for soil, <0.01 to <0.05 µg/L for soil leachate and <0.01 to <0.05 µg/L for groundwater.

GHD (2018b) comprised an investigation of 2 areas (Site 1 and Site 2) of the airport that were proposed for further development, between November 2017 and February 2018. Fifteen soil bores (BH01 to BH15) were installed across the 2 areas and one groundwater well (P33) was installed and sampled. Note that a well labelled P33 was also installed on the southern airport boundary, the P33 referred to in this investigation is in a different location.

Collected soil samples from 6 bores were analysed for an extended suite of PFAS compounds and the groundwater sample from well P33 was analysed for PFOS, PFOS, PFHxS and 6:2 FtS. The main analysing laboratory was ALS. The adopted laboratory LORs were in the range <0.0005 to <0.001 mg/kg for soil, and <0.01 to <0.05 µg/L for groundwater.

GHD (2018a; 2018b) provides a review of the QA/QC procedures undertaken as part of the soil and groundwater sampling and concludes that the data is considered representative and suitable for the purpose of the assessment.

3.3.4 2019 Investigations

In 2019, on-airport investigations were undertaken by GHD (2019a; 2019b) and Environmental Projects (2019).

GHD (2019a) included the installation of on-airport wells P34, P35 and P44, located on the western airport boundary. The following rounds of groundwater sampling of the new wells and other on-airport wells were undertaken:

- November/December 2018: well P9
- December 2018: wells P34 and P35; and
- February 2019: well P44 and GWP3-PFC, P9, P17, P18 and P33 to P35;
- March 2019: GWP1-PFC, GWP2-PFC, GWP3-PFC, P9, P34, P35 and P44; and
- May 2019: GWP1-PFC, GWP2-PFC, GWP3-PFC, P34, P35 and P44.

Groundwater samples were analysed by the Australian Government National Measurement Institute for and extended or short PFAS suite (LOR of <0.001 to 0.05 µg/L). Soil sampling was also undertaken at 1 location (HA01; adjacent to location P44) with 2 soil samples analysed for an extended PFAS suite (LOR <0.001 to <0.05 mg/kg).

GHD (2019b) comprised the installation of 4 additional on-airport groundwater wells (P45 to P48) adjacent to the western airport boundary in July2019. GHD (2019c) comprised the installation of 1 additional on-airport groundwater well (P49) adjacent to the western airport boundary in August/September 2019. The location of P49 is downgradient of on-airport wells P44 and P45. One round of groundwater sampling was undertaken in each investigation, with collected samples analysed by Envirolab for PFOS, PFOA, PFHxS, 6:2 FtS and 8:2 FtS (LOR of <0.01 µg/L).

Environmental Projects (2019) comprised the sampling of wells GWP2-PFC, GWP3-PFC and P44 in April 2019. Collected samples analysed by ALS for an extended PFAS suite (LOR of <0.0005 to 0.001 µg/L).

A review of the QA/QC procedures undertaken as part of the groundwater sampling for each of the above assessments is provided in the relevant report, where it is concluded that the data set is valid and acceptable.

3.3.5 Stormwater Data

Tabulated and/or NATA endorsed laboratory results for stormwater samples collected from the airport have also been provided for review. It is understood that stormwater sampling is undertaken via automated samplers from three locations at the airport (SW-DS1/SWP2, SW-US1 and SW-DS3). Five rounds of data are available for location SW-DS1/SWP2, with one round of data available for the other locations. Surface water samples were collected between June 2016 and January 2017 and analysed for an extended PFAS suite.

No duplicate or split samples are collected during stormwater sampling as samples are collected via automated samplers.

3.4 Nature and Extent of PFOS, PFOA and PFHxS

Table 3.2 presents a summary of concentrations of PFAS in environmental media at the airport, based on a compilation and review of the data presented in the available reports (as listed in **Section 1.4**). Concentrations of PFOS, PFOA and PFHxS have been presented in this section as these three PFAS are the CoPC for the purpose of the HHERA.

Table 3.2: Summary of PFOS, PFOA and PFHxS Concentrations Detected On-Airport

Media	Investigation	Reported Concentration Range		
		PFOS	PFHxS	PFOA
Soil (mg/kg)	GHD (2016a; 2016b)	<LOR – 0.07	<LOR – 0.008	<LOR – 0.0006
	GHD (2018a)	<LOR	<LOR	<LOR
	GHD (2018b)	<LOR	<LOR	<LOR
	GHD (2019a)	<LOR	<LOR	<LOR
Groundwater (µg/L)	LBW (2016)	<LOR – 0.044	<LOR – 0.072	<LOR – 0.01
	GHD (2016a; 2016b; 2016c)	<LOR – 72.8	<LOR - 24.9	<LOR – 1.36
	GHD (2018a)	<LOR – 180	<LOR - 46	<LOR – 2.7
	GHD (2018b)	<LOR	<LOR	<LOR
	GHD (2019a)	0.013 – 0.13	0.027 – 1.74	ND – 0.08
	GHD (2019a) historical results[1]	180	NA	2.7
	GHD (2019b)	0.02 – 0.03	0.01 – 1.1	ND – 0.02
	GHD (2019c)	0.05	0.38	0.34
	Environmental Projects (2019)	0.02 – 0.05	0.009 – 0.07	0.003 – 0.004
Stormwater (µg/L)	Data for Parafield Airport (2016; 2017	<LOR – 0.19	<LOR – 0.15	<LOR

Notes for Table 3.2:
LOR = Limit of Reporting.
NA = Not available.
1 = Maximum concentration, review of this table included to cross check available concentration data.

3.5 Review of Soil Data

3.5.1 General

This section of the HHERA provides a review of the concentrations of PFOS, PFOA and/or PFHxS reported in soil on-airport against the adopted screening level guidelines for the protection of human health.

3.5.2 Adopted Guidelines

The commercial/industrial guidelines from the PFAS NEMP (HEPA 2020) have been adopted for the review consistent with on-going use as an airport with no sensitive land uses.

3.5.3 Screening Assessment

The review of PFAS concentrations in soil against the adopted screening level guidelines is presented in **Table 3.3**.

Table 3.3: Summary and Review of PFAS Reported in Soil On-Airport, Human Health

Area Investigated	Maximum Reported Concentration (mg/kg)	
	PFOS + PFHxS	PFOA
GHD (2016a; 2016b)	0.08	0.0006
GHD (2018a)	<LOR	<LOR
GHD (2018b)	<LOR	<LOR
GHD (2019a)	<LOR	<LOR
Adopted Screening Guidelines[1]		
Commercial/Industrial	**20**	**50**

Notes:
LOR = Limit of Reporting.
Shading indicates an exceedance of the adopted guideline value.

Review of **Table 3.3** indicates that concentrations of PFOS + PFHxS and PFOS in soil at all locations are below the adopted screening level guidelines relevant for airport workers and tenants. Hence, there are no health risk issues for PFOS + PFHxS and PFOA that require further evaluation in this HHERA.

3.6 Review of Water Data

3.6.1 General

In this section of the HHERA, PFOS, PFOA and/or PFHxS concentrations in groundwater and water in the on-airport stormwater drains have been compared against available screening level guidelines to determine if further evaluation is required in relation to incidental direct contact exposures that may occur by airport workers (including contractors) and tenants.

3.6.2 Adopted Guidelines

Available screening level guidelines for PFOS, PFHxS and PFOA including drinking water guidelines and recreational water quality guidelines.

The Australian Drinking Water Guidelines (NHMRC 2011 updated 2018) are 0.07 µg/L for PFOS + PFHxS and 0.56 µg/L for PFOA. The drinking water guidelines are based on the most current toxicity reference values (TRV) of 0.02 µg/kg/day for PFOS + PFHxS and 0.16 µg/kg/day for PFOA (FSANZ 2017a).

The NHMRC (NHMRC 2019) has derived recreational water quality guidelines, that are approximately 20 to 30 times higher than drinking water guidelines. The recreational water quality guidelines are 2 µg/L for PFOS + PFHxS and 10 µg/L for PFOA. This accounts for the ingestion of a smaller volume of water during recreational activities as compared to potable water supply, and the assumption that recreational activities only occur on up to 150 days/year.

Airport workers and tenants will not be swimming in water used or present on-airport. Hence, an additional risk-based criteria (RBC) for incidental contact has been derived for use in the screening assessment. This is a project-specific guideline that more specifically relates to the frequency and duration of exposures that may occur during activities where incidental contact with water may occur. The use of management procedures, including appropriate health and safety plans and safe work practices that include personal protective equipment, have not been considered in the derivation of the site-specific guideline. Such practices will reduce exposures to PFAS in water and hence, the approach adopted is conservative.

If it is assumed that a worker comes into contact with PFAS impacted water for 2 hours per day on 96 days per year (2 days per working week) for 30 years, and they get their hands and forearms wet during this time and ingest 1 teaspoon of water, the RBC for PFOS + PFHxS is 200 µg/L and the RBC for PFOA is 1,800 µg/L. The derivation of the RBC is presented in **Table 3.4** and **Appendix B**.

Table 3.4: Summary of Guidelines for PFOS + PFHxS and PFOA – Incidental Direct Contact with Water

PFAS	Adopted Toxicity Reference Value (TRV) (µg/kg/day)[1]	Guideline Values (µg/L)		
		Drinking Water[1]	Primary Contact Recreation[3]	RBC for Incidental Direct Contact[3]
PFOS + PFHxS	0.02	0.07	2	200
PFOA	0.16	0.56	10	1,800

Notes:
RBC = Risk-based criteria.
1 = Ref. Department of Health (2017) and HEPA (2018).
2 = Ref. NHMRC (2019).
3 = Risk Based Criteria (RBC) derived for use in this HHERA (refer to **Appendix B** for details of assumptions adopted).

3.6.3 Screening Assessment

The review of maximum concentrations of PFOS + PFHxS and PFOA in groundwater and stormwater with the adopted screening level guidelines is presented in **Table 3.5**.

Table 3.5: Summary and Review of PFAS Reported in Water On-Airport, Health of Airport Workers

Area/Media Investigated	Maximum Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
Groundwater		
LBW (2016) and GHD (2016a; 2016b; 2016c)	97.7	1.36
GHD (2018a)	226	2.7
GHD (2018b)	<LOR	<LOR
GHD (2019a)	1.87	0.08
GHD (2019b)	1.1	0.02
GHD (2019c)	0.42	0.03
Environmental Projects (2019)	0.12	0.004
Stormwater		
Data for Parafield Airport (2016; 2017	0.34	<LOR
Adopted Screening Guidelines[1]		
Incidental Direct Contact by Airport Workers (including Contractors)	**200**	**1,800**

Notes:

Shading indicates an exceedance of the adopted guideline value.

LOR = Limit of Reporting.

1 = Risk Based Criteria (RBC) derived for use in this HHERA (refer to **Appendix B** for details of assumptions adopted).

Review of **Table 3.5** indicates the following:

- Concentrations of PFOA in groundwater and stormwater at all locations are below the adopted screening level guidelines for incidental direct contact exposures by airport workers and tenants. Hence, there are no health risk issues for PFOA that require further evaluation in this HHERA;
- Concentrations of PFOS + PFHxS in stormwater are below the adopted screening level guidelines for incidental direct contact exposures by airport workers and tenants. Hence, there are no health risk issues for PFOS + PFHxS in stormwater that require further evaluation in this HHERA;
- Concentrations of PFOS + PFHxS in groundwater are below the adopted screening level guidelines for incidental direct contact exposures by airport workers except at location GWP6-PFC.

Given this, further quantitative evaluation of potential exposures following incidental contact with groundwater by workers has been undertaken in this HHERA (refer to **Section 5** to **Section 7**).

3.7 Uncertainties

Detectable concentrations of PFAS other than PFOS, PFOA and PFHxS (the "Other PFAS") have been reported in soil, groundwater and stormwater at the airport. There are currently no regulatory guidelines for soil or water, or approved TRVs, in Australia for Other PFAS. This is primarily due to the limited amount of toxicological data for Other PFAS.

The key PFAS that normally drive HHERA outcomes are PFOS and PFHxS (refer to **Section 2.3**) and where data gaps or the potential for unacceptable risks/need for management measures are identified, any implemented strategies will address impacts from Other PFAS as well as PFOS and PFHxS. Concentrations of Other PFAS will only affect the outcomes of this HHERA where risks from PFOS, PFHxS and PFOA are concluded to be acceptable (i.e. concentrations are below screening level guidelines). Where further evaluation for PFOS and PFHxS has not been triggered in this HHERA (for soil and stormwater), concentrations are well below the adopted screening level guidelines. Given this, concentrations of Other PFAS have not been considered quantitatively in the further evaluation of potential exposures following incidental contact with soil, groundwater and surface by workers in this HHERA.

Review of the available data has identified the following data gaps:

- With the exception of stormwater sampling location SW-DS1/SWP2, there is limited data to assess seasonal variability in concentrations in groundwater and stormwater, and the potential for interactions between groundwater and stormwater (as could be investigated through the collection of co-located samples); and
- Sampling has not been undertaken in all of the identified PFAS source areas.

Section 4. HHRA, Issue Identification – Off-Airport

This section of the report provides a more detailed review of the exposure pathways and individuals or groups of individuals relevant to PFAS compounds identified in environmental media off-airport, and if the PFAS concentrations are sufficiently elevated to require a detailed assessment of risk. The review presented here has considered data collected off-airport for the purpose of characterising PFAS risk issues.

The relevant data and plans have been extracted from the available investigation reports and provided in **Appendix A**.

4.1 Potential for Exposure

The main human receptors identified for the purpose of the off-airport HHERA comprise users of groundwater in the vicinity of the airport including those who may extract groundwater for non-potable uses including irrigation, industrial use, stock watering (i.e. watering chickens) or filling of swimming pools.

The available information indicates that shallow groundwater in the residential areas to the south and west of the airport is not currently used for potable water supply or for any non-potable uses except for irrigating lawns at 1 residential property. This means that groundwater is not currently being used in a way that could result in the accumulation of PFAS into edible products that could be subsequently home consumed. This exposure pathway is currently incomplete, and where there is no exposure to PFAS in edible products, there are no health risks from PFAS in edible products. No swimming pools have been identified. Hence, the only current exposure pathway of concern in the area to the south and west of the airport is incidental direct contact during the non-potable use.

In relation to the potential for the future extraction and use of groundwater for growing fruit/vegetables or watering chickens:

- Groundwater to the south of the airport is unsuitable for these purposes due to its high TDS content; and
- Groundwater to the west of the airport is suitable for these purposes.

The future use of groundwater for filling swimming pools in both areas is also considered possible, as is the potential for incidental direct contact with groundwater during non-potable use.

The City of Salisbury website[4] indicates that Dry Creek flows freely throughout winter, but often dries up during summer. Dry Creek Linear Park forms a secluded nature corridor along Dry Creek, extending 3.5 kilometres from Walkleys Road to Bridge Road.

Based on the ephemeral (stormwater fed) nature of Dry Creek, it is unlikely that surface water from the wetland areas downgradient of the airport would be extracted for non-potable use e.g. irrigation/stock watering, or used for primary contact recreation. Investigations undertaken to date have not identified that surface water downgradient of the airport is extracted and used. It is also

[4] http://www.salisbury.sa.gov.au/Live/Environment_and_Sustainability/Wetlands_and_Water/Wetlands/Wetlands_Locations

unlikely that Dry Creek would be used routinely for primary and secondary contact recreation (i.e. swimming, boating or fishing). However, incidental direct contact exposures may occur while accessing the creek area for other types of recreation.

The following human receptors have been identified for the off-airport HHERA:

- Users of off-airport groundwater (adults and children); and
- Recreational users of Dry Creek (adults and children).

Table 4.1 presents a more detailed overview of the exposure pathways relevant to the assessment of human exposures off-airport. The table also outlines the data that is relevant to the assessment of these exposures and outcomes of the screening level assessment undertaken. Text shown in **blue** indicates that risks have been concluded to be acceptable while text shown in **purple** indicates that further assessment is required or recommended. Where data is available this further assessment has been presented in the HHERA.

Table 4.1: Summary of Key Exposure Pathways – Off-Airport

Exposure Pathway/Mechanism	Potentially Significant Pathway?	Comments	Screening Assessment
Residents			
Incidental ingestion of PFAS in groundwater	✓	Incidental direct contact exposures may occur during the current use of groundwater at off-airport residential properties for irrigating lawns, or the future use of groundwater for filling swimming pools.	The suitability of the use of groundwater for non-potable uses has been undertaken by comparing the relevant data against recreational water guidelines. This is presented in **Section 4.2**. **No PFAS concentrations of concern identified in groundwater.**
Dermal contact with PFAS in groundwater[1]	✓		
Ingestion of home-grown produce (fruit and vegetables) (potential future use only)	✓	Where produce is grown on a residential site, where PFAS is reported in water used for irrigation, PFAS may accumulate in fruit, vegetables and/or chicken eggs that may be home-consumed by residents.	The screening level assessment for the use of groundwater for future watering home-grown produce is presented in **Section 4.2**. **Groundwater off-airport to the west is suitable for watering produce and chickens and contains concentrations of PFAS exceeding the screening level guidelines. Further evaluation is required in this HHERA and is presented in Section 5, Section 8 and Section 9.**
Ingestion of home-grown eggs from chickens (potential future use only)[2]	✓		
Recreational Users of Dry Creek (Including Residents)			
Extraction and use of surface water	*x*	Surface water from Dry Creek is not known to be extracted for any use	**Not required.**
Incidental ingestion of PFAS in surface water	✓	Direct contact exposures (incidental ingestion and dermal contact) may occur during the recreational use of Dry Creek	The suitability of the use of surface water for recreational activities has been undertaken by comparing surface water data against recreational water guidelines. This is presented in **Section 4.3**. **No PFAS concentrations of concern identified in surface water.**
Dermal contact with PFAS in surface water[1]	✓		
Ingestion of fish	✓	Consumption of fish from Dry Creek.	A screening level assessment of PFAS reported in samples of edible fish collected from Patawalonga Creek (adjacent to Adelaide Airport) has been undertaken and is presented in **Section 4.5**. **No PFAS concentrations of concern identified in fish from Patawalonga Creek.**

Notes:

"✓" = Exposure pathway is considered to be potentially complete. "

"✓" = Exposure pathway is considered to be limited, however has been assessed further in this HHERA for completeness.

"*x*" = Exposure pathway is considered to be incomplete and has not been assessed further in this HHERA.

1 = Dermal uptake of PFAS in soil and water is understood to be limited in comparison to the incidental ingestion pathways (refer below for further information) however further assessment has been provided in this HHERA for completeness.

2 = This relates to the home-consumption of produce. The assessment of risks following the sale of produce into the market is outside of the scope of this HHERA.

4.2 Nature and Extent of Impacts in Groundwater

4.2.1 Available Data

A total of 12 groundwater locations on the airport boundary and 21 off-airport groundwater locations have been investigated by GHD and Environmental Projects in 2018 to 2020 (Environmental Projects 2019; Environmental Projects 2020; GHD 2019a; GHD 2019b; GHD 2019c; GHD 2019d; GHD 2020a; GHD 2020b).

Investigations undertaken by GHD comprised the following:

- Investigation works in November/December 2018 and February 2019, March 2019 and May 2019. Included the installation of wells P34 to P44, as well as the sampling of existing wells GWP1-PFC, GWP2-PFC, GWP3-PFC and P9;
- Installation and sampling of wells P45 to P48 in July 2019;
- Installation and sampling of wells P49 to P52 in September 2019;
- Installation and sampling of wells P53 to P55 in November 2019;
- Installation and sampling of wells P56 and P57 in December 2019; and
- Installation and sampling of wells P58, P59 and MW15 in February 2020

Investigations undertaken by Environmental Projects comprised the following:

- Sampling of existing wells GWP2-PFC, GWP3-PFC and P44 in April 2019; and
- Sampling of wells P59 and P61 in July 2020.

Wells installed included 2 wells to the south of the airport (P38 and P39) and 19 wells (P36, P37, P40 to P43, P50 to 61 and MW17) the west of the airport. This HHERA has considered the data obtained from all off-airport locations except for location P61, as PAL has indicated that the PFAS detected at well P61 has been identified to be from a non-airport source. Data from southern and western boundary groundwater wells has also been reviewed for completeness and as there are some residential properties between the airport boundaries and the closest off-airport wells.

The PFAS analytical schedule and adopted LORs varied between rounds, as shown in the tabulated data in **Appendix A**. A review of the QA/QC procedures undertaken as part of the groundwater sampling for each of the above assessments is provided in the relevant report, where it is concluded that the data set is valid and acceptable.

Table 4.2 provides a summary of the groundwater sampling works undertaken. Well locations are shown on the site plans in **Appendix A**. Reported PFAS concentrations are summarised in **Table 4.3**

Table 4.2: Summary of Off-Airport Groundwater Investigations, 2018 to 2020

Well ID	Sampling Round										
	November/ December 2018	February 2019	March 2019	April 2019	May 2019	July 2019	September 2019	November 2019	December 2019	July 2020	February 2020
On-Airport (Boundary)											
GWP1-PFC	--	--	✓	--	✓	--	--	--	--	--	--
GWP2-PFC	--	--	✓	✓	✓	--	--	--	--	--	--
GWP3-PFC	--	--	✓	✓	✓	--	--	--	--	--	--
P9	✓	--	✓	--	--	--	--	--	--	--	--
P34	✓	--	✓	--	✓	--	--	--	--	--	--
P35	✓	--	✓	--	✓	--	--	--	--	--	--
P44	--	✓	✓	✓	✓	--	--	--	--	--	--
P45	--	--	--	--	--	✓	--	--	--	--	--
P46	--	--	--	--	--	✓	--	--	--	--	--
P47	--	--	--	--	--	✓	--	--	--	--	--
P48	--	--	--	--	--	✓	--	--	--	--	--
P49	--	--	--	--	--	--	✓	--	--	--	--
Off-Airport											
P36	✓	--	✓	--	✓	--	--	--	--	--	--
P37	✓	--	--	--	✓	--	--	--	--	--	--
P38	✓	--	--	--	--	--	--	--	--	--	--
P39	✓	--	--	--	--	--	--	--	--	--	--
P40	--	✓	✓	--	✓	--	--	--	--	--	--
P41	--	✓	✓	--	✓	--	--	--	--	--	--
P42	--	✓	✓	--	✓	--	--	--	--	--	--
P43	--	✓	✓	--	✓	--	--	--	--	--	--
P50	--	--	--	--	--	--	✓	--	--	--	--
P51	--	--	--	--	--	--	✓	--	--	--	--
P52	--	--	--	--	--	--	✓	--	--	--	--
P53	--	--	--	--	--	--	--	✓	--	--	--
P54	--	--	--	--	--	--	--	✓	--	--	--
P55	--	--	--	--	--	--	--	✓	--	--	--
P56	--	--	--	--	--	--	--	--	✓	--	--
P57	--	--	--	--	--	--	--	--	✓	--	--
P58	--	--	--	--	--	--	--	--	--	--	✓
P59	--	--	--	--	--	--	--	--	--	✓	✓
P60	--	--	--	--	--	--	--	--	--	✓	--
MW15	--	--	--	--	--	--	--	--	--	--	✓

Notes:

Refer to **Appendix A** for further information.

✓ = Sampling undertaken.

Table 4.3: Summary of PFAS Concentrations in Off-Airport Wells and On-Airport Boundary Wells, 2018 to 2020

Well ID	Maximum PFAS Concentration (µg/L)			
	PFOS	PFHxS	PFOS + PFHxS	PFOA
On-Airport (Southern Boundary)				
P9	0.013	0.027	0.04	<0.01
Off-Airport to the South, Bridges Estate (Area 1)				
P38	0.013	0.019	0.032	0.0041
P39	0.0035	0.0094	0.013	0.0098
On-Airport (Western Boundary)				
GWP1-PFC	0.02	0.039	0.06	0.011
GWP2-PFC	0.039	0.068	0.11	0.004
GWP3-PFC	0.05	0.0065	0.12	0.004
P34	0.04	0.14	0.18	0.0023
P35	0.05	0.027	0.07	0.0063
P44	0.13	1.74	1.87	0.08
P45	0.03	1.1	1.1	0.02
P46	0.03	0.01	0.04	<0.01
P47	0.03	0.03	0.06	<0.01
P48	0.02	0.12	0.14	<0.01
P49	0.05	0.38	0.42	0.03
Off-Airport to the West, Parafield Gardens Area 2 and 3				
P36	0.07	0.085	0.17	0.024
P37	0.043	0.037	0.08	0.0028
P40	0.032	0.038	0.07	0.05
P41	0.05	0.082	0.17	0.0048
P42	0.07	0.077	0.16	0.02
P43	0.24	0.050	0.29	0.031
P50	<0.01	0.01	0.01	<0.01
P51	<0.01	0.01	0.01	<0.01
P52	<0.01	0.02	0.02	<0.01
Off-Airport to the West				
P53	0.04	0.02	0.06	<0.01
P54	0.06	0.13	0.19	0.01
P55	0.03	0.02	0.05	<0.01
P56	0.18	0.04	0.22	0.01
P57	0.20	0.05	0.25	0.01
P58	0.03	0.12	0.15	<0.01
P59	0.06	0.1	0.16	<0.01
P60	<0.01	<0.02	<0.01	<0.01
MW15	0.01	<0.02	0.01	<0.01

Notes:

Refer to **Appendix A** for further information.

4.2.2 Adopted Guidelines

The Australian Drinking Water Guidelines (NHMRC 2011 updated 2018) and the NHMRC recreational water quality guidelines (NHMRC 2019) have been adopted for the off-airport screening assessment for groundwater.

The recreational water quality guidelines are relevant for the assessment of the future use of groundwater for filling swimming pools, and for the assessment of incidental direct contact exposures with groundwater that may occur during the current use of groundwater for irrigating lawns, or other future non-potable uses of groundwater.

The drinking water guidelines have been adopted for the assessment of the future use of groundwater for watering fruit, vegetables and chickens, to confirm whether evaluation of the potential uptake into edible products (fruit, vegetables and eggs) is required.

Where concentrations are below drinking water guidelines, the use of this water for all uses including potable water supply, irrigation or crops and stock watering is considered suitable. This is because the drinking water guidelines are derived in a manner that allows for all exposures considered likely to occur during home use of water, including use of water for washing, food preparation, irrigation of gardens etc. It is considered that assuming consumption of 2L/day is sufficient to cover for the exposure pathway which people would be exposed to every day for their whole life. The drinking water guidelines also assume that only 10% of a person's exposure to the chemical comes from drinking water (90% is assumed to come from other pathways). From an overall perspective, the drinking water guideline represents the concentration of a chemical in water that the Australian Government has determined is safe to drink and use for any purpose commonly undertaken for domestic purposes for a lifetime. The assessment of risks following the sale of produce into the market is outside of the scope of this HHERA.

4.2.3 Screening Assessment

Table 4.4 presents a review of maximum concentrations of PFOS + PFHxS and PFOA in groundwater on the airport boundary or off-airport to the south and west, with the adopted screening level guidelines.

Table 4.4: Summary and Review of PFAS Reported in Groundwater, Off-Airport or Boundary

Well ID	Maximum PFAS Concentration (µg/L)	
	PFOS + PFHxS	PFOA
On-Airport (Southern Boundary)		
P9	0.04	<0.01
Off-Airport to the South, Bridges Estate (Area 1)		
P38	0.032	0.0041
P39	0.013	0.0098
On-Airport (Western Boundary)		
GWP1-PFC	0.06	0.011
GWP2-PFC	0.11	0.004
GWP3-PFC	0.12	0.004
P34	0.18	0.0023
P35	0.07	0.0063
P44	1.87	0.08
P45	1.1	0.02
P46	0.04	<0.01
P47	0.06	<0.01

Well ID	Maximum PFAS Concentration (µg/L)	
	PFOS + PFHxS	PFOA
P48	0.14	<0.01
P49	0.42	0.03
Off-Airport to the West, Parafield Gardens Area 2 and 3		
P36	0.17	0.024
P37	0.08	0.0028
P40	0.07	0.05
P41	0.17	0.0048
P42	0.16	0.02
P43	0.29	0.031
P50	0.01	<0.01
P51	0.01	<0.01
P52	0.02	<0.01
Off-Airport to the West		
P53	0.06	<0.01
P54	0.19	0.01
P55	0.05	<0.01
P56	0.22	0.01
P57	0.25	0.01
P58	0.15	<0.01
P59	0.16	<0.01
P60	<0.01	<0.01
MW15	0.01	<0.01
Adopted Screening Guidelines		
Uptake into Edible Products[1]	**0.07**	**0.56**
Incidental Direct Contact by Residents[2]	**2**	**10**

Notes:

Shading indicates an exceedance of the adopted guideline value.

1 = Re. HEPA (2020).

2 = Ref. NHMRC (2019).

Review of **Table 4.4** indicates the following:

- Concentrations of PFOS + PFHxS and PFOA in groundwater are below the adopted recreational water quality guidelines. Hence, there are no health risk issues of concern in relation to the future use of groundwater for filling swimming pools, or current and future incidental direct contact exposures with groundwater during its non-potable use;
- Concentrations of PFOA in groundwater are below the adopted drinking water guidelines. Hence, there are no health risk issues of concern in relation to the uptake of PFOA in edible produce that may be home-consumed (where this occurs in the future); and
- Concentrations of PFOS + PFHxS in groundwater on the western airport boundary and off-airport to the west exceed the adopted drinking water guidelines.

As discussed above, groundwater to the west of the airport is not currently used for watering fruit/vegetables or chickens. However, the potential for future use for these purposes is unable to be precluded given that water is suitable for these uses based on TDS concentration. Hence, an assessment of potential health risks following the consumption of home-grown fruit, vegetables and eggs from chickens has been undertaken in this HHERA, as provided in **Section 5**, **Section 8** and **Section 9**.

4.3 Nature and Extent of Impacts in Stormwater

4.3.1 Available Data

As discussed in **Section 3.3**, stormwater data has been collected from three locations across the site. The following sampling locations are the downstream locations, closest to the point of discharge for stormwater at the site into Dry Creek:

- SW-DS1/SWP2 (these are different names for the same sampling location); and
- SW-DS3.

Stormwater samples were analysed for an extended PFAS suite. Sampling locations shown on **Figure 4**. The available assessment data is provided in **Appendix A**.

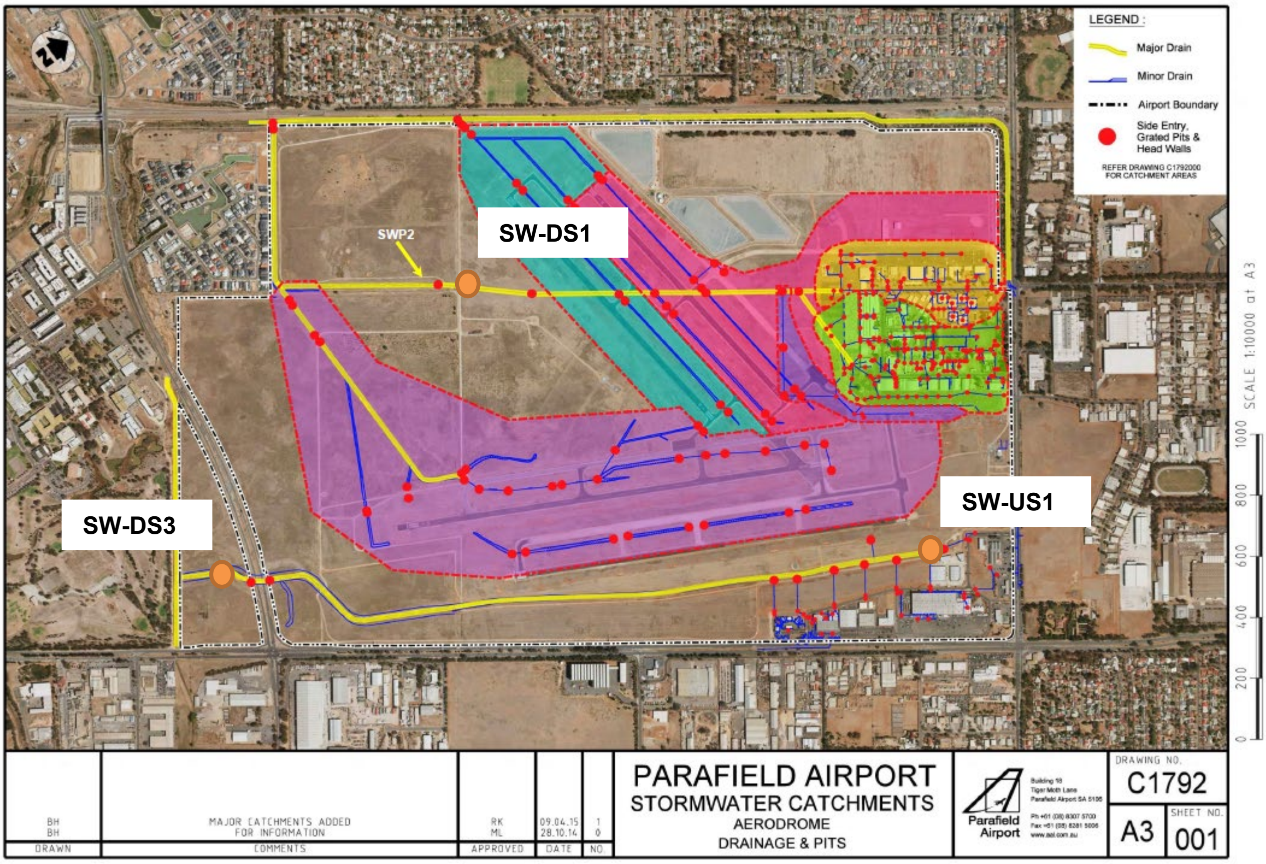


Figure 4: Stormwater Water Sampling Locations (2016; 2017)

4.3.2 Adopted Guidelines

The NHMRC recreational water quality guidelines (NHMRC 2019) have been adopted for the off-airport screening assessment for surface water in Dry Creek, where incidental direct contact exposures may occur. Data from all stormwater samples collected has been reviewed against the above guidelines.

The screening level guidelines for water do not consider the uptake of PFAS into fish that may be caught from the Dry Creek and consumed by humans. Potential risks to human health following recreational fishing in these water bodies (should this occur which is considered unlikely noting the Dry Creek is ephemeral and stormwater fed) have been evaluated separately based on the fish sampling and analysis undertaken by SA EPA at Adelaide Airport, with the assessment presented in **Section 4.4**.

4.3.3 Screening Assessment

The review of PFOS + PFHxS and PFOA concentrations in stormwater with the adopted screening level guidelines is provided in **Table 4.5**.

Table 4.5: Summary and Review of PFAS Reported in Stormwater, Off-Airport

Sampling Location (Date Sampled)	Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
SW-US1		
June 2016	0.01	<LOR
SWP2/SW-DS1		
June 2016	0.04	<LOR
July 2016	0.11	<LOR
September 2016	0.22	<LOR
November 2016	0.34	<LOR
January 2016	0.30	<LOR
SW-DS3		
June 2016	<LOR	<LOR
Adopted Screening Guidelines		
Recreational Exposures[1]	**2**	**10**

Notes:
Shading indicates an exceedance of the adopted guideline value.
LOR = Laboratory Limit of Reporting (LOR) in the range <0.005 to <0.05 µg/L.
1 = Ref. NHMRC (2019).

Review of **Table 4.5** indicates that PFOA was not detected in stormwater at downstream locations on-airport, and concentrations of PFOS + PFHxS in stormwater at downstream locations are 5 to 200 times below the adopted recreational guidelines (relevant to potential incidental direct contact exposures in Dry Creek). These guidelines are based on exposures during regular swimming, hence, are highly conservative for the assessment of any incidental direct contact exposures that may occur during recreational activities along Dry Creek.

On this basis, there are no human health risks issues for PFAS in stormwater that require further review in this HHERA, in relation to potential incidental direct contact exposures with water in Dry Creek.

Irrespective of this, PFOS and PFOA are persistent organic pollutants and it is therefore recommended that PAL consider remediation of identified PFAS source areas or implement management measures to prevent concentrations of PFAS exiting the site in stormwater (where possible).

4.4 Nature and Extent of Impacts in Fish

4.4.1 Available Data

As discussed above, there is the potential for recreational fishing activities to be undertaken in Dry Creek although there is no specific information available as to the likely frequency of these fishing activities, the fish species that may be caught and whether these fish are likely to be consumed (noting that some species, e.g. carp, may be caught but not consumed).

No fish sampling and analysis results are available for the site, however tabulated results and laboratory analysis reports for concentrations of PFAS in fish caught from Patawalonga Creek (in the vicinity of Adelaide Airport) during sampling by SA EPA in September 2012 has been provided by PAL.

SA EPA have indicated the following with respect to the methodology adopted for the sampling program:

- Black bream from selected estuarine habitats were targeted to provide an indication if PFAS were accumulating in a resident fish species at the end point for urban and agricultural catchments including Patawalonga Creek;
- SA EPA aimed to collect adult fish using a three to six fish per sample strategy;
- Caught fish were filleted for laboratory analyses of the edible portion of fish and the remaining fish frames;
- Two samples of fish were collected with each comprising three to six composited fish from the same collection date; and
- Bream were hard to collect in Patawalonga Creek and problems with stormwater pulses were encountered making it hard to find these fish. Given this, only two samples were collected.

It is noted that the stormwater discharge from Adelaide Airport does not directly enter Patawalonga Creek, and the potential for groundwater to discharge into Patawalonga Creek is unknown. Hence the review of fish data from Patawalonga Creek with known concentrations of PFAS in groundwater and stormwater at Adelaide Airport, and any subsequent inference about conditions at Parafield Airport, needs to be undertaken with some caution. This is because concentrations of PFAS reported in fish in Patawalonga Creek may, or may not, be influenced by impacts attributable to discharges from Adelaide Airport.

4.4.2 Adopted Guidelines

In April 2017, FSANZ released proposed trigger points for investigation for PFOS + PFHxS and PFOA in food products (FSANZ 2017a). Trigger points are provided for PFOS + PFHxS and PFOA in finfish fillets, finfish liver and crustaceans

The trigger points are stated to be the maximum concentration of the chemical that could be present in individual foods or food groups so even high consumers of these foods would not have dietary exposures exceeding the relevant TRV. The trigger points are lower for those foods that are normally consumed in larger amounts. Trigger points are not provided for PFAS other than PFOS, PFOA and PFHxS.

4.4.3 Screening Assessment

The review of PFOS concentrations in fish with the adopted screening level guidelines is provided in **Table 4.6**. PFOA was not detected at a concentration below the trigger levels. No analysis for PFHxS was undertaken. The laboratory reports for fish samples are provided in **Appendix A**.

Table 4.6: Summary and Review of PFAS Reported in Fish, Patawalonga Creek (Adelaide Airport)

Sample ID	Sample Type	PFOS (ng/g)
PAT1A	Fish Frames	3.7
PAT2A	Fish Frames	<2
Laboratory Duplicate	Fish Frames	3.9
PAT1B	Fish Fillets	0.94
PAT2B	Fish Fillets	<0.8
Laboratory Duplicate	Fish Fillets	0.97
Adopted Screening Guidelines[1]		
Finfish Fillets		**5.2**
PFOS Concentration Range in Water		
Adelaide Airport, Groundwater		<LOR – 7.6 µg/L
Parafield Airport, Groundwater		<LOR – 3.51 µg/L
Adelaide Airport, Stormwater		<LOR – 26 µg/L
Parafield Airport, Stormwater		<LOR – 0.19 µg/L

Notes:

Shading indicates an exceedance of the adopted guideline value based on the maximum concentration.

1 = Ref. FSANZ (2017). These trigger levels assume that all (100%) of the tolerable daily intake is sourced from either fish or crustaceans (i.e. they do not consider exposures from multiple pathways).

Review of **Table 4.6** indicates that maximum concentrations of PFOS in fish fillets and fish frames from Patawalonga Creek are below the trigger points for finfish. Concentrations reported in fish frames were around 4 times higher than concentrations reported in fillets, with concentrations in fillets 5 times below the trigger level. Given this, the lack of data for PFHxS is not considered to be a significant data gap for the HHERA.

Table 4.6 also indicates that concentrations of PFOS in groundwater and stormwater that may be discharging off-site from Parafield Airport are lower than concentrations of PFOS in groundwater and stormwater that may be discharging off-site from Adelaide Airport. It is also noted that stormwater is a more direct transport pathway than groundwater (i.e. concentrations in stormwater may provide a better indication of concentrations in surface water downstream) and concentrations of PFOS in stormwater at Parafield Airport are around 100 times lower than those at Adelaide Airport. Hence, the use of fish sampling data from Patawalonga Creek downstream of Adelaide Airport may be conservative for use as an indication of concentrations of PFOS in fish in Dry Creek downstream of Parafield Airport (assuming similar inputs and flows into the water bodies).

The FSANZ trigger levels assume that all (100%) of the tolerable daily intake is sourced from either fish or crustaceans (i.e. they do not consider exposures from multiple pathways). Concentrations of PFOS + PFHxS and PFOA in stormwater at downgradient sampling points on-airport are below the adopted screening level guidelines, which are sufficiently conservative to consider multiple exposure pathways. On this basis, no further consideration of multiple exposures within Dry Creek has been undertaken in this HHERA.

4.5 Uncertainties

One to three rounds of sampling of off-airport wells to the west has been undertaken. While some off-airport wells have only been sampled once, reported PFOS + PFHxS concentrations are relatively consistent. It is understood that a PFAS Management Plan for the airport is currently being prepared, and which will include any requirements for ongoing monitoring.

Stormwater data is available from sampling in 2016/2017, and this HHERA has been based on the available data which does not indicate any PFAS concentrations of concern in relation to off-site recreational use of and Dry Creek.

Section 5. Toxicity of PFAS to Humans

5.1 Approach

This section outlines the approach used to assess the toxicity of PFAS to human health. The quantitative assessment of potential risks to human health for any chemical requires the consideration of the health end-points and where carcinogenicity is identified; the mechanism of action needs to be understood.

For chemicals that do not cause cancer (are not carcinogenic), a threshold exists below which there are no adverse effects. This threshold is known as a toxicity reference value (TRV). Other names for a TRV include Health Based Guideline Value (HBGV), tolerable daily intake (TDI) or acceptable daily intake (ADI). The TRV typically adopted in risk calculations, including those in this HHERA, is based on the lowest no observed adverse effect level (NOAEL; typically from animal or human e.g. occupational studies), and the application of several safety or uncertainty factors (UF). The adoption of the NOAEL along with the addition of UF adds conservatism into the TRV. Hence, intakes/exposures lower than the TRV are considered safe, or not associated with an adverse health risk (NHMRC 1999).

There are two general groups of chemicals that cause cancer (called carcinogens) (NEPC 1999 amended 2013a):

- Genotoxic carcinogens for which, in theory, any level of exposure could result in a response as the chemical has the ability to interact directly with our DNA; and
- Non-genotoxic carcinogens, for which there is a threshold below which exposure is not expected to result in adverse health effects.

PFAS do not possess the chemical/physical properties typically associated with direct genotoxicity and are not considered to be genotoxic from an overall perspective (deWitt. J.C. 2015). Hence, in this HHERA, TRVs relevant to the characterisation of potential health effects associated with exposure to PFAS have been selected from credible peer-reviewed sources using the process outlined in enHealth and NEPC (enHealth 2012a; NEPC 1999 amended 2013a).

The toxicology of PFAS is complex and not well understood despite a significant amount of research in the last five to 10 years. **Appendix B** presents a summary of the human toxicity of PFOS and PFHxS, with the following providing a summary of the key aspects considered in this assessment.

5.2 PFAS Compounds

5.2.1 General

PFAS compounds are widely distributed throughout the environment and can be highly persistent in the body and present in many products and foods. FSANZ (FSANZ 2017a) provides a recent current evaluation of PFAS toxicity, for the purpose of establishing Australian guidelines for these compounds in edible produce to protect human health. The Australian Government also convened an Expert Health Panel for PFAS in 2018 (Australian Government Department of Health 2018). From an international perspective, the US Interstate Technology and Regulatory Council (ITRC) provides several well written PFAS fact sheets.[5] Some of the key aspects of PFAS toxicology are outlined below, with a focus on PFOS + PFHxS which are the key PFAS that require further evaluation in this HHERA. Further information is provided in **Appendix C**.

5.2.2 PFOS

The following provides a general summary of health effects that have been associated with PFOS and PFOA (Rumsby, McLaughlin & Hall 2009):

- Although the acute toxicity of PFAS is moderate, their persistence in the body has led to increasing concerns over long-term effects. The toxicity of PFOS is not clearly understood at present. Different animal species appear to have different sensitivities to these compounds, which makes interpretation of experiments difficult (e.g. Rhesus monkeys are more sensitive to PFOS than rats, while mice are the least sensitive). The species variability may be due to the different handling of these compounds in the body;
- At present, the mechanism for PFOS activity is unclear, and high and low doses may differ in their toxic effects. High-dose studies on animals have indicated that cancer, developmental delays, endocrine disruption, immunotoxicity and neonatal mortality are potential toxic endpoints; and
- Recent research has also suggested that receptor binding may be an important general mechanism. PFOS binds to peroxisomal proliferator-activated receptors (PPAR). Activation of such receptors may alter fatty acid metabolism and play a role in cancer, foetal growth, hormone and immune function.

The toxicity of PFAS to humans can be inferred from animal toxicity studies as well as occupational exposure studies. The occupational exposure studies consider workers who handle or make PFAS, where the exposure levels are high. These studies have been undertaken in the US and Belgium, and have evaluated a range of health effects based on blood serum levels of PFAS in workers. These studies have identified some associations between altered cholesterol, triglyceride and high-density lipoprotein production (for PFOS > 6 mg/L in serum) and PFAS exposure. Review of these studies (ToxConsult 2014) identified that a no effect level of 2 mg/L (in serum) can be established for adult workers.

In general, observations from toxicological studies undertaken in animals with PFOS include irritation of eyes, skin and nose; loss of appetite, reductions in body-weight and weight gain, changes in the liver (including increases in liver weight [characterised by increased centrilobular hepatocellular hypertrophy]), mild-to-moderate peroxisome proliferation in rats, increased incidence of hepatocellular adenomas in rats (non-genotoxic), and hypo-cholesterolemia (ATSDR 2018). Effects identified appear to be related to a threshold body burden and often are observed with a steep dose–response (i.e. after the threshold the potential for adverse effects increases rapidly with increasing exposure level) (ToxConsult 2014).

Data from epidemiological studies with occupationally exposed workers at 3M manufacturing facilities (Alabama, USA and Belgium), communities exposed to contaminated drinking water (USA)

[5] https://pfas-1.itrcweb.org/

and general populations (USA, UK and Scandinavia) are also available. It is noted that concentrations of PFAS in occupationally exposed workers are higher than those in the general populations. Despite this, epidemiology studies have generally failed to draw conclusive links between exposure to PFOS and adverse health effects. Associations between exposure and the following health effects have been suggested:

- Changes in serum lipid levels e.g. increase total cholesterol levels;
- Changes in serum liver enzymes levels;
- Kidney disease;
- Effects on fertility, pregnancy, lactation, and birth outcomes;
- Effects on thyroid and immune function;
- Endocrine effects (e.g. elevated thyroxine levels and increased risk of thyroid disease, diabetes mellitus and early onset menopause);
- Cardiovascular disease; and
- Cancer.

Overall, the evidence for adverse effects in humans following exposure is inconsistent from the epidemiological studies. In addition, the biological significance of some of the observed effects has been questioned (i.e. just because an effect is observed it does not mean it is, or will lead to, an adverse effect) and there is the potential that observed effects may be due to confounding factors e.g. exposure to other contaminants or diet.

5.2.3 Characterising toxicity for PFOS and PFHxS

Consistent with reviews by other authorities (EFSA 2008; enHealth 2016; USEPA 2016a, 2016b), FSANZ has determined a tolerable daily intakes (TDI) for PFOS on the basis of data derived from animal studies, that show exposure to these compounds can cause liver toxicity and tumours and reproductive and developmental effects. The available epidemiological studies have not provided sufficient evidence of a link between exposure to PFOS and PFHxS and any cancer type in human beings.

In relation to PFHxS, FSANZ determined there was insufficient information to establish a TDI for PFHxS. In the absence of a TDI, FSANZ agrees with enHealth (enHealth 2016) that using the TDI for PFOS is likely to be conservative and protective of public health. This means that PFHxS and PFOS should be summed for the purposes of exposure assessment and risk characterisation. The TDIs adopted by FSANZ for the assessment PFOS + PFHxS are summarised in **Table 5.1**. This table also includes the background intakes adopted for the HHERA, which are based on the review presented by ToxConsult (ToxConsult 2016).

Table 5.1: Summary of toxicity reference values adopted for PFOS + PFHxS and PFOA

PFAS Compound	TDI	Adopted Background intake	Reference
PFOS + PFHxS	0.02 µg/kg/day	0.0014 µg/kg/day (7% of the TDI)	(ToxConsult 2016)

Notes:
Refer to **Appendix B** for further information

It is noted that the human health screening criteria adopted in this review (and presented in **Section 3** and **Section 4**) are based on the TDIs identified above.

5.3 Uncertainties

In general, the available scientific information is insufficient to provide a thorough understanding of all the potential toxic properties of chemicals to which humans may be exposed. It is necessary, therefore, to extrapolate these properties from data obtained under other conditions of exposure and involving experimental laboratory animals. Most of the toxicological knowledge of chemicals comes from experiments with laboratory animals, although there may be interspecies differences in chemical absorption, metabolism, excretion and toxic response, as is particularly the case for PFAS compounds. There may also be uncertainties concerning the relevance of animal studies using exposure routes that differ from human exposure routes. In addition, the frequent necessity to extrapolate results of short-term or sub-chronic animal studies to humans exposed over a lifetime has inherent uncertainty. The uncertainties inherent in the toxicological values adopted are considered likely to result in an overestimation of actual risk assessed for long-term or chronic exposures.

Overall, it can be concluded that the toxicology of PFAS is complex and not well understood despite a significant amount of research in the last five to 10 years. Although the epidemiological studies have not provided convincing evidence of a correlation between exposure to PFAS and adverse health effects in humans (FSANZ 2017a), there is evidence of adverse effects in experimental animals exposed to PFOS and PFOA. The potential interspecies differences, including in the activation of PPARα, between animals and humans are acknowledged. However, it is noted that PFOS and PFOA are known to interact with other receptors, and the effects of activating these other receptors in animals and humans has not yet been determined.

The use of toxicity data from laboratory experiments with animals is the recognised approach in Australia and overseas for the assessment of toxicity to humans in the absence of more relevant experimental data for humans (i.e. epidemiological studies). This is because the use of this animal toxicity data (and the overall approach) is established and precautionary. This applies equally to PFAS, as it does to any other chemical where it is suspected that exposure may lead to adverse health effects.

It is also noted that toxicity guidelines have also been drafted or established for PFOS and PFOA by a number of international agencies including the European Food Safety Authority (EFSA), the USEPA and the United States Agency for Toxic Substances and Disease Registry (ATSDR). In February 2020, EFSA released updated toxicity values for PFOS and PFOA in food which are lower than the values recommended by FSANZ in 2017. The EFSA conclusions are noted to be provisional based on uncertainties in the report and disagreement with other prominent European scientific agencies. FSANZ is currently reviewing the EFSA report to see whether it contains any new information that would warrant a need to reconsider the tolerable daily intakes it published in 2017. [6]

[6] http://www.foodstandards.gov.au/consumer/chemicals/Pages/Perfluorinated-compounds.aspx

Section 6. HHRA, Exposure Assessment: On-Airport

6.1 General

This section provides a discussion on the human receptors of potential significance that warrant quantification in this assessment. The potential for exposure has been quantified using industry best practice and guidance available from USEPA (1989, 2002 and 2009) and Australia (NEPC 1999 amended 2013b). Where specific guidance is not available, parameters comprise industry standard values that have been demonstrated to be acceptable in the Australian regulatory context.

6.2 Exposure Assumptions

The assessment presented has calculated for a RME scenario estimated by chemical concentrations that define the highest exposure that is reasonably likely to occur on the airport. The RME is likely to provide a conservative or overestimate of total exposure and therefore health risk.

The magnitude of the exposure is a function of a number of variables, termed exposure parameters, which describe the site-specific physical and behavioural parameters relevant to the potentially exposed population. Where available, and where relevant to the site-specific assessment conducted, additional exposure data has been obtained from Australian sources (enHealth 2012a, 2012b; NEPC 1999 amended 2013d).

Table 6.1 presents a summary of the parameters adopted for the quantification of human exposures to PFOS + PFHxS in groundwater, based on the information currently available. The exposure parameters are also presented in the risk calculations provided in **Appendix D**.

As noted above, the AAL Guideline for PFAS Work Health and Safety specifies that PFAS exposure risks should be considered and where necessary, and included in JSAs, SWIs and Take 5 risk assessments prior to the commencement of works. Suggested control measures include dust control, the use of PPE comprising gloves, dust masks and protective eyewear and the appropriate decontamination of PPE following works. The Guideline notes that these control measures form part of controls already in place to manage existing risks.

Regardless, this HHERA (and **Table 6.1**) has assumed that exposures to PFOS + PFHxS do occur to assess the magnitude of likely risks to health should control measures not be implemented adequately and inform the need for additional management measures.

Table 6.1: Summary of Exposure Parameters – Airport Workers

Exposure	Airport Worker
Exposure Duration	30 years (conservative value). (Note, as PFOS and PFOA act via a threshold mechanism, the assumption of a 1 year or 30-year exposure duration does not affect the risk calculations as this value cancels out).
Exposure Frequency	60 days per year (assumes a worker is in contact with PFAS impacted water for 60 days per year) (conservative based on the existing management controls at the airport).
Body weight	70 kg (average adult body weight) (enHealth 2012b)
Averaging Time (non-carcinogenic)	Exposure duration x 365 days
Bioavailability	100% (maximum possible)

Exposure	Airport Worker
Incidental Contact with Water	
Gastrointestinal Absorption	100% (maximum possible)
Ingestion Rate	0.005 L/day (industry standard value for contaminated site risk assessments in Australia, assumes 5 mL of water or 1 teaspoon is ingested including water droplets/mist in air)
Time Spent Wet	2 hrs/day (assumed time workers may be wet)
Skin Surface Area	6,300 cm^2 (NEPC 1999 amended 2013e)
Dermal Permeability to Water	3.25×10^{-5} cm/hour (dermal permeability value for PFOA from ATSDR (2015) for mouse skin (more conservative than human skin), adopted for PFOS + PFHxS and PFOA in the absence of chemical specific data

6.3 Quantification of Exposures

6.3.1 Incidental Ingestion of Water

Ingestion of water is a key pathway of exposure relevant for Airport workers.

The potential intake of PFOS+ PFHxS in water via incidental ingestion has been undertaken using the following equation:

$$Daily\ Chemical\ Intake_{Iw} = C_w \bullet \frac{IRw \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

where:
Cs = Concentration of PFAS in water (mg/L)
IRw = Ingestion rate of water (L/day)
FI = Fraction of daily ingestion that is derived from contamination source (unitless), taken as 1
B = Bioavailability or absorption of chemical via ingestion (unitless) (assumed to be 100%)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time for threshold exposures, (=ED x 365 days)

The assumptions adopted for the quantification of potential intakes via incidental ingestion of water are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

6.3.2 Dermal Contact with Water

The potential intake of PFOS+ PFHxS in water via dermal absorption has been undertaken using the following equation:

$$Daily\ Chemical\ Intake = C_W \bullet \frac{SAw \bullet ET \bullet DP \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

where:
Cw = Concentration of PFAS in water (mg/L)
SAw = Surface area of body exposed to water per day (cm^2)
ET = Exposure time to PFAS in water (hr/day)
DP = Dermal permeability (cm/hr)
CF = Conversion factor of 1×10^{-3} (L/cm^3)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time for threshold exposures, (=ED x 365 days)

The assumptions adopted for the quantification of potential intakes via dermal absorption following contact with water are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

6.4 Adopted Concentrations

Table 6.2 outlines the maximum concentrations of PFOS + PFHxS at well GWP6-PFC, that airport workers may be exposed to in accordance with the exposure parameters outlined in **Table 6.1**. This approach is conservative, as airport workers will be exposed to average and not maximum concentrations, however there is not sufficient data available to refine the assessment (e.g. through the use of statistics).

Table 6.2: Summary of Input Concentrations for HHERA

Location	PFOS+ PFHxS
	Groundwater (µg/L)
GWP6-PFC (south-west part of the airport)	226

Notes:
"--" = Not a CoPC for this area of the airport.

6.5 Uncertainties

The values adopted for the purpose of quantifying exposure are point values that are derived from a wide range of physiological or behavioural values that are better defined using a distribution. However, it is overly complex to present the assessment based on distributions and the point values adopted in this HHERA provide a reasonable approximation of potential exposure.

The quantification of exposure has adopted a number of conservative assumptions regarding activities that Airport workers may undertake and how these activities may result in exposure to impacted groundwater. Many of the parameters adopted for the assessment of exposures are considered to be an overestimate of actual exposures. For example, it has been assumed that a worker is exposed to soil, groundwater and/or stormwater impacted with maximum PFAS concentrations for 60 days/year. Hence the risk calculations presented in this report are expected to be conservative from an overall exposure point of view.

In addition, the HHERA has assumed that PFOS + PFHxS and PFOA have the ability to penetrate through human skin and result in adverse health effects which is conservative based on the information in the scientific literature (de Witt 2015). Effects in animals that have been correlated with dermal exposure to PFAS include (ATSDR 2018):

- Hepatic changes in rats;
- Mild skin irritation and acute necrotizing dermatitis in rats;
- Conjunctival irritation in rabbits;
- Transient weight loss changes in rats; and
- Increase the IgE response to environmental allergens in mice.

ATSDR (2018) indicates that relevance of the above effects in animals to human is questionable given the severity of effects reported and that animals are generally thought to be poor surrogates for humans when assessing PFAS toxicology. Significant adverse health effects have also not been associated with long term dermal exposure to PFAS by workers. It is also interesting to note that when the dermal absorption of PFOS was studied in rabbits, absorption was not actually detected at an applied concentration of 0.3 mg/kg potassium PFOS. This indicates that PFOA, and not PFOS, may be more important when assessing dermal contact in animals. Notwithstanding the above, systemic effects have been reported in rats following exposure to PFOA and hence the HHERA has conservatively assumed that the dermal exposure pathway is complete for PFOS.

In this HHERA, the upper bound experimental value for PFOA and rat skin (which is likely to be protective of human skin) has been adopted for PFOS and PFHxS. No experimental values are available for PFOS/PFHxS however in the absence of specific experimental data, chemical behaviour is often inferred based on a similarity (or lack thereof) in chemical form and structure. Both perfluoroalkyl carboxylates (e.g. PFOA) and sulfonates (e.g. PFOS) are made of a long perfluorocarbon tail (that is both hydrophobic and oleophobic) and a charged end that is hydrophylic. This is what gives PFAS their unique surfactant properties. The molecular weight of PFOA is similar to PFOS and PFHxS (PFOS at 500.03 g/mol, PFHxS at 400.02 g/mol and PFOA at 414.07 g/mol). All three PFAS are expected to be present in ionic form at environmental pH.

Therefore, based on the similarities in chemical form and structure between PFOS/PFHxS and PFOA, and the available experimental data which suggests skin may be most permeable to PFOA, the adoption of experimental values for PFOA for PFOS and PFHxS is considered reasonable.

Section 7. HHRA, Risk Characterisation: On-Airport

7.1 Approach

Risk characterisation is the final step in a quantitative risk assessment. It involves the incorporation of the exposure and toxicity assessment to provide a quantitative evaluation of risk. In this HHERA, the quantification of potential exposure and threshold risks to human health associated with the presence of PFOS + PFHxS and / or PFOA in soil and water at the airport has been undertaken by comparing the estimated intake (or exposure concentration) with the threshold values adopted that represent a tolerable intake (or concentration), with consideration for background intakes. The calculated ratio is termed a Hazard Index (HI), which is the sum of all ratios (termed Hazard Quotients [HQ]) over all relevant pathways of exposure. These are calculated using the following equations:

$$Hazard\ Quotient\ [HQ]\ (oral\ or\ dermal) = \frac{Daily\ Chemical\ Intake}{(ADI, TDI, RfD - Background)}$$

$$Hazard\ Quotient\ [HQ]\ (inhalation) = \frac{Exposure\ Concentration\ in\ Air}{(TC, RfC - Background)\ or\ TWA}$$

$$Hazard\ Index\ (HI) = \sum_{All\ pathways} HQ$$

The interpretation of an acceptable HI needs to recognise an inherent degree of conservatism that is built in to the establishment of appropriate guideline (threshold) values (using many uncertainty factors) and the exposure assessment. Hence, in reviewing and interpreting the calculated HI the following is noted:

- A HI less than or equal to a value of 1 (where intake or exposure is less than or equal to the threshold) represents no cause for concern (as per risk assessment industry practice, supported by protocols outlined in ASC NEPM and USEPA guidance); and
- A HI greater than 1 requires further consideration within the context of the assessment undertaken, particularly with respect to the level of conservatism in the assumptions adopted for the quantification of exposure and the level of uncertainty within the toxicity (threshold) values adopted.

7.2 Calculated Risks

Table 7.1 presents a summary of the threshold HQ and the total HI calculated for the exposures evaluated. The values presented in **Table 7.1** (and all other risk calculations) are rounded to 1 or 2 significant figures reflecting the level of certainty inherent in risk calculations. Detailed calculations are presented in **Appendix D**.

Table 7.1: Summary of Risk Estimates, On-Airport

Potential Exposures by Airport Workers	Threshold Risk (HQ/HI)
	GWP6-PFC
- Ingestion of Groundwater	0.15
- Dermal Contact with Groundwater	0.01
Total Groundwater	0.16
Acceptable Risk	**≤1**

Review of **Table 7.1** indicates that risks to workers who may come into contact with PFAS impacted groundwater at location GWP6-PFC in the south-west portion of the site are low and acceptable.

As noted in **Section 3.7**, sampling has not been undertaken in all of the identified PFAS source areas on-airport. This means that higher concentrations of PFAS could be present in other areas of the airport that have not yet been investigated. Given this, the management measures outlined in the AAL Guideline for PFAS Work Health and Safety are supported and should be applied to all potential PFAS source areas at the airport. If works may intercept groundwater, the list of required PPE should be expanded to include long sleeves and long trousers, and waterproof boots if workers may get their feet wet in the course of activities.

7.3 Uncertainties

7.3.1 General

Uncertainty in any assessment refers to a lack of knowledge (that could be better refined through the collection of additional data or conduct of additional studies) and is an important aspect of the risk assessment process. An assessment of uncertainty is a qualitative process relating to the selection and rejection of specific data, estimates or scenarios within the risk assessment.

In general, the uncertainties and limitations of the risk assessment can be classified into the following categories, where uncertainties relevant to each have been addressed within the report (as noted):

- Identification of risk issues (addressed in **Section 3.7**);
- Toxicological assessment (addressed in **Section 5.3**); and
- Exposure assessment (addressed in **Section 6.5**).

Given it is not possible to fully define all exposures to PFAS that might occur at the airport, a further quantitative sensitivity analysis has been undertaken, as outlined below. The quantitative sensitivity analysis has considered the likely exposure frequency to groundwater at location GWP6-PFC. The original HHERA calculations (**Table 7.1**) assumed that workers are exposed to maximum PFAS concentrations in water on 60 days per year. Where this is reduced to 20 days per year (for 1/3 of the original assumed time), health risks will decrease accordingly to 1/3 of the original risk estimates. In this instance, health risks from PFAS in groundwater at GWP6-PFC are negligible (HI = 0.05).

Section 8. HHRA, Exposure Assessment: Off-Airport

8.1 General

This section provides a discussion on the human receptors of potential significance that warrant quantification in this assessment. The potential for exposure has been quantified using industry best practice and guidance available from USEPA (1989, 2002 and 2009) and Australia (NEPC 1999 amended 2013e). Where specific guidance is not available, parameters comprise industry standard values that have been demonstrated to be acceptable in the Australian regulatory context.

8.2 Exposure Assumptions

Based on the review of risk issues presented in **Section 4**, the following exposure scenarios require a more detailed assessment of potential risks to human health, in relation to the presence of PFAS in groundwater off-airport to the west:

- Consumption of home-grown fruit and vegetables; and
- Consumption of home-grown chicken eggs.

These are the exposure pathways where concentrations of PFAS exceeded the adopted screening level guidelines and hence further, more detailed, evaluation is required in the HHERA.

These exposure scenarios are potential future exposure scenarios, off-airport groundwater has not been identified to be currently used for growing edible products.

Exposures that may occur for the above scenarios have been calculated for adults and young children, noting that children aged 2 to 3 years are considered to be most sensitive (NEPC 1999 amended 2013a), as their behaviour and activities result in higher levels of intake, compared with adults. In addition, young children have a lower body weight, so their intake per unit body weight is higher.

Risks following the sale of edible products into the market have not been quantitatively assessed in this HHERA.

8.2.1 Home-Consumption of Chicken Eggs

Exposure parameters adopted for the assessment of intakes from eggs are presented **Table 8.1**.

The modelled PFOS + PFHxS concentrations in eggs, including the adopted transfer factors (TF), are presented in **Appendix E**.

Table 8.1: Exposure Parameters for Estimating Intakes from Home Consumption of Eggs

Parameter	Units	Value		Basis/comment
		Adult	Child	
C_e	µg/kg	Modelled		Refer to **Appendix E**
IR – eggs	kg/day	0.06		Assumes the consumption of one large egg per day by both adults and children. This is more conservative than the estimates presented in the ABS 2011-2012 NNPAS (FSANZ 2017d). The consumption of 1 large egg per day includes regularly eating eggs as well as regularly cooking with eggs.

Parameter	Units	Value		Basis/comment
		Adult	Child	
FI	unitless	1		This assumes that 100% of all eggs consumed will be from the property.
B_O	unitless	1		Assumed to be 100%.
EF	days/ year	365		Assumed to occur every day.
ED	years	35	5	Average and 95th percentile values for the duration at a residence in Australia (enHealth 2012b). The duration of exposure as a child relates to the time spent as a child aged 1-6 years.
AT	days	= ED x 365		Equal to exposure duration.
BW	kg	70	15	ASC NEPM, relevant to children aged 2-3 years.

8.2.2 Home-Consumption of Fruit and Vegetables

Exposure parameters adopted for the assessment of intakes from fruit and vegetables are presented **Table 8.2** and **Table 8.3**.

The modelled PFOS + PFHxS concentrations in fruit and vegetables, including the adopted TF, are presented in **Appendix E**.

Table 8.2: Exposure Parameters for Estimating Intakes from Home Consumption of Fruit/Vegetables

Parameter	Units	Value		Basis/comment
		Adult	Child	
C_{fv}	µg/kg	Modelled		Refer to **Appendix E**
IR – fruit and vegetables	kg/day	Refer to **Table 8.3**		Based on the P90 values for consumers from FSANZ (2017g)
FI	unitless	0.01		This assumes that 10% of all fruit/vegetables consumed will be from the property.
B_O	unitless	1		Assumed to be 100%.
EF	days/ year	365		Assumed to occur every day.
ED	years	35	5	Average and 95th percentile values for the duration at a residence in Australia (enHealth 2012b). The duration of exposure as a child relates to the time spent as a child aged 1-6 years.
AT	days	= ED x 365		Equal to exposure duration.
BW	kg	70	15	ASC NEPM, relevant to children aged 2-3 years.

Table 8.3: Assumed Ingestion Rate for Fruit and Vegetables (FSANZ 2017g; P90 for Consumers)

Parameter	Produce Group		
	Green and Fruiting Vegetables	Root and Tuber Vegetables	Fruit
Consumption Rate – Adult (kg/day)	0.37	0.27	0.86
Consumption Rate – Child (kg/day)	0.3	0.16	0.59

8.3 Quantification of Exposures

Intakes of PFOS from the consumption of fruit, vegetables and eggs from chickens have been calculated based on the following equation:

$$Intake_p = \frac{C_p \times IR_p \times FI \times B_o \times EF \times ED}{BW \times AT} \quad \text{...Equation 8.1}$$

Where
$Intake_p$ = Daily intake of PFAS from produce (µg/kg/day)
C_p = PFAS concentration in produce (µg/kg)
IR_p = Produce ingestion rate (kg/day)
FI = Fraction ingested from contaminated source (unitless)
B_o = Oral bioavailability (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time (days)
BW = Body weight (kg)

8.4 Adopted Concentrations

The off-airport (or boundary) groundwater wells with concentrations of PFOS + PFHxS exceeding the adopted screening level guidelines are summarised in **Table 8.4**.

Table 8.4: Summary of PFOS, PFHxS and PFOS + PFHxS Concentrations in Western Wells

Well ID	Maximum PFAS Concentration (µg/L)		
	PFOS	PFHxS	PFOS + PFHxS
On-Airport (Western Boundary)			
GWP2-PFC	0.04	0.068	0.11
GWP3-PFC	0.05	0.0065	0.12
P34	0.04	0.14	0.18
P44	0.13	1.74	1.87
P45	0.03	1.1	1.1
P48	0.02	0.12	0.14
P49	0.05	0.38	0.42
Range	**0.02 to 0.13**	**0.007 – 1.74**	**0.11 – 1.87**
Off-Airport to the West, Parafield Gardens Area 2 and 3			
P36	0.07	0.085	0.17
P37	0.04	0.037	0.08
P41	0.05	0.082	0.17
P42	0.07	0.077	0.16
P43	0.24	0.050	0.29
Range	**0.04 to 0.24**	**0.05 – 0.09**	**0.8 – 0.29**
Off-Airport to the West			
P54	0.06	0.13	0.19
P56	0.18	0.04	0.22
P57	0.20	0.05	0.25
P58	0.03	0.12	0.15
P59	0.06	0.1	0.16
Range	**0.03 to 0.18**	**0.04 – 0.13**	**0.19 – 0.25**

Except for wells P44 and P45, concentrations off-airport are similar to or higher than those on-airport. Wells P44 and P45 are in the same location on the western airport boundary and wells P49 and P53 to P55 are located immediately downgradient of these wells, between the airport and the residential properties. Of these wells, PFOS + PFHxS concentrations exceeding the screening level guidelines were only identified in P54. Hence, data for wells P44 and P45 has not been adopted for the HHERA (the off-airport data has been considered).

Table 8.5 presents the data for the off-airport wells, where the maximum concentrations are highlighted in blue. The wells where the maximum concentrations of PFOS, PFHxS and/or PFOS + PFHxS have been reported are wells P43 and P54, and the PFAS concentrations for these wells have been adopted for the HHERA.

Table 8.5: Summary of PFOS, PFHxS and PFOS + PFHxS Concentrations in Western Off-Airport Wells

Well ID	Maximum PFAS Concentration (µg/L)		
	PFOS	PFHxS	PFOS + PFHxS
P36	0.07	0.09	0.17
P37	0.04	0.04	0.08
P41	0.05	0.08	0.17
P42	0.07	0.08	0.16
P43	0.24	0.05	0.29
P54	0.06	0.13	0.19
P56	0.18	0.04	0.22
P57	0.20	0.05	0.25
P58	0.03	0.12	0.15
P59	0.06	0.1	0.16

Notes:

Maximum concentration shaded blue.

8.5 Uncertainties

Consistent with the on-airport HHERA, the quantification of exposures off-airport has adopted a number of conservative assumptions regarding activities that residents may undertake in the future. This HHERA has assumed that a resident keeps a enough chickens to be able to consume 1 egg per day for the whole year, and also sources 10% of the fruit and vegetables they consume each year from their property. All produce is assumed to be grown using only water containing maximum concentrations of PFAS reported in groundwater off-airport. 90^{th} percentile fruit and vegetable consumption rates have been adopted for the HHERA. These assumptions are conservative and will overestimate exposures that may occur in the future.

Section 9. HHRA, Risk Characterisation: Off-Airport

9.1 Approach

The risk characterisation approach is outlined in **Section 7.1**.

9.2 Calculated Risks

Table 9.1 presents a summary of the threshold HQ and the total HI calculated for the exposures evaluated. The values presented in **Table 9.1** (and all other risk calculations) are rounded to 1 or 2 significant figures reflecting the level of certainty inherent in risk calculations. Detailed calculations are presented in **Appendix E**.

Table 9.1: Summary of Risk Estimates, Off-Airport

Potential Exposures by Residents	Threshold Risk for Resident (HQ/HI)			
	Well P43		Well P54	
	Adult	Child	Adult	Child
Consumption of Eggs	0.05	0.25	0.03	0.14
Consumption of Fruit	0.02	0.06	0.02	0.05
Consumption of Vegetables	0.04	0.13	0.03	0.11
Total for all Produce	0.11	0.4	0.08	0.3
Acceptable Risk	**≤1**			

Notes:

Risks greater than the acceptable level are shown in **bold**.

Table 9.1 indicates that overall risks to residents who may home-consume fruit, vegetables and eggs from chickens, that are watered with groundwater containing PFAS, are low and acceptable.

9.3 Uncertainties

9.3.1 General

The 3 main areas of uncertainty identified during the conduct of the HHERA are discussed below.

9.3.2 Transfer Factors for Uptake Modelling

The modelling of the uptake of PFOS + PFHxS into eggs, fruit and vegetables presented in this HHERA is based the use of TF that describe how much of the PFAS in the water may accumulate in the edible produce. The units for TF are µg/kg plant (wet weight) to µg/L water (units are not quoted hereafter for readability).

Data is available from a relatively robust study for eggs. The uptake of PFAS into fruit and vegetables has been less well studied and the range of available TF for uptake of PFOS + PFHxS from water into fruit/vegetables is summarised in **Appendix E** (**Table E3**). The maximum reported TF for fruit and root vegetables has been adopted in this HHERA. Hence, the assessment presented is appropriate for the assessment of these edible produce types (eggs, fruit and root vegetables).

For green and fruiting vegetables, where there is more information available, average values have been used. For most studies, the maximum value has been adopted to calculate the average. The exception is the AECOM (2017) study where average TF for each produce type have been determined. This average has been used to calculate the overall average for green and fruiting vegetables. The TF used in the HHERA calculations are 2.0 for PFOS and 2.1 for PFHxS.

It is noted that there is some variability in the TF reported by the AECOM (2017) study, and that the highest TF were reported for this study. This study was undertaken as part of the RAAF Williamtown investigation. This study was a 120-day greenhouse trial that investigated the uptake of PFAS into 7 horticultural crops comprising alfalfa, beet, cucumber, radish, lettuce, strawberry and tomatoes. The crops were housed in 4 different greenhouses and were irrigated with test solutions containing 0 µg/L, 1 µg/L, 10 µg/L and 100 µg/L of PFOS, PFHxS, PFOA and PFHxA (AECOM 2017).

AECOM (2017) concluded that uptake of PFAS into plants was directly correlated to PFAS concentration in water (with a linear relationship) where irrigation water was artificially modified with PFAS. There were also some experimental issues with raising the tomatoes, strawberries and cucumbers which means that the TF were not statistically significant for strawberries and cucumbers and no TF was derived for tomatoes. Overall, it is generally considered that the data from the AECOM (2017) study supports other studies from the literature but does not provide robust individual TF for use in a HHERA.

If the AECOM (2017) data is excluded from the HHERA, the revised TF are 1.4 for PFOS and 1.9 for PFHxS. If the maximum TF for each produce type from AECOM (2017) are used to calculate the average for green and fruiting vegetables, the revised TF are 3.1 for PFOS and 3.0 for PFHxS. There is no change in HHERA outcomes based on either set of revised TF.

9.3.3 Variability in PFOS and PFHxS Concentrations

Well P43 has been sampled on 3 occasions (in 2019) and well P54 has been sampled on one occasion. The reported PFOS and PFHxS concentrations in well P43 are summarised in **Table 9.2**. Concentrations of PFOS + PFHxS in well P43 on 2 of the 3 occasions are at or below the adopted screening level guidelines. The maximum concentrations of PFOS + PFHxS reported in this well in February 2019 have been adopted in the HHERA, where no unacceptable risks to residents have been identified. Similar PFAS concentrations to those reported in well P43 in February 2019 have been reported in other off-airport wells. This shows the conservative, however appropriate, nature of the assessment and provides confidence that off-airport risks are acceptable (should groundwater be used in the future for the assessed purposes).

Table 9.2: Summary of PFOS, PFHxS and PFOS + PFHxS Concentrations in well P43

Sampling Round	Maximum PFAS Concentration (µg/L)		
	PFOS	PFHxS	PFOS + PFHxS
February 2019	0.24	0.05	0.29
March 2019	0.03	0.02	0.05
May 2019	0.04	0.03	0.07

In relation to the potential variability in PFAS concentrations off-airport and given that some off-airport wells have only been sampled once, it is noted that concentrations would need to double before calculated risks approach the acceptable level.

9.3.4 Other PFAS

In relation to PFAS other than PFOS and PFHxS, well P54 has not been sampled for an extended PFAS suite, hence, concentrations of total PFAS are not known. Well P43 has been sampled for an extended PFAS suite on 2 of the 3 occasions, and the detected PFAS are summarised in **Table 9.3**.

Table 9.3: Summary of Other PFAS Detected in Off-Airport Groundwater, Well P43

PFAS Detected	Concentration (µg/L)	
	February 2019	March 2019
PFOS + PFHxS	0.29	0.05
PFOA	0.003	0.001
PFBA	0.007	<0.001
PFHxA	0.005	<0.001
PFBS	0.004	0.004
PFPeS	0.004	0.003
PFHpS	0.003	<0.001
6:2 FtS	0.13	0.006
Total PFAS	**0.45**	**0.06**
% PFOS + PFHxS	**64**	**83**
% PFOS + PFHxS + 6:2 FtS	**93**	**93**

Review of **Table 9.3** indicates that PFOS + PFHxS concentrations comprised 64 to 83% of total PFAS concentrations reported in off-airport groundwater well P43 (February and March 2019 respectively). The main other PFAS detected was 6:2 FtS (29% and 10% of the total PFAS concentration in February and March 2019 respectively). Together, PFOS, PFHxS, PFOA and 6:2 FtS comprised 93% of the total PFAS concentration (for both wells).

PFOS + PFHxS have been assessed above and PFOA concentrations are below screening level guidelines. Some toxicity data is available for 6:2 FtS as summarised in **Table 9.4**.

Table 9.4: Summary of Toxicity Data Relevant to 6:2 FTS

Test Material	Study Type	Study Details	Effects Reported	Reported NOAEL (mg/kg bw/day)
Forafac 1157 (fluorotelomer foam) (Dupont, unpublished)	Developmental toxicity study with rats	Rats. Dose levels set at 0, 25, 150 or 1,000 mg/kg-day during gestation (days 6-20).	No maternal mortality or other clinical observations reported. Reduction in body weight gain at 1,000 mg/kg-day (17% lower than control group). Reduction in food consumption also observed however not considered adverse (small & transient).	150
6:2 FTS with some 8:2 FTS (Dupont, unpublished)	Repeated dose toxicity study	Rats. Dose levels of 15, 50 and 150 mg/kg/day for 28 consecutive days.	Effects reported at 50 and 150 mg/kg/day including lower body weight gain & food consumption. Anaemia, inflammation and signs of kidney/liver toxicity, lower weights for other organs (heart, spleen, reproductive organs) also reported.	15

Test Material	Study Type	Study Details	Effects Reported	Reported NOAEL (mg/kg bw/day)
Commercial fluorotelomer-based urethane polymeric dispersion (Stadler et. al. 2008)	Sub-chronic, reproduction, and developmental toxicity study	Rats. Dose levels of 0, 50, 250, or 1,000 mg/kg/day.	Reported effects included nasal olfactory epithelial degeneration and necrosis, liver enzyme alterations and decrease in thyroid weight and fetal weight.	Sub-chronic toxicity: 50 Developmental toxicity: 250

Notes:

NOAEL = No Observed Adverse Effect Level

The available toxicity data indicates no effect levels for humans (NOAELS) in the range 15 to 250 mg/kg bw/day for 6:2 FtS. The adoption of the lowest NOAEL with a high uncertainty factor of 1,000 (based on 10x intraspecies variation, 3x adequacy of database, 3x sub-chronic to chronic and 10 x interspecies variation) results in a toxicity value for 6:2 FtS of 15 µg/kg bw/day. This is in the range of toxicity values for 6:2 FtS adopted at other contaminated sites in Australia (range of 5 to 30 µg/kg bw/day). This also means that 6:2 FtS is 750 times less toxic to humans than PFOS and PFHxS (toxicity value of 0.02 µg/kg/day; refer to **Section 5.2.3**).

If 6:2 FtS is added into the HHERA calculations based on a groundwater concentration of 0.13 µg/L (maximum), a toxicity value of 15 µg/kg bw/day and the highest TF for either PFOS or PFHxS, there is no change in HHERA outcomes.

Section 10. Screening Level ERA – On-Airport

10.1 General

This section presents a screening level assessment of potential ecological risks relevant to the on-airport environment.

This assessment is a screening level assessment, as it is based on the comparison of PFOS and PFOA concentrations reported in various media with screening level guidelines, available and relevant to the protection of the terrestrial ecosystems. Screening level guidelines are only available for PFOS and PFOA. There is limited information available to assess terrestrial and aquatic effects from PFAS other than PFOS and PFOA, including PFHxS, hence there are no screening level guidelines for these other PFAS. For this reason, the focus of this ERA is PFOS and PFOA. This is in accordance with the requirements of the PFAS NEMP which indicates that the guideline levels for PFOS and PFOA are "*intended to identify PFAS levels protective of wildlife, based on scientific evidence*".

In relation to the assessment of potential ecological risk issues relevant to PFOS and PFOA, it is important to note that PFAS are chemically and biologically stable in the environment, are mobile (in water and can easily leach from soil to water) and are persistent and bioaccumulative. Hence the assessment presented has considered issues relevant to the direct toxicity of PFAS, as well as the potential for bioaccumulation and secondary poisoning (i.e. where predators are harmed through the consumption of prey or food sources that contain PFAS).

10.2 Receptors and Exposure Pathways

PAL (2017) and AAL (2016c) indicates that, in general, the airport has limited ecological value and lacks sensitive environmental receptors. This is unsurprising given the former and ongoing use of the land as an airport. The exception is the Vernal Pools Conservation Zone (VPCZ), an area of environmental and indigenous significance.

The VPCZ is approximately 20 ha in area and is located in the southern portion of the airport. Vernal pools are "patch habitats" (ephemeral wetlands) that are dependent on winter/spring surface water run-off. The airport hosts the last known array of vernal pools within metropolitan Adelaide. The habitat of the pools has a high wetland value, hosting significant vegetation and uncommon aquatic fauna. Twenty-five vernal pools were studied by Coleman and Cook (2002) who indicated that the areas varied from weed-infested grassy hollows to good quality vernal pools in their dry autumn state. The Wetland Inventory for the Mount Loft Ranges identified the vernal pools as containing species of state and regional significance as well as being a threatened habitat. No nationally significant species listed under the *Environment Protection and Biodiversity Conservation Act 1999* were identified however other species of state significance such as the Black Cotton Bush, Peregrine Falcon, Fairy Wren, Stubble Quail, Shield Shrimp and Clam Shrimp have been identified in the pools.

Most of the vernal pools at the airport are located in the VPCZ however one additional vernal pool (Pool 11) is located outside of the conservation zone. Pool 11 has been identified to be degraded with a low biodiversity value and is located adjacent to a future potential runway extension area. Given this, the vernal pool outside of the VPCZ has been earmarked as requiring protection however has also been identified to be suitable for use as a control pool that can be used to investigate the success of remediating the VPCZ.

It is indicated in the Master Plan that there is the need for strict management of the VPCZ ephemeral pools in recognition that similar conservation activities are often classed as an incompatible activity near airports (because of their potential to attract birds).

Site is indigenous significance have been recorded in the VPCZ. Vegetation surveys undertaken in January 2001 (BUSH-ANEW 2001) identified at least 31 indigenous plant species in in the north-west corner of the airport (Area 8), 10 with conservation status. Some areas of remnant indigenous vegetation also remain outside of the VPCZ (in the north-west corner of the airport).

10.3 Review of Potential Risks to Terrestrial Environments

As discussed above, sensitive environmental receptors at the airport are limited to the VPCZ and some areas of remnant indigenous vegetation outside of the conservation zone (in the north-west corner of the airport). Soil investigations undertaken to date have focused on the south-west corner of the airport, in the proposed NAFP area, which is adjacent to the VPCZ. There is no information available for concentrations of PFAS in soil in the VPCZ. PFOS and PFOA has not been detected at locations within the proposed NAFP close to the VPCZ (no PFAS was detected in soil or soil leachate). Information of vegetation type and cover was not documented as part of the LBW and GHD contamination assessments (as per standard practice).

This means that a complete exposure pathway between PFAS impacts in soil at the airport and sensitive ecological receptors (i.e. flora) has not been identified. Regardless, a screening assessment for soil and ecological health has been included in the HHERA for completeness and to inform the need for further management. The review of PFAS concentrations in soil against the adopted screening level guidelines for the protection of ecological health is presented in **Table 10.1**. It is noted that screening level guidelines for ecological receptors are only available for PFOS (for direct toxicity and bioaccumulation) and PFOA (for direct toxicity only).

Table 10.1: Summary and Review of PFAS Reported in Soil On-Airport, Ecological Health

Data Source	Maximum Reported Concentration (mg/kg)	
	PFOS	PFOA
GHD (2016a; 2016b)	0.08	0.0006
GHD (2018a)	<LOR	<LOR
GHD (2018b)	<LOR	<LOR
GHD (2019a)	<LOR	<LOR
Adopted Screening Guidelines[1]		
Bioaccumulation – Industrial/Commercial	**0.01**	**--**
Direct Toxicity – Industrial/Commercial	**1**	**10**

Notes:

Shading indicates an exceedance of the adopted guideline value.

Table 10.1 indicates that concentrations of PFOS in soil in the south-western corner of the airport are above the adopted guideline value for the protection of terrestrial ecosystems. The available information does not indicate that sensitive terrestrial ecological receptors are present in this area of the airport, however it is noted that this area of the site is proposed for development as the NAFP.

10.4 Review of Potential Risks to Aquatic Environments

In relation to potential risks to ecological receptors, the stormwater drains at the airport do not support an aquatic environment (sediment dwelling organisms or aquatic species) and therefore this potential exposure pathway is incomplete and no assessment of potential risks to ecological receptors within the drains has been undertaken in this HHERA.

The other relevant on-airport surface water body is the vernal pools. As noted above, vernal pools are "patch habitats", dependent on winter/spring surface water (rain) water run-off. The VPCZ is also located to in the vicinity of a potential PFAS source are. No sampling for PFAS within the Vernal Pools has been undertaken to date however groundwater well GWP4-PFC and stormwater sampling location SW-DS3 are located within the vicinity of the vernal pools. Groundwater well GWP4-PFC has been sampled on one occasion (June 2016) and concentrations of PFHxS of 0.006 µg/L were reported (PFOS and PFOA were not detected). Location SW-DS3 was also sampled in June 2016 and no PFAS were detected. This does not suggest the potential for significant PFAS impacts within the VPCZ.

The airport stormwater drains discharge into Dry Creek. Groundwater beneath the airport flows to the south-west towards Gulf St Vincent. Potential risks to the aquatic environments of Dry Creek and Gulf St Vincent are assessed in **Section 11**.

10.5 Uncertainties

Sampling and analysis for PFAS near and within the VPCZ has been limited to date. Further information is required to confirm if the exposure pathways between PFAS impacts and terrestrial and aquatic receptors in the VPCZ is currently complete and/or would be complete in the future (e.g. following airport re-development works). If the exposure pathway between PFAS impacts and ecological receptors is found to be complete or potentially complete, further investigation and/or management would be recommended.

Section 11. Screening Level ERA – Off-Airport

11.1 General

This section presents a screening level assessment of potential ecological risks relevant to the off-airport environments of:

- Dry Creek that flows into Barker Inlet, which is the known point of discharge for stormwater; and
- Gulf St Vincent, the likely point of discharge for groundwater downgradient of the airport.

The City of Salisbury website indicates that[7] Dry Creek flows freely throughout winter, but often dries up during summer. Several aquatic birds have made their home at Dry Creek, including the Australian Grey Teal, White-faced Heron, Cormorant, and the Pacific Black Duck. Other birds commonly reported include the Willie Wagtail, Yellow Thornbill, New Holland Honeyeater and Australian and Murray Magpies.

This assessment is a screening level assessment, as it is based on the comparison of PFOS and PFOA concentrations reported in various media with screening level guidelines, available and relevant to the protection of aquatic ecosystems. Screening level guidelines are only available for PFOS and PFOA. There is limited information available to assess terrestrial and aquatic effects from PFAS other than PFOS and PFOA, including PFHxS, hence there are no screening level guidelines for these other PFAS. For this reason, the focus of this ERA is PFOS and PFOA. This is in accordance with the requirements of the PFAS NEMP which indicates that the guideline levels for PFOS and PFOA are "*intended to identify PFAS levels protective of wildlife, based on scientific evidence*".

In relation to the assessment of potential ecological risk issues relevant to PFOS and PFOA, it is important to note that PFAS are chemically and biologically stable in the environment, are mobile (in water and can easily leach from soil to water) and are persistent and bioaccumulative. Hence the assessment presented has considered issues relevant to the direct toxicity of PFAS, as well as the potential for bioaccumulation and secondary poisoning (i.e. where predators are harmed through the consumption of prey or food sources that contain PFAS).

11.2 Review of Potential Risks to Aquatic Environments

This section provides a review of concentrations of PFOS and PFOA in stormwater on-airport, and groundwater on the airport boundary and off-airport, with available screening guidelines for the protection of aquatic ecosystems.

It is understood that the protection levels for the downstream water bodies have not yet been determined. Given this, and as requested by PAL, the 80%, 90% and 95% protection levels have been adopted to inform further discussions with SA EPA.

Comparison of PFOS and PFOA concentrations in groundwater and stormwater with these guideline values is provided in **Table 11.1**. Groundwater sampling locations are discussed in

[7] http://www.salisbury.sa.gov.au/Live/Environment_and_Sustainability/Wetlands_and_Water/Wetlands/Wetlands_Locations

Section 4 and are shown on the site plans in **Appendix A**. Stormwater sampling locations are shown on **Figure 4**.

Table 11.1: Summary and Review of PFAS Reported in Groundwater and Stormwater, Off-Airport or Boundary

Well ID	Maximum PFAS Concentration (µg/L)	
	PFOS	PFOA
Groundwater, On-Airport (Southern Boundary)		
P9	0.013	<0.01
Groundwater, Off-Airport to the South, Bridges Estate (Area 1)		
P38	0.013	0.0041
P39	0.0035	0.0098
Groundwater, On-Airport (Western Boundary)		
GWP1-PFC	0.02	0.011
GWP2-PFC	0.039	0.004
GWP3-PFC	0.05	0.004
P34	0.04	0.0023
P35	0.05	0.0063
P44	0.13	0.08
P45	0.03	0.02
P46	0.03	<0.01
P47	0.03	<0.01
P48	0.02	<0.01
P49	0.05	0.03
Groundwater, Off-Airport to the West, Parafield Gardens Area 2 and 3		
P36	0.07	0.024
P37	0.043	0.0028
P40	0.032	0.05
P41	0.05	0.0048
P42	0.07	0.02
P43	0.24	0.031
P50	<0.01	<0.01
P51	<0.01	<0.01
P52	<0.01	<0.01
Groundwater, Off-Airport to the West		
P53	0.04	<0.01
P54	0.06	0.01
P55	0.03	<0.01
P56	0.18	0.01
P57	0.20	0.01
P58	0.03	<0.01
P59	0.06	<0.01
P60	<0.01	<0.01
MW15	0.01	<0.01
Stormwater, On-Airport[2]		
SW-US1	0.006	<LOR
SWP2/SW-DS1	0.19[3]	LOR
SW-DS3	<LOR	<LOR
Adopted Screening Guidelines[1]		
95% Species Protection	**0.13**	**220**
90% Species Protection	**2**	**632**
80% Species Protection	**31**	**1,824**

Notes for Table 11.1:

Shading indicates an exceedance of the adopted guideline value.

1 = Re. HEPA (2020).

2 = Concentrations at the sampling location closest to the point of discharge.

Review of **Table 11.1** indicates concentrations of PFOS in groundwater and stormwater are below the guidelines for 90% and 80% species protection, and concentrations of PFOA in groundwater and stormwater are below all the guidelines (80%, 90% and 95% species protection). Further discussion of PFOS concentrations in groundwater and surface water in relation to the 95% protection level is provided below.

Discharge of Groundwater to Gulf St Vincent

Maximum concentrations of PFOS in groundwater wells P43, P56 and P57, off-airport to the west, exceed the guideline for 95% species protection. Concentrations of PFOS in all other off-airport wells are below the 95% species protection level.

PFOS concentrations in wells P43, P56 and P57 are in the range 0.18 to 0.24 µg/L, 1 to 2 times the 95% species protection level (0.13 µg/L).

However:

- Well P43 has been sampled 3 times (refer to **Table 9.2**), where PFOS concentrations were reported at 0.03, 0.04 and 0.24 µg/L. The average PFOS concentration in well P43 is 0.10 µg/L, below the 95% species protection level;
- PFOS concentrations in well P43 are delineated to the south-west by wells P50 to P52 where PFOS was reported at less than the LOR (<0.01 µg/L); and
- PFOS concentrations in wells P56 and P57 are delineated by wells P58 to P60 which reported PFOS concentrations below the 95% species protection level (concentrations in the range <0.01 to 0.06 µg/L).

Hence, there are no risk issues of concern in relation to the aquatic ecosystem of Gulf St Vincent, concentrations of PFOS in groundwater and ecological effects at the 95% species protection level (or a lower protection level).

It is recommended that PAL initiate discussions with SA EPA to confirm the relevant protection level for ecosystems within Gulf St Vincent (understood to be 80%, 90% or 95%).

Discharge of Stormwater to Dry Creek

Maximum concentrations of PFOS at stormwater sampling location SWP2/SW-DS1 also exceed the guideline for 95% species protection. Stormwater location SWP2/SW-DS1 has been sampled 5 times, and PFOS concentrations have been reported at 0.03, 0.07, 0.14, 0.17 and 0.19 µg/L. The average PFOS concentration at SWP2/SW-DS1 is 0.12 µg/L, below the 95% species protection level.

The nature of the low-level guideline exceedances reported for stormwater on-airport does not suggest a high potential for direct toxicity to the aquatic ecosystem of Dry Creek.

It is recommended that PAL initiate discussions with SA EPA to confirm the relevant protection level for ecosystems within Dry Creek (understood to be 80%, 90% or 95%).

11.3 Review of Fish Data for Patawalonga Creek

This section provides a review of concentrations of PFOS in fish from Patawalonga Creek (near Adelaide Airport), with available screening guidelines for the protection of aquatic ecosystems.

The HEPA (2020) guidelines for birds and mammals consuming aquatic biota have also been adopted to assess the potential for effects due to bioaccumulation in the downstream surface water bodies. Comparison of PFOS concentrations in biota against these guidelines, which are adopted from Environment Canada guidance, is presented in **Table 11.2**.

Table 11.2: Summary and Review of PFOS Reported in Fish, Patawalonga Creek (Adelaide Airport)

Biota Species	PFOS Concentration (µg/kg wet weight)
Fish Frames	<2 – 3.9
Fish Fillets	<0.8 – 0.97
Adopted Screening Guidelines[1]	
Mammals (Consumption of Aquatic Biota)	**4.6**
Birds (Consumption of Aquatic Biota)	**8.2**

Notes:
Shading indicates an exceedance of the adopted guideline value.
1 = Ref. HEPA (2020).

Review of **Table 11.2** indicates that maximum concentrations of PFOS in fish fillets and fish frames from Patawalonga Creek are below the adopted screening level guidelines for the protection of effects due to bioaccumulation. Concentrations reported in fish frames were around 4 times higher than concentrations reported in fillets, with concentrations in fillets 5 to 8 times below the adopted guidelines.

11.4 Uncertainties

As noted above, fish from Dry Creek have not been sampled for PFAS, hence, this HHERA has evaluated the PFAS data for fish caught from Patawalonga Creek adjacent to Adelaide Airport. As discussed above, (refer to **Table 4.5** and following text) concentrations of PFOS in groundwater and stormwater that may be discharging off-site from Parafield Airport are lower than concentrations of PFOS in groundwater and stormwater that may be discharging off-site from Adelaide Airport. It is also noted that stormwater is a more direct transport pathway than groundwater (i.e. concentrations in stormwater may provide a better indication of concentrations in surface water downstream) and concentrations of PFOS in stormwater at Parafield Airport are around 100 times lower than those at Adelaide Airport. Hence, the use of fish sampling data from Patawalonga Creek downstream of Adelaide Airport may be conservative for use as an indication of concentrations of PFOS in fish in Dry Creek downstream of Parafield Airport (assuming similar inputs and flows into the water bodies).

The HEPA (2020) biota guidelines apply to whole fish that may be consumed by birds and mammals and to concentrations of PFOS + PFHxS. It is not possible to calculate the concentration of PFOS in a whole fish in Patawalonga Creek, as fish fillets and fish frames have been analysed separately and no information on sample weights is available. In addition, fish fillets and frames from Patawalonga Creek were not analysed for PFHxS. As noted above, concentrations of PFOS in fish fillets are 5 to 8 times below the adopted guidelines. Based on enRiskS' experience, PFOS is the main PFAS of concern in relation to bioaccumulation in seafood and concentrations of PFOS in the whole fish can be 1-2 times the concentration measured in the fillets. On this basis, the lack of data for PFHxS and whole fish is unlikely to significantly affect HHERA outcomes.[8,9,10] It is also noted that the Environment Canada guidelines for aquatic biota only apply to PFOS (not PFOS + PFHxS as recommended in the PFAS NEMP).

[8] https://www.defence.gov.au/Environment/PFAS/Wagga/publications.asp
[9] https://www.defence.gov.au/Environment/PFAS/Williamtown/publications.asp
[10] Taylor, MD & Johnson, DD 2016

Section 12. Conclusions

Based on the data outlined in **Section 1.4**, Environmental Risk Sciences Pty Ltd has undertaken a human health and ecological risk assessment (HHERA) in relation to the presence of per- and polyfluoroalkyl substances (PFAS) at Parafield Airport, South Australia (the “airport”).

The HHERA has addressed human health and environmental risk issues relevant to PFAS in soil, groundwater and/or stormwater at Parafield Airport and off-airport. The assessment has not addressed human health or environmental risk issues associated with other chemicals or any other environmental media.

Table 12.1 provides an overview of the ways in which on- and off-airport human receptors (including members of the community) may be exposed to PFAS, derived from the airport, and the conclusions and recommendations relevant to these areas. The conclusions and recommendations are made based on the available data, and with consideration of the available information on the existing land use patterns on-airport and off-airport, and the uncertainties identified in this assessment.

Table 12.1: Conclusions and Recommendation, Risks to Human Health from PFAS

How the Community May be Exposed	Potential Risks to Human Health and the Environment[1]	Areas where Potential Risk Issues Identified[1]	Recommendations[1]
Human Health – On-Airport, Current Exposures			
Direct contact with PFAS in soil by Airport Workers	Low and acceptable.	NA	Management measures outlined in the AAL Guideline for PFAS Work Health and Safety are supported and should be applied to all potential PFAS source areas at the airport. If works may intercept groundwater or stormwater, the list of required personal protective equipment should be expanded to include long sleeves and long trousers, and waterproof boots if workers may get their feet wet in the course of activities.
Direct contact with PFAS in groundwater by Airport Workers.	Low and acceptable.	NA	
Direct contact with PFAS in stormwater by Airport Workers.	Low and acceptable.	NA	
Human Health – Off-Airport, Current Exposures			
Non-potable use of groundwater with PFAS where exposures occur via direct contact	Low and acceptable.	NA	NA
Recreational use of Dry Creek where exposures to PFAS in water occur via incidental direct contact	Low and acceptable.	NA	NA
Consumption of fish with PFAS caught from Dry Creek	Low and acceptable based on the results of the preliminary fish sampling undertaken in Patawalonga Creek adjacent to Adelaide Airport.	NA	NA
Human Health – Off-Airport, Potential Future Exposures			
Use of groundwater with PFAS for filling swimming pools where exposures occur via direct contact	Low and acceptable.	NA	NA
Consumption of eggs from chickens on properties where PFAS is present in groundwater used for stock watering	Low and acceptable.	NA	NA
Ingestion of homegrown fruit and vegetables on properties where water containing PFAS is used for irrigation	Low and acceptable.	NA	NA

Notes:

1 = The conclusions of the HHERA are based on the available sampling and analysis results.

2

The findings of the ecological risk assessment component of the HHERA were as follows:

- On-airport: sampling and analysis for PFAS near and within the VPCZ has been limited to date. Further information is therefore required to confirm if the exposure pathways between PFAS impacts and terrestrial and aquatic receptors in the VPCZ is currently complete and/or would be complete or potentially complete following airport re-development works (e.g. the construction of a development similar to that of the proposed NAFP); and
- Off-airport: it is recommended that PAL initiate discussions with SA EPA to confirm the relevant protection level for aquatic ecosystems within Dry Creek and Gulf St Vincent (understood to be 80%, 90% or 95%):
  - There are no ecological risk issues of concern at the 80% and 90% species protection levels
  - Maximum concentrations of PFOS in groundwater off-airport exceed the 95% species protection level at 3 locations, however concentrations are delineated to below this protection level before Gulf St Vincent
  - Maximum concentrations of PFOS in stormwater on-airport exceed the 95% species protection level, however average PFOS concentrations are below this protection level
  - Based on fish data for Patawalonga Creek adjacent to Adelaide Airport, there are no risk issues of concern in relation to bioaccumulation.

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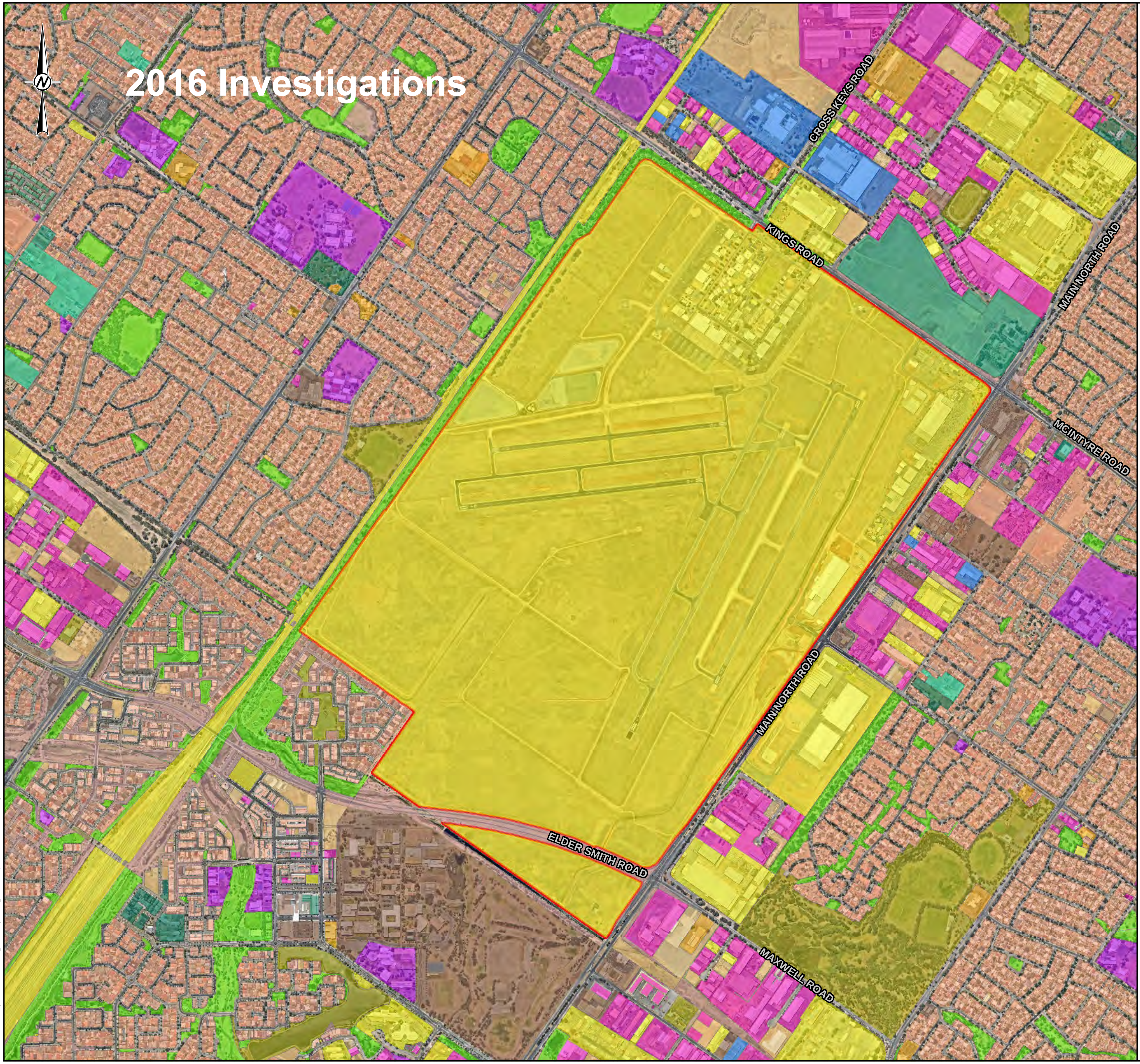
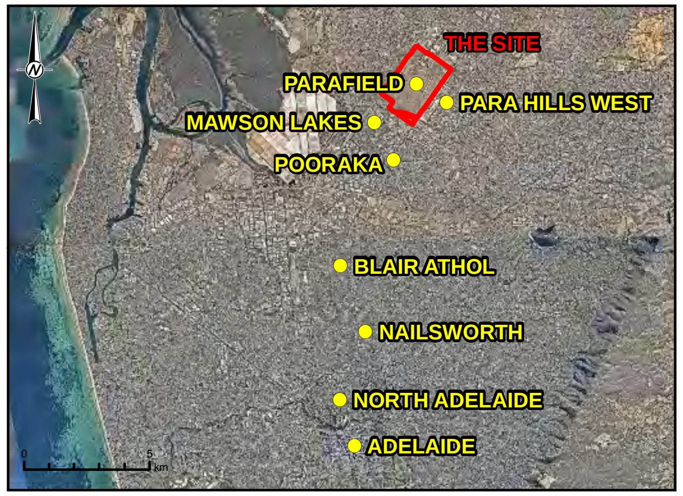
Appendix A Extracts of Assessment Data



LOCATION MAP



LEGEND

- Commercial
- Education
- Food Industry
- Golf
- Horticulture
- Public Institution
- Recreation
- Reserve
- Residential
- Retail / Commercial
- Non-Private Residence
- Rural Residence
- Utility Industry
- Vacant
- Vacant Residence
- Approximate Site Boundary

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1. Aerial image sourced from Nearmap Pty. Ltd, aerial dated 27.12.2015, sourced 11.02.2016.
2. Roads data sourced from DPTI, Department for Transport Energy and Infrastructure, South Australian Government, sourced http://www.dptiapps.com.au/dataportal/Roads.zip, sourced 19.06.2014.
3. Suburb and road data sourced from MapInfo StreetPro.
4. General landuse data source from Data.SA, South Australian Government Data Directory, sourced 01.04.2016.

0 200 400 600 800 1,000
METRES

REFERENCE SCALE: 1:15,000 (at A3)

PROJECTION: GDA 1994 MGA Zone 54

CLIENT
ADELAIDE AIRPORT LIMITED

PROJECT
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - PARAFIELD AIRPORT

TITLE
GENERAL LAND USE ZONES

CONSULTANT
Golder Associates

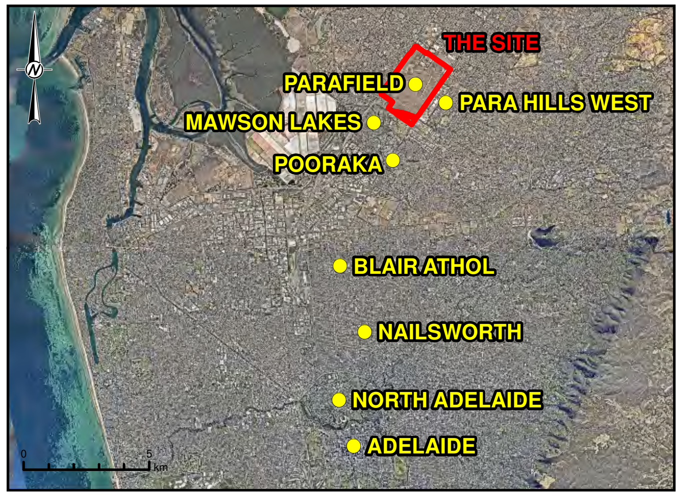
YYYY-MM-DD	2016-05-26
PREPARED	KB
DESIGN	-
REVIEW	MP
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1546945	002-R	1	1

ID No.	Current Off-Site Features of Interest
1	Antrum Upholstery
2	Coolchem (Automotive Fluids Distribution)
3	GM Hosking & EC Stainless Steel Welding/Aluminium Supplier
4	Superior Stainless (Stel Fabrication)
5	Griffin Press (Book Manufacturer)
6	CAS Supreme Canvas & Vinyl Products
7	Powder Coating/Crash Repair
8	Stevenson AC (Air Conditioning Servicing)
9	Adelaide All Clean Carpet Cleaning
10	Tri Metal Engineering
11	Blacksilver Painters
12	NOV Tuboscope
13	Carpet Selection Centre

ID No.	Current On-Site Features of Interest
1	Aeroservices Pty Ltd
2	Flight Training Adelaide
3	Stark Aviation
4	North Former Fire Fighting Training Ground
5	West Former Fire Fighting Training Ground
6	South-East Former Fire Fighting Training Ground
7	Former Fire Station
8	Former Landfill Bunker
9	Former Landfill

LOCATION MAP



LEGEND

- Current On-Site Features of Interest (Approximate Location)
- Current Off-Site Features of Interest (Approximate Location)
- Approximate Fire Station / Fire Services Location

Potential PFC Risk

- High Risk
- Moderate Risk
- Low Risk
- Very Low Risk
- Approximate Site Boundary

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2. Roads data sourced from DPTI, Department for Transport Energy and Infrastructure, South Australian Government, sourced http://www.dptiapps.com.au/dataportal/Roads.zip, sourced 19.06.2014.
3. Suburb and road data sourced from MapInfo StreetPro.

0 200 400 600 800 1,000
METRES

REFERENCE SCALE: 1:15,000 (at A3)

PROJECTION: GDA 1994 MGA Zone 54

CLIENT
ADELAIDE AIRPORT LIMITED

PROJECT
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - PARAFIELD AIRPORT

TITLE
SITE LAYOUT AND FEATURES OF INTEREST

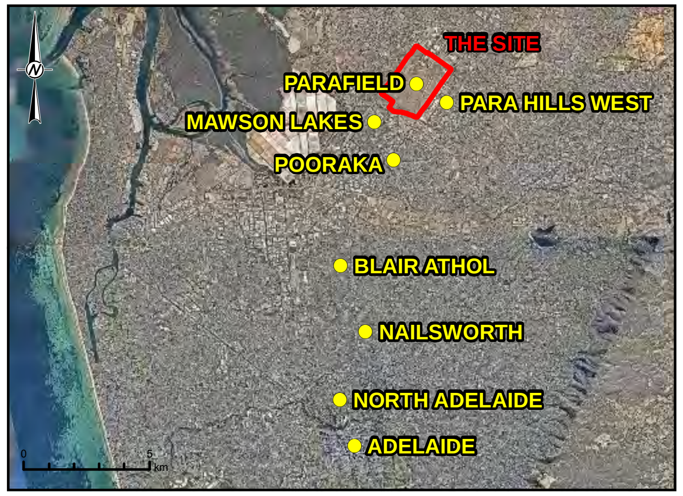
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-26
PREPARED	KB
DESIGN	-
REVIEW	MP
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1546945	002-R	1	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 25mm

LOCATION MAP



LEGEND

- Groundwater Monitoirng Well Location and Groundwater Elevation (m AHD)
- Groundwater Monitoring Well Location (Historical)
- General / Unknown Groundwater Well Location (Water Connect)
- Inferred Groundwater Contour (m AHD)
- Inferred Groundwater Flow Direction
- Approximate Site Boundary

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3. Suburb data sourced from MapInfo StreetPro.
4. Watercoarse and groundwater monitoring well data sourced from WaterConnect, South Australian Government.

0 200 400 600 800 1,000 METRES

REFERENCE SCALE: 1:12,500 (at A3)

PROJECTION: GDA 1994 MGA Zone 54

CLIENT
ADELAIDE AIRPORT LIMITED

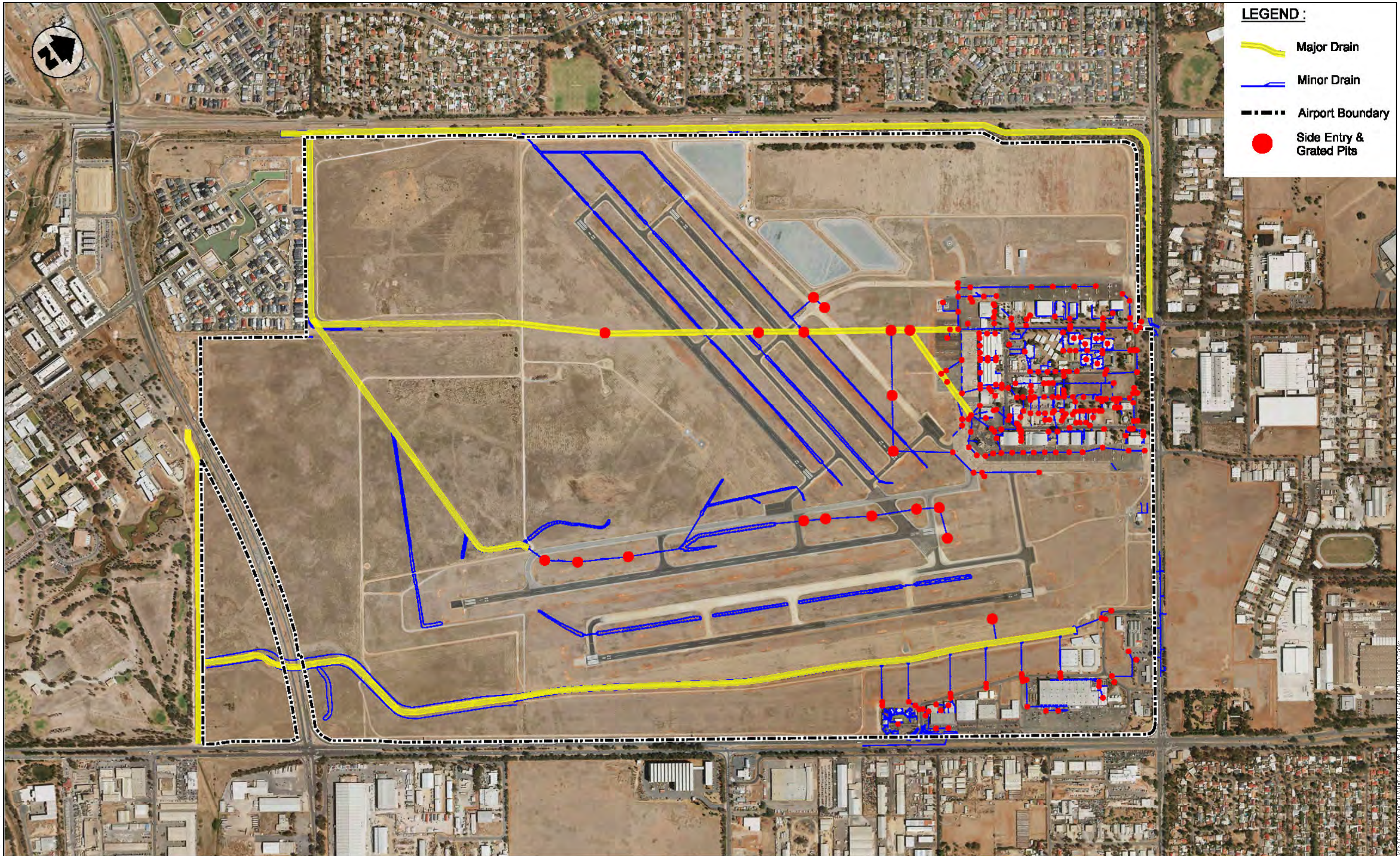
PROJECT
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - PARAFIELD

TITLE
MONITORING WELL LOCATIONS AND INFERRED GROUNDWATER CONTOURS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-27
PREPARED	KB
DESIGN	-
REVIEW	JC
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1546945	002-R	1	3



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1. Base image sourced from Adelaide Airport Limited

CLIENT
ADELAIDE AIRPORT LIMITED

PROJECT
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - PARAFIELD

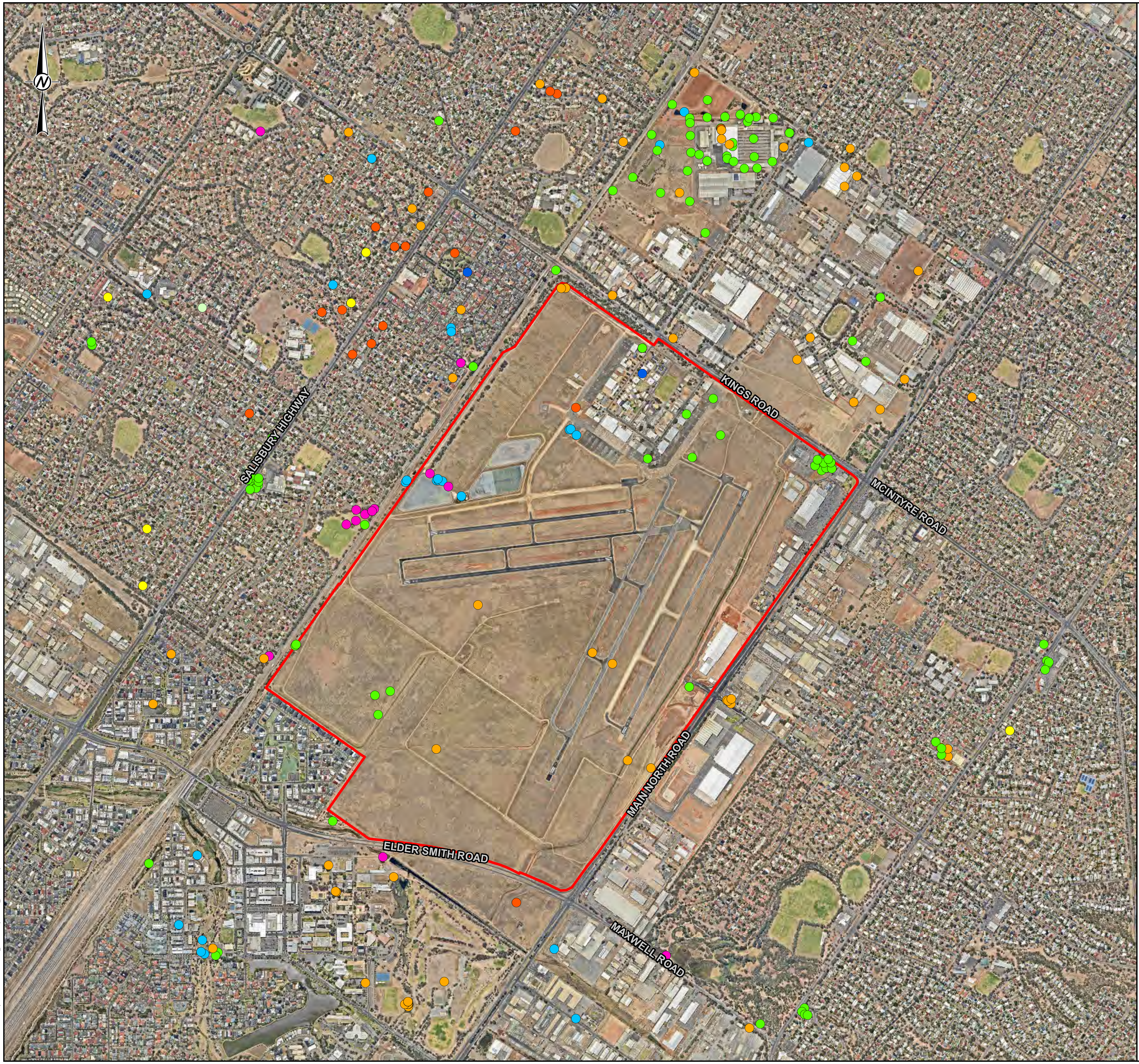
REFERENCE SCALE: Not to Scale

TITLE
STORMWATER CATCHMENTS AND DRAINAGE AREAS

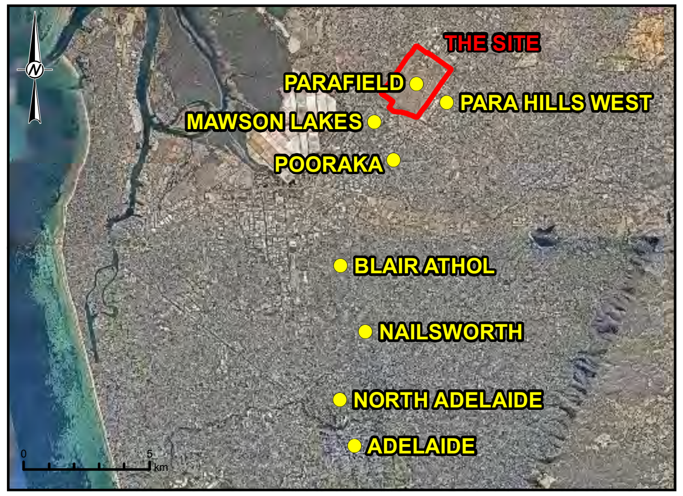
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-26
PREPARED	KB
DESIGN	-
REVIEW	JC
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1546945	002-R	1	4



LOCATION MAP



LEGEND

- Domestic
- Drainage / Industrial
- General / Unknown
- Investigation
- Irrigation
- Managed Aquifer Recharge / Aquifer Storage and Recovery
- Monitoring / Observation
- Stock
- Approximate Site Boundary

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2. Roads data sourced from DPTI, Department for Transport Energy and Infrastructure, South Australian Government, sourced http://www.dptiapps.com.au/dataportal/Roads.zip, sourced 19.06.2014.
3. Suburb data sourced from MapInfo StreetPro.
4. Watercoarse and groundwater monitoring well data sourced from WaterConnect, South Australian Government.

0 200 400 600 800 1,000 METRES

REFERENCE SCALE: 1:17,500 (at A3)

PROJECTION: GDA 1994 MGA Zone 54

CLIENT
ADELAIDE AIRPORT LIMITED

PROJECT
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - PARAFIELD

TITLE
WATER CONNECT – IDENTIFIED BORES WITHIN 2.5KM RADIUS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-26
PREPARED	KB
DESIGN	-
REVIEW	JC
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1546945	002-R	1	A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

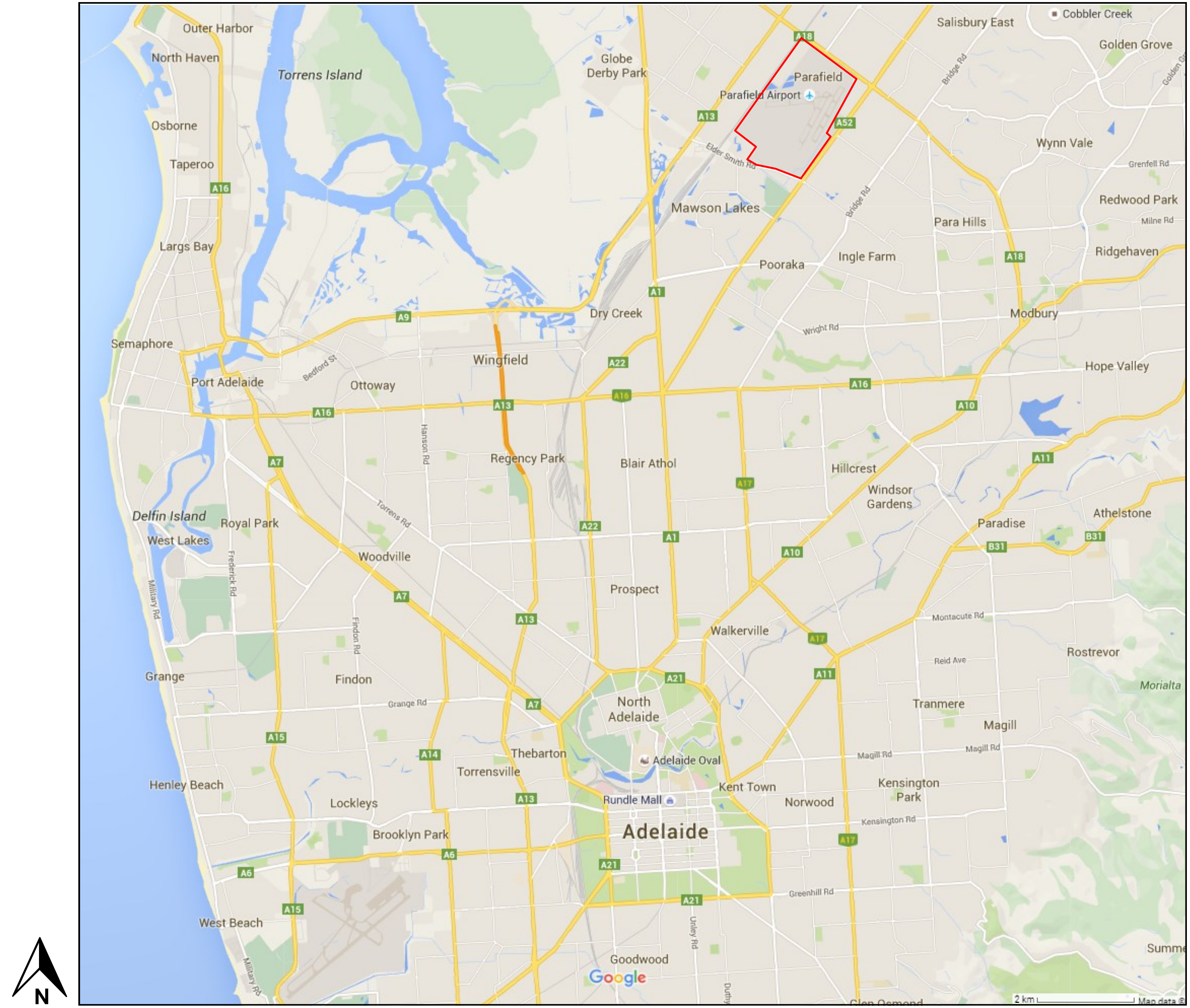


FIGURE 1B

Site Location Map—Parafield Airport

Parafield Airport

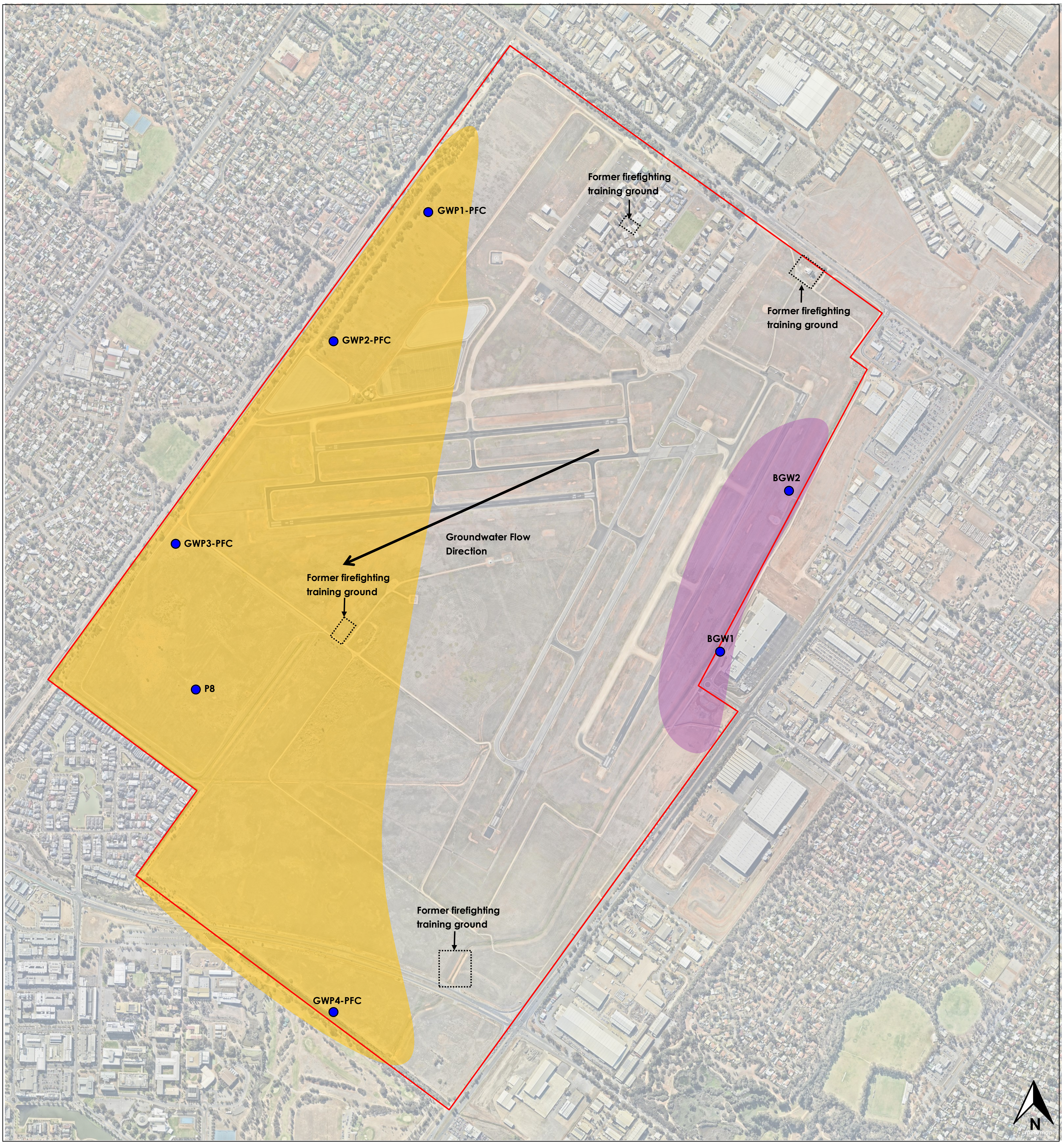
Detailed PFAS Assessment

For

Adelaide Airport Limited

Job No: 160786
Drawn: K Bradey
Checked:

LBW environmental projects



Scale

0 250 500 m

LBW environmental projects

Job No: 160786

Drawn: H Custance

Checked:

Legend

- Approximate Site Boundary
- Groundwater Well Location
- A—up gradient groundwater zone
- B—down gradient groundwater zone

Adelaide and Parafield Airports

Detailed PFAS Assessment

For

Adelaide Airport Limited

Figure 2B
Sample Location Plan —Parafield Airport

	Perfluorooctanoic acid (PFOA)	Perfluorooctanesulfonic acid (PFOS)	Perfluorohexanesulfonic acid (PFHxS)	PFOS + PFOA	PFOS + PFHxS
Criteria	µg/L	µg/L	µg/L	µg/L	µg/L
enHealth Interim National Guidance on human health reference values - Drinking Water Quality Guidelines	5				0.5
enHealth Interim National Guidance on human health reference values - Recreational Water Quality Guidelines	50				5

Scale

0 250 500 m

Job No: 160786

Drawn: H Custance

Checked:

Legend

Approximate Site Boundary

Groundwater Well Location

LBW environmental projects

Adelaide and Parafield Airports

Detailed PFAS Assessment

For

Adelaide Airport Limited

Figure 3B
Groundwater Concentrations—Parafield Airport

		PFAS in water				
		PFOA: Perfluorooctanoic acid	**PFOS**: Perfluorooctanesulfonic acid	**PFHxS**: Perfluorohexanesulfonic acid	**PFOS + PFOA**	**PFOS + PFHxS**
		µg/L	µg/L	µg/L	µg/L	µg/L
PQL		0.005	0.005	0.005	-	-
enHealth Interim National Guidance on human health reference values - Drinking Water Quality Guidelines		5				0.5
enHealth Interim National Guidance on human health reference values - Recreational Water Quality Guidelines		50				5
Sample ID	**Sample Date**					
Groundwater						
BGW1	17/03/2016	<0.005	<0.005	<0.005	<0.01	<0.01
BGW2	17/03/2016	0.01	0.019	0.007	0.029	0.026
P8	17/03/2016	<0.005	0.013	0.068	0.013	0.081
GWP1-PFC	27/05/2016	<0.005	0.014	0.047	0.014	0.028
GWP2-PFC	27/05/2016	<0.005	0.044	0.011	0.044	0.088
GWP3-PFC	27/05/2016	<0.005	0.03	0.072	0.03	0.06
GWP4-PFC	27/05/2016	<0.005	<0.005	0.0057	<0.01	0.0057
QA / QC Samples: Duplicates (Intra-Laboratory)						
GWP1-PFC	27/05/2016	<0.005	0.014	0.047	0.014	0.028
GWP100-PFC	27/05/2016	<0.005	0.013	0.044	0.013	0.026
RPD%		^	-7%	-7%	-7%	-7%

RPD value exceeds 20%

$$\%RPD = \frac{(\text{Concentration 1 - Concentration 2}) \times 100}{\text{Mean Concentration}}$$

LEGEND

Proposed Northern Adelaide Foodpark Site Boundary

Groundwater Wells

Paper Size A3

0 125 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Baseline Contamination Assessment and Geotechnical Investigation

Job Number	33-18216
Revision	A
Date	14 Dec 2016

Sampling Locations

Figure 1

N:\AU\Adelaide\Projects\33\18216\GIS\Maps\Working\3318216_001_Sampling_locations_A3P_JL (MJ Rev1).mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

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Data source:Aerial Imagery: Google Earth Pro (© 2016), DigitalGlobe, captured 13-7-2016; Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket building locations, 2016. Created by:mking3

Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

Site boundary

Inferred Groundwater Contours (mAHD)

Groundwater Wells

Note: Groundwater well GWP3_PFC was not included in the calculation of groundwater contours

Adelaide Airport Limited
Proposed Northern Adelaide Food Park

Job Number	31-33213
Revision	A
Date	14 Dec 2016

Groundwater contours

Figure 2

N:\AU\Adelaide\Projects\33\18216\GIS\Maps\Deliverables\33-18216-Z003_GroundwaterContoursNov.mxd

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Data source: Aerial Imagery: Google Earth Pro (© 2016), captured 13-7-2016. Created by:mking3

Paper Size A3

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

Site boundary

Groundwater Wells

Adelaide Airport Limited
Proposed Northern Adelaide Food Park

Job Number 31-33213
Revision A
Date 14 Dec 2016

PFOS + PFHxS Concentrations Figure 3

N:\AU\Adelaide\Projects\33\18216\GIS\Maps\Deliverables\33-18216-Z004_PFOSandPFHxS_20161207_2.mxd

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Data source: Aerial Imagery: Google Earth Pro (2016), DigitalGlobe - Captured 3/03/2016. Created by:mking3

Appendix B
Table B1
Groundwater PFAS Analytical Results

GME	Field_ID	Sampled_Date	PFAS													
			PFHxS and PFOS (Sum of Total) - Lab Calc	4:2 Fluorotelomer sulfonic acid	10:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	8:2 Fluorotelomer sulfonic acid	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluorobutanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorooctane sulfonic acid (PFOS)	PFAS (Sum of Total)(WA DER List)
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			0.01	0.05	0.05	0.02	0.02	0.02	0.05	0.05	0.01	0.1	0.02	0.02	0.01	0.01
Airservices EISLs (toxicity effects on aquatic organisms)									**2900**		**2900**				**6.66**	
Airservices HISLs (consumption of fish)									*0.3*	*0.0065*	*0.3*				*0.00065*	
Airservices HISLs (drinking water only)									0.4	5	0.4				0.2	
enHealth Interim Human Health PFC Guidelines (Drinking Water)			0.5								5					
enHealth Interim Human Health PFC Guidelines (Recreational Water)			5								50					
August 2016	P6	15/08/2016	6.58	<0.05	<0.05	-	2.23	-	<0.05	<0.05	0.05	-	-	-	4.35	-
	P8	15/08/2016	0.07	<0.05	<0.05	-	0.06	-	<0.05	<0.05	<0.01	-	-	-	0.01	-
	P9	15/08/2016	0.06	<0.05	<0.05	-	0.04	-	<0.05	<0.05	<0.01	-	-	-	0.02	-
	P10	15/08/2016	<0.05	<0.05	<0.05	-	<0.05	-	<0.05	<0.05	<0.05	-	-	-	<0.05	-
	P11	15/08/2016	7.35	<0.05	<0.05	-	3.91	-	<0.05	<0.05	0.06	-	-	-	3.44	-
	BGW3	15/08/2016	<0.01	<0.05	<0.05	-	<0.02	-	<0.05	<0.05	<0.01	-	-	-	<0.01	-
	GWP6-PFC	15/08/2016	97.7	<0.05	<0.05	-	24.9	-	<0.05	<0.05	1.28	-	-	-	72.8	-
November 2016	P1	22/11/2016	7.99	<0.05	<0.05	0.24	2.66	0.06	<0.05	<0.05	0.08	<0.1	0.05	0.2	5.33	8.62
	P3	22/11/2016	0.55	<0.05	<0.05	0.05	0.3	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	0.25	0.6
	P6	23/11/2016	5.27	<0.05	<0.05	0.19	1.64	<0.02	<0.05	<0.05	0.05	<0.1	<0.02	0.04	3.63	5.55
	P8	22/11/2016	0.11	<0.05	<0.05	0.05	0.07	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	0.04	0.16
	P9	23/11/2016	0.12	<0.05	<0.05	<0.02	0.06	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	0.06	0.12
	P10	22/11/2016	0.1	<0.05	<0.05	0.06	0.08	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	0.02	0.16
	P11	23/11/2016	15.1	<0.05	<0.05	1.32	9.46	0.26	<0.05	<0.05	0.2	<0.1	0.1	1.43	5.65	18.4
	P12	24/11/2016	80.9	<0.05	<0.05	2.45	15.2	0.66	<0.05	<0.05	0.79	<0.1	0.2	1.85	65.7	86.8
	P13	24/11/2016	33	<0.05	<0.05	1.68	10.3	0.67	<0.05	<0.05	0.67	<0.1	0.17	2.71	22.7	38.9
	P14	24/11/2016	3.52	<0.05	<0.05	0.46	2	0.1	<0.05	<0.05	0.08	<0.1	0.03	0.38	1.52	4.57
	P15	24/11/2016	11.3	<0.05	<0.05	0.52	4.82	0.18	<0.05	<0.05	0.16	<0.1	0.06	0.48	6.44	12.7
	P16	24/11/2016	5.22	<0.05	<0.05	0.1	1.5	<0.02	<0.05	<0.05	0.06	<0.1	<0.02	<0.02	3.72	5.38
	P17	24/11/2016	<0.01	<0.05	<0.05	<0.02	<0.02	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	<0.01	<0.01
	P18	24/11/2016	5.24	<0.05	<0.05	0.32	1.73	0.11	<0.05	<0.05	0.05	<0.1	0.02	0.09	3.51	5.83
	P19	24/11/2016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
	P20	25/11/2016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
	P21	25/11/2016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
	BGW3	23/11/2016	0.01	<0.05	<0.05	<0.02	<0.02	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	0.01	0.01
	GWP6_PFC	23/11/2016	88.7	<0.05	<0.05	2.11	21.4	1.25	<0.05	<0.05	1.36	<0.1	0.41	6.8	67.3	101
	GWP3-PFC	7/12/2016	0.11	<0.05	<0.05	<0.02	0.07	<0.02	<0.05	<0.05	<0.01	<0.1	<0.02	<0.02	0.04	0.11

Appendix B
Table B4
Soil PFAS Analytical Results

	Field_ID	Location_Code	Sampled_Date	PFAS: PFHxS and PFOS (Sum of Total) - Lab Calc	4:2 Fluorotelomer sulfonic acid	10:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	8:2 Fluorotelomer sulfonic acid	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluorobutanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorooctane sulfonic acid (PFOS)	PFAS (Sum of Total)(WA DER List)
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.0002	0.0005	0.0005	0.0002	0.0002	0.0002	0.0005	0.0005	0.0002	0.001	0.0002	0.0002	0.0002	0.0002
Airservices HISLs – industrial (direct contact only)										240	900	240				90	
Airservices Interim Waste Classification – Category 1 Material (Max.Conc.)												*3.73*				*0.373*	
Airservices Interim Waste Classification – Category 2 Material (Max.Conc.)												**240**				**90**	
August 2016	P9_6.0	P9	8/08/2016	<0.0002	<0.0005	<0.0005	-	<0.0002	-	<0.0005	<0.0005	<0.0002	-	-	-	<0.0002	-
	P10_0.7	P10	8/08/2016	<0.0002	<0.0005	<0.0005	-	<0.0002	-	<0.0005	<0.0005	<0.0002	-	-	-	<0.0002	-
	P11_0.05	P11	9/08/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	P11_2.0	P11	9/08/2016	0.0059	<0.0005	<0.0005	-	0.0008	-	<0.0005	<0.0005	<0.0002	-	-	-	0.0051	-
	BGW3_5.0	BGW3	9/08/2016	<0.0002	<0.0005	<0.0005	-	<0.0002	-	<0.0005	<0.0005	<0.0002	-	-	-	<0.0002	-
	GW6-PFC_0.05	GW6-PFC	8/08/2016	0.0089	<0.0005	<0.0005	-	0.0015	-	<0.0005	<0.0005	0.0002	-	-	-	0.0074	-
	GW6-PFC_2.0	GW6-PFC	8/08/2016	0.0774	<0.0005	<0.0005	-	0.008	-	<0.0005	<0.0005	0.0006	-	-	-	0.0694	-
November 2016	P12_0-0.1	P12	17/11/2016	0.03	<0.0005	<0.0005	<0.0002	0.0012	<0.0002	<0.0005	<0.0005	0.0003	<0.001	<0.0002	0.0002	0.0288	0.0305
	P12_4.0	P12	17/11/2016	0.0161	<0.0005	<0.0005	<0.0002	0.002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	0.0003	0.0141	0.0164
	P13_0-0.1	P13	18/11/2016	0.0024	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	0.0024	0.0024
	P13_3.5	P13	18/11/2016	0.0037	<0.0005	<0.0005	<0.0002	0.001	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	0.0005	0.0027	0.0042
	P14_0-0.1	P14	18/11/2016	0.0252	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	0.0002	<0.001	<0.0002	<0.0002	0.0252	0.0254
	P14_3.5	P14	18/11/2016	0.0003	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	0.0003	0.0003
	P15_1.0	P15	18/11/2016	0.0021	<0.0005	<0.0005	<0.0002	0.0006	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	0.0015	0.0021
	P16_4.0	P16	17/11/2016	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002
	P17_3.0	P17	17/11/2016	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002
	P18_2.5	P18	17/11/2016	0.001	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	0.001	0.001
	P19_5.0	P19	17/11/2016	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002
	P20_4.0	P20	18/11/2016	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002
	P21_2.0	P21	18/11/2016	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002

Table 1
Tabulated Soil Analytical Results
Per- and Poly-Fluoroalkyl Substances (PFAS)

						Location Code	BGW3	BGW4	BGW4	GW6-PFC	GW6-PFC	GWP5-PFC	GWP5-PFC	P10	P11	P11	P9
						Sample ID	BGW3_5.0	BGW4_0.5	BGW4_8.5	GW6-PFC_0.05	GW6-PFC_2.0	GWP5-PFC_0.05	GWP5-PFC_8.5	P10_0.7	P11_0.05	P11_2.0	P9_6.0
						Sampled Date	9/08/2016	11/08/2016	11/08/2016	8/08/2016	8/08/2016	9/08/2016	9/08/2016	8/08/2016	9/08/2016	9/08/2016	8/08/2016
						Lab Report Number	EM1609358	ES1618035	ES1618035	EM1609358	EM1609358	EM1609358	EM1609358	EM1609358	EM1609358	EM1609358	EM1609358
Chemical Group	**Chemical Name**	**Units**	**EQL**	Airservices Interim Waste Classification – Category 2 Material (Max.Conc.)	Airservices HISLs – industrial (direct contact only)	Airservices Interim Waste Classification – Category 1 Material (Max.Conc.)											
PFAS	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	mg/kg	0.0005				<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005
	1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTS)	mg/kg	0.0005				<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005
	Perfluorohexane sulfonic acid (PFHxS)	mg/kg	0.0002				<0.0002	-	<0.0002	0.0015	0.008	0.0002	<0.0002	<0.0002	-	0.0008	<0.0002
	8:2 Fluorotelomer sulfonate	mg/kg	0.0005		240		<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005
	6:2 Fluorotelomer Sulfonate (6:2 FtS)	mg/kg	0.0005		900		<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005
	PFOA	mg/kg	0.0002	240	240	3.73	<0.0002	-	<0.0002	0.0002	0.0006	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
	PFOS	mg/kg	0.0002	90	90	0.373	<0.0002	-	<0.0002	0.0074	0.0694	0.0041	0.0003	<0.0002	-	0.0051	<0.0002

Table 3
Tabulated Groundwater Analytical Results
Per- and Poly-Fluoroalkyl Substances (PFAS)

Chemical Group	Chemical Name	Units	EQL	Airservices EISLs (toxicity effects on aquatic organisms) *Surface Water Values	Airservices HISLs (consumption of fish) *Surface Water Values	Airservices HISLs (drinking water only)	enHealth Interim Human Health PFC Guidelines (Drinking Water)	enHealth Interim Human Health PFC Guidelines (Recreational Water)	BGW3	BGW4	GWP5-PFC	GWP6-PFC	P10	P11	P6	P8	P9
								Sample ID	BGW3	BGW4	GWP5-PFC	GWP6-PFC	P10	P11	P6	P8	P9
								Sampled Date	15/08/2016	15/08/2016	15/08/2016	15/08/2016	15/08/2016	15/08/2016	15/08/2016	15/08/2016	15/08/2016
								Lab Report Number	EM1609656	EM1609656	EM1609656	EM1609656	EM1609656	EM1609656	EM1609656	EM1609656	EM1609656
PFAS	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.05						<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTS)	µg/L	0.05						<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.02						<0.02	<0.02	<0.02	24.9	<0.05	3.91	2.23	0.06	0.04
	8:2 Fluorotelomer sulfonate	µg/L	0.05	2900	0.3	0.4			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	6:2 Fluorotelomer Sulfonate (6:2 FtS)	µg/L	0.05		0.0065	5			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	PFOA	µg/L	0.01	2900	0.3	0.4	5	50	<0.01	<0.01	<0.01	1.28	<0.05	0.06	0.05	<0.01	<0.01
	PFOS	µg/L	0.01	6.66	0.00065	0.2			<0.01	<0.01	<0.01	72.8	<0.05	3.44	4.35	0.01	0.02

Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Site boundary
- Environmental Borehole
- Groundwater well
- Environmental testpit
- Geotechnical testpit
- Geotechnical/Environmental testpit

GHD

Adelaide Airport Limited
Proposed Northern Adelaide Food Park

Job Number	31-33213
Revision	A
Date	13 Sep 2016

Site location

Figure 1

G:\33\18216\GIS\Maps\Deliverables (Optional)\33-18216-Z001_SiteLocation.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

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Data source: Google Earth Pro, Aerial imagery, captured 13-7-2016. Created by:msjervis

Table B2
Tabulated Soil Analytical Results
Per- and Poly-Fluoroalkyl Substances (PFAS)

						Location Code	BH(TP)28	BH(TP)33	BH(TP)35	BH55	BH60
						Sample ID	BH(TP)28_0.0-0.2	BH(TP)33_0.0-0.2	BH(TP)35_0.0-0.2	BH55_1.0-1.2	BH60_1.0-1.2
						Sampled Date	26/06/2016	26/06/2016	26/06/2016	23/06/2016	23/06/2016
						Lab Report Number	506089	506089	506089	506562	506562
Chem_Group	**Chemical Name**	**output unit**	**EQL**	Airservices Interim Waste Classification – Category 1 Material (Max.Conc.)	Airservices Interim Waste Classification – Category 2 Material (Max.Conc.)	Airservices HISLs – industrial (direct contact only)					
PFAS	6:2 Fluorotelomer Sulfonate (6:2 FtS)	mg/kg	0.01			900	<0.01	<0.01	<0.01	<0.01	<0.01
	PFOA	mg/kg	0.005	3.73	240	240	<0.005	<0.005	<0.005	<0.005	<0.005
	PFOS	mg/kg	0.005	0.373	90	90	<0.005	<0.005	<0.005	<0.005	<0.005

Table B4
Tabulated Groundwater Analytical Results
Per- and Poly-Fluoroalkyl Substances (PFAS)

Chem_Group	Chemical Name	output unit	EQL	Airservices EISLs (toxicity effects on aquatic organisms) *Surface Water Values	Airservices HISLs (consumption of fish) *Surface Water Values	Airservices HISLs (drinking water only)	enHealth Interim Human Health PFC Guidelines (Drinking Water)	enHealth Interim Human Health PFC Guidelines (Recreational Water)	P1	P3	P6
								Sample ID	P1	P3	P6
								Sampled Date	14/06/2016	14/06/2016	14/06/2016
								Lab Report Number	504508	504508	504508
PFAS	Perfluorodecanesulfonic acid (PFDS)	µg/L	0.01						<0.01	<0.01	<0.01
	1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTS)	µg/L	0.01						<0.01	<0.01	<0.01
	Perfluorobutane Sulfonate	ug/L	0.01						0.1	0.03	0.11
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.01				0.5	5	0.1	0.21	1.2
	Perfluoropentanoic acid (PFPeA)	µg/L	0.01						0.04	<0.01	0.01
	8:2 Fluorotelomer sulfonate	µg/L	0.01	2900	0.3	0.4			<0.01	<0.01	<0.01
	N-Et-FOSA	mg/L	0.00005						<0.00005	<0.00005	<0.00005
	N-Me-FOSA	mg/L	0.00005						<0.00005	<0.00005	<0.00005
	6:2 Fluorotelomer Sulfonate (6:2 FtS)	µg/L	0.05		0.0065	5			<0.05	<0.05	<0.05
	PFOA	µg/L	0.01	2900	0.3	0.4	5	50	0.09	<0.01	0.05
	PFDcA	mg/L	0.00001						<0.00001	<0.00001	<0.00001
	PFDoA	mg/L	0.00001						<0.00001	<0.00001	<0.00001
	PFHpA	mg/L	0.00001						0.00005	<0.00001	0.00002
	PFHxA	mg/L	0.00001						0.00018	<0.00001	0.00004
	PFNA	mg/L	0.00001						<0.00001	<0.00001	<0.00001
	PFOS	µg/L	0.01	6.66	0.00065	0.2	0.5	5	<0.01	0.04	0.48
	PFOSA	mg/L	0.00005						<0.00005	<0.00005	<0.00005
	PFTeA	mg/L	0.00001						<0.00001	<0.00001	<0.00001
	PFTriA	mg/L	0.00001						<0.00001	<0.00001	<0.00001
	PFUnA	mg/L	0.00001						<0.00001	<0.00001	<0.00001

SAMPLE REFERENCE	SAMPLE DESCRIPTION	Units	REPORT NUMBER	NMI LRN	Date	PFBuA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUdA	PFDoA
BGW1	Groundwater	µg/L	RN1107974	N16/007202	Mar-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BGW2	Groundwater	µg/L	RN1107974	N16/007203	Mar-16	-	<LOR	<LOR	<LOR	0.01	<LOR	<LOR	<LOR	<LOR
P8	Groundwater	µg/L	RN1107974	N16/007204	Mar-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
GWP1-PFC	Groundwater	µg/L	RN1117149	N16/015311	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
GWP100-PFC	*Groundwater*	µg/L	*RN1117149*	*N16/015315*	*Jun-16*	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
GWP2-PFC	Groundwater	µg/L	RN1117149	N16/015312	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
GWP3-PFC	Groundwater	µg/L	RN1117149	N16/015313	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
GWP4-PFC	Groundwater	*µg/L*	RN1117149	N16/015314	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SW-US1	Surface water	µg/L	RN1117149	N16/015318	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SW-DS1 (SWP2)	Surface water	µg/L	RN1117149	N16/015319	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Jul-16	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Sep-16	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Nov-16	<LOR	<LOR	0.015	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Jan-17	<LOR	<LOR	0.015	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
SW-DS3	Surface water	µg/L	RN1117149	N16/015320	Jun-16	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Notes

QA/QC samples shown in *italics* underneath the relevant primary sample

LORs in the range <0.01 to <0.5 to ug/L

SAMPLE REFERENCE	SAMPLE DESCRIPTION	Units	REPORT NUMBER	NMI LRN	Date	PFBS	PFHxS	PFOS	PFOS + PFHxS	6:2 FTS	8:2 FTS	PFOSA	PFDS
BGW1	Groundwater	µg/L	RN1107974	N16/007202	Mar-16	<LOR	<LOR	<LOR	--	<LOR	<LOR	-	-
BGW2	Groundwater	µg/L	RN1107974	N16/007203	Mar-16	<LOR	0.007	0.019	0.03	<LOR	<LOR	-	-
P8	Groundwater	µg/L	RN1107974	N16/007204	Mar-16	0.029	0.068	0.013	0.08	<LOR	<LOR	-	-
GWP1-PFC	Groundwater	µg/L	RN1117149	N16/015311	Jun-16	<LOR	0.047	0.014	0.06	<LOR	<LOR	-	-
GWP100-PFC	*Groundwater*	µg/L	*RN1117149*	*N16/015315*	*Jun-16*	<LOR	*0.044*	*0.013*	0.06	<LOR	<LOR	-	-
GWP2-PFC	Groundwater	µg/L	RN1117149	N16/015312	Jun-16	<LOR	0.011	0.044	0.06	<LOR	<LOR	-	-
GWP3-PFC	Groundwater	µg/L	RN1117149	N16/015313	Jun-16	<LOR	0.072	0.03	0.10	<LOR	<LOR	-	-
GWP4-PFC	Groundwater	*µg/L*	RN1117149	N16/015314	Jun-16	<LOR	0.0057	<LOR	0.006	<LOR	<LOR	-	-
SW-US1	Surface water	µg/L	RN1117149	N16/015318	Jun-16	<LOR	<LOR	0.0062	0.01	<LOR	<LOR	-	-
SW-DS1 (SWP2)	Surface water	µg/L	RN1117149	N16/015319	Jun-16	<LOR	0.0075	0.032	0.04	<LOR	<LOR	-	-
SWP2	Surface water	µg/L	-	-	Jul-16	<LOR	0.046	0.066	0.11	<LOR	<LOR	-	-
SWP2	Surface water	µg/L	-	-	Sep-16	0.012	0.076	0.14	0.22	<LOR	<LOR	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Nov-16	0.017	0.15	0.19	0.34	<LOR	<LOR	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Jan-17	0.015	0.13	0.17	0.30	<LOR	<LOR	<LOR	<LOR
SW-DS3	Surface water	µg/L	RN1117149	N16/015320	Jun-16	<LOR	<LOR	<LOR	--	<LOR	<LOR	-	-

Notes

QA/QC samples shown in *italics* underneath the relevant primary sample

LORs in the range <0.01 to <0.5 to ug/L

SAMPLE REFERENCE	SAMPLE DESCRIPTION	Units	REPORT NUMBER	NMI LRN	Date	PFTrDA	PFTeDA
BGW1	Groundwater	µg/L	RN1107974	N16/007202	Mar-16	-	-
BGW2	Groundwater	µg/L	RN1107974	N16/007203	Mar-16	-	-
P8	Groundwater	µg/L	RN1107974	N16/007204	Mar-16	-	-
GWP1-PFC	Groundwater	µg/L	RN1117149	N16/015311	Jun-16	-	-
GWP100-PFC	*Groundwater*	µg/L	*RN1117149*	*N16/015315*	*Jun-16*	-	-
GWP2-PFC	Groundwater	µg/L	RN1117149	N16/015312	Jun-16	-	-
GWP3-PFC	Groundwater	µg/L	RN1117149	N16/015313	Jun-16	-	-
GWP4-PFC	Groundwater	*µg/L*	RN1117149	N16/015314	Jun-16	-	-
SW-US1	Surface water	µg/L	RN1117149	N16/015318	Jun-16	-	-
SW-DS1 (SWP2)	Surface water	µg/L	RN1117149	N16/015319	Jun-16	-	-
SWP2	Surface water	µg/L	-	-	Jul-16	-	-
SWP2	Surface water	µg/L	-	-	Sep-16	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Nov-16	<LOR	<LOR
SWP2	Surface water	µg/L	-	-	Jan-17	<LOR	<LOR
SW-DS3	Surface water	µg/L	RN1117149	N16/015320	Jun-16	-	-

Notes

QA/QC samples shown in *italics* underneath the relevant primary sample

LORs in the range <0.01 to <0.5 to ug/L

Paper Size A4

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Proposed Northern Adelaide Foodpark Site Boundary
- Railway
- Highways
- Arterial Roads
- Minor Roads
- Waterways
- Waterbodies

Adelaide Airpot Limited
Proposed Northern Adelaide Food Park

Job Number	33-18216
Revision	A
Date	12 Dec 2017

Site Location

Figure 1

N:\AU\Adelaide\Projects\33\18216\GIS\Maps\Deliverables\33_18216_Z005_GW_SiteLocation.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

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Data source: Aerial Imagery: Google Earth Pro (© 2016), Extracted 13-7-2016, ESRI World Imagery and Topographic Basemap; Railways and Roads: SA DPTI; Waterways: SA DEWNR. Created by:mking3

Paper Size A4

0 25 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Proposed Northern Adelaide Foodpark Site Boundary
- Allotment A
- Distribution Centre Boundary
- Distribution Centre Building
- Distribution Centre Pavement
- Groundwater Wells

Adelaide Airport Limited
Proposed Northern Adelaide Food Park

Job Number	33-18216
Revision	A
Date	14 Dec 2017

Site Layout Plan

Figure 2

N:\AU\Adelaide\Projects\33\18216\GIS\Maps\Deliverables\33_18216_Z006_GW_SiteLayout.mxd

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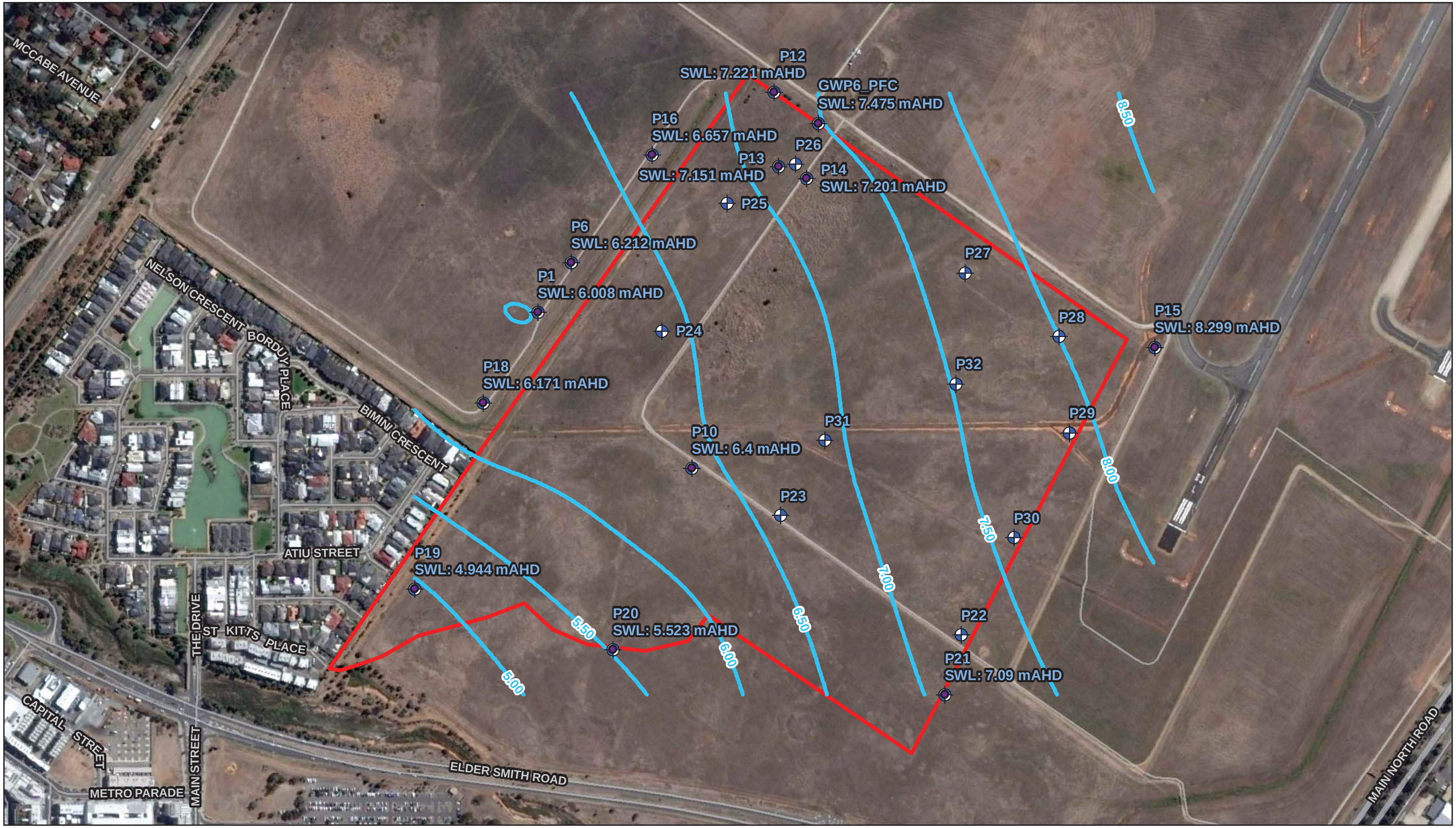

Paper Size A4

0 25 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

Proposed Northern Adelaide Foodpark Site Boundary
Highways
Minor Roads
Groundwater Wells
Groundwater Elevation (mAHD)

Adelaide Airpot Limited
Proposed Northern Adelaide Food Park

Job Number	33-18216
Revision	A
Date	14 Dec 2017

Groundwater Contour Plan

Figure 3

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Paper Size A4

0 25 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Proposed Northern Adelaide Foodpark Site Boundary
- PFHxS and PFOS Concentrations (µg/L)
- Highways
- Minor Roads
- Groundwater Wells

GHD

Adelaide Airpot Limited
Proposed Northern Adelaide Food Park

Job Number	33-18216
Revision	A
Date	14 Dec 2017

Contamination Contour Plan

Figure 4

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Data source: Aerial Imagery: Google Earth Pro (© 2016), Extracted 13-7-2016, ESRI World Imagery and Topographic Basemap; Railways and Roads: SA DPTI; Waterways: SA DEWNR. Created by:mking3

Table 1
Soil Analytical Results

			Inorganics	Metals								TRH - NEPM 2013						TRH - NEPM 1999				
			Moisture Content (dried @ 103°C)	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc	C6-C10 minus BTEX (F1)	C6 - C10 Fraction	>C10-C16 minus Naphthalene (F2)	>C10 - C16 Fraction	>C16 - C34 Fraction (F3)	>C34 - C40 Fraction (F4)	C6 - C 9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 (Sum of Total)
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			1	2	0.4	5	5	5	0.1	5	5	20	20	50	50	100	100	20	20	50	50	50
NEPM 2013 Table 1A(1) HIL D Comm/Ind				3,000	900	3,600	240,000	1,500	730	6,000	400,000											
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, Cl																						
0-1m												310		NL								
1-2m												480		NL								
2-4m												NL		NL								
>4m												NL		NL								
FSANZ - Tolerable daily intake guideline																						
Field ID	**Date**	**Matrix Type**																				
P22_0-0.2	27/11/2017	soil	8.4	6.4	<0.4	51	28	30	<0.1	27	42	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P22_2.5-2.7	27/11/2017	soil	18																			
P22_2-2.2	27/11/2017	soil	15	7.2	<0.4	49	26	16	<0.1	22	37	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P23_0.5-0.7	27/11/2017	soil	6.3	3.1	<0.4	38	18	12	<0.1	16	28	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P23_1-1.2	27/11/2017	soil	18	5.7	<0.4	57	30	14	<0.1	29	52	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P23_3.5-3.7	27/11/2017	soil	15																			
P24_0.5-0.7	27/11/2017	soil	22	7.1	<0.4	54	30	15	<0.1	32	42	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P24_1.5-1.7	27/11/2017	soil	10	4.5	<0.4	34	17	11	<0.1	18	25	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P24_4.1-4.3	27/11/2017	soil	19																			
P25_0-0.2	28/11/2017	soil	5.2	5.7	<0.4	50	17	32	<0.1	13	30	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P25_0.3-0.5	28/11/2017	soil	18	6.8	<0.4	57	33	17	<0.1	30	38	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P25_4.2-4.4	28/11/2017	soil	19																			
P26_0-0.2	28/11/2017	soil	6.3	3.3	<0.4	28	11	27	<0.1	11	31	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P26_2.25-2.45	28/11/2017	soil	17	5.9	<0.4	41	21	15	<0.1	23	31	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P26_4.1-4.3	28/11/2017	soil	22																			
P27_0.2-0.3	28/11/2017	soil	13	7.0	<0.4	49	27	16	<0.1	26	36	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P27_0.75-0.85	28/11/2017	soil	20	5.5	<0.4	38	20	12	<0.1	23	32	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P27_4.5-4.7	28/11/2017	soil	19																			
P28_0.4-0.5	28/11/2017	soil	14	6.8	<0.4	51	27	15	<0.1	25	38	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P28_1-1.2	28/11/2017	soil	15	4.6	<0.4	32	17	9.5	<0.1	20	25	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P28_3.7-3.9	28/11/2017	soil	24																			
P29_0-0.2	29/11/2017	soil	6.5	4.4	<0.4	36	13	28	<0.1	13	25	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P29_0.5-0.7	29/11/2017	soil	15	5.8	<0.4	36	41	12	<0.1	25	39	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P29_4-4.2	29/11/2017	soil	10																			
P30_2.0-2.2	29/11/2017	soil	16	6.8	<0.4	36	22	14	<0.1	17	30	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P30_3.0-3.2	29/11/2017	soil	15	3.9	<0.4	28	12	10	<0.1	12	19	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P30_3.8-4	29/11/2017	soil	17																			
P31_0.2-0.4	29/11/2017	soil	11	5.5	<0.4	42	19	14	<0.1	24	24	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P31_2-2.2	29/11/2017	soil	17	5.0	<0.4	32	17	12	<0.1	16	23	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P31_3.7-3.9	29/11/2017	soil	15																			
P32_0-0.2	29/11/2017	soil	13	3.9	<0.4	38	12	27	<0.1	17	30	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P32_1.8-2	29/11/2017	soil	16	3.4	<0.4	29	12	9.7	<0.1	13	19	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50
P32_3.8-4	29/11/2017	soil	15																			

NL - HSL is non-limiting

Table 1
Soil Analytical Results

			BTEXN						PAHs	PFAS										
			Benzene	Toluene	Ethylbenzene	Xylene (o)	Xylene (m & p)	Xylene Total	Naphthalene	N-Ethyl perfluorooctane sulfonamidoacetic acid	Perfluoroheptane sulfonic acid	Perfluorodecanesulfonic acid (PFDS)	10:2 Fluorotelomer sulfonic acid	4:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	N-Methyl perfluorooctane sulfonamidoacetic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	PFHxS and PFOS (Sum of Total) - Lab Calc	8:2 Fluorotelomer sulfonic acid
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.01	0.005	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.005
NEPM 2013 Table 1A(1) HIL D Comm/Ind																				
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, Cl																				
0-1m			4	NL	NL			NL	NL											
1-2m			6	NL	NL			NL	NL											
2-4m			9	NL	NL			NL	NL											
>4m			20	NL	NL			NL	NL											
FSANZ - Tolerable daily intake guideline																			**0.14**	
Field ID	**Date**	**Matrix Type**																		
P22_0-0.2	27/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P22_2.5-2.7	27/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P22_2-2.2	27/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P23_0.5-0.7	27/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P23_1-1.2	27/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P23_3.5-3.7	27/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P24_0.5-0.7	27/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P24_1.5-1.7	27/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P24_4.1-4.3	27/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P25_0-0.2	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P25_0.3-0.5	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P25_4.2-4.4	28/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P26_0-0.2	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P26_2.25-2.45	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P26_4.1-4.3	28/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P27_0.2-0.3	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P27_0.75-0.85	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P27_4.5-4.7	28/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P28_0.4-0.5	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P28_1-1.2	28/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P28_3.7-3.9	28/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P29_0-0.2	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P29_0.5-0.7	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P29_4-4.2	29/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P30_2.0-2.2	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P30_3.0-3.2	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P30_3.8-4	29/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P31_0.2-0.4	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P31_2-2.2	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P31_3.7-3.9	29/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
P32_0-0.2	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P32_1.8-2	29/11/2017	soil	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5											
P32_3.8-4	29/11/2017	soil								<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005

NL - HSL is non-limiting

			PFAS																			
			N-Ethyl perfluorooctane sulfonamide	N-Ethyl perfluorooctane sulfonamidoethanol	N-Methyl perfluorooctane sulfonamide	N-Methyl perfluorooctane sulfonamidoethanol	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluoropentane sulfonic acid	Perfluorobutanoic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorononanoic acid	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctane sulfonamide (FOSA)	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFAS (Sum of Total)	PFAS (Sum of Total)(WA DER List)
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.05	0.01
NEPM 2013 Table 1A(1) HIL D Comm/Ind																						
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, Cl																						
0-1m																						
1-2m																						
2-4m																						
>4m																						
FSANZ - Tolerable daily intake guideline								1.12														
Field ID	**Date**	**Matrix Type**																				
P22_0-0.2	27/11/2017	soil																				
P22_2.5-2.7	27/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P22_2-2.2	27/11/2017	soil																				
P23_0.5-0.7	27/11/2017	soil																				
P23_1-1.2	27/11/2017	soil																				
P23_3.5-3.7	27/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P24_0.5-0.7	27/11/2017	soil																				
P24_1.5-1.7	27/11/2017	soil																				
P24_4.1-4.3	27/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P25_0-0.2	28/11/2017	soil																				
P25_0.3-0.5	28/11/2017	soil																				
P25_4.2-4.4	28/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P26_0-0.2	28/11/2017	soil																				
P26_2.25-2.45	28/11/2017	soil																				
P26_4.1-4.3	28/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P27_0.2-0.3	28/11/2017	soil																				
P27_0.75-0.85	28/11/2017	soil																				
P27_4.5-4.7	28/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P28_0.4-0.5	28/11/2017	soil																				
P28_1-1.2	28/11/2017	soil																				
P28_3.7-3.9	28/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P29_0-0.2	29/11/2017	soil																				
P29_0.5-0.7	29/11/2017	soil																				
P29_4-4.2	29/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P30_2.0-2.2	29/11/2017	soil																				
P30_3.0-3.2	29/11/2017	soil																				
P30_3.8-4	29/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P31_0.2-0.4	29/11/2017	soil																				
P31_2-2.2	29/11/2017	soil																				
P31_3.7-3.9	29/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01
P32_0-0.2	29/11/2017	soil																				
P32_1.8-2	29/11/2017	soil																				
P32_3.8-4	29/11/2017	soil	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01

NL - HSL is non-limiting

Table 2
Leachate Analytical Results

Parafield Airport
3318216

Field ID	Date	Matrix Type	Inorganics			PFAS														
			pH of Leaching Fluid	pH (Final)	pH (Initial)	N-Ethyl perfluorooctane sulfonamidoacetic acid	Perfluoroheptane sulfonic acid	Perfluorodecanesulfonic acid (PFDS)	10:2 Fluorotelomer sulfonic acid	4:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	N-Methyl perfluorooctane sulfonamidoacetic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	PFHxS and PFOS (Sum of Total) - Lab Calc	8:2 Fluorotelomer sulfonic acid	N-Ethyl perfluorooctane sulfonamide	N-Ethyl perfluorooctane sulfonamidoethanol	N-Methyl perfluorooctane sulfonamide	N-Methyl perfluorooctane sulfonamidoethanol
			pH Units	pH Units	pH Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			0.1	0.1	0.1	0.05	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.05
Modified FSANZ - PFAS Drinking water quality guideline - Leachate															1.4					
Modified FSANZ - PFAS Recreational water quality guideline - Leachate															14					
P22_2.5-2.7	30/11/2017	soil	7.0	9.4	9.7	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
P23_3.5-3.7	30/11/2017	soil	7.0	9.5	9.4	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
P24_4.1-4.3	30/11/2017	soil	7.0	9.3	8.4	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
P29_4-4.2	30/11/2017	soil	7.0	9.3	8.3	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
P30_3.8-4	30/11/2017	soil	7.0	9.4	9.2	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
P31_3.7-3.9	30/11/2017	soil	7.0	9.6	8.3	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
P32_3.8-4	30/11/2017	soil	7.0	9.6	9.3	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05

Notes:
Assessment criteria has been modified by applying a

Table 2
Leachate Analytical Results

Parafield Airport
3318216

			PFAS															
			6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluoropentane sulfonic acid	Perfluorobutanoic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorononanoic acid	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctane sulfonamide (FOSA)	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFAS (Sum of Total)	PFAS (Sum of Total)(WA DER List)
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			0.05	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.1	0.05
Modified FSANZ - PFAS Drinking water quality guideline - Leachate				11.2														
Modified FSANZ - PFAS Recreational water quality guideline - Leachate				**112**														
Field ID	**Date**	**Matrix Type**																
P22_2.5-2.7	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05
P23_3.5-3.7	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05
P24_4.1-4.3	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05
P29_4-4.2	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05
P30_3.8-4	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05
P31_3.7-3.9	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05
P32_3.8-4	30/11/2017	soil	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.05

Notes:
Assessment criteria has been modified by applying a

Table 3
Groundwater Analytical Results

					Inorganics	Metals										PAHs
			Carbonate Alkalinity-mg CaCO3/L	Total Organic Carbon	Total Dissolved Solids	Arsenic (filtered)	Cadmium (filtered)	Chromium (III+VI) (filtered)	Copper (filtered)	Iron (filtered)	Lead (filtered)	Manganese (filtered)	Mercury (filtered)	Nickel (filtered)	Zinc (filtered)	Naphthalene
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L
EQL			10	1	10	0.001	0.0001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.001	1
Airservices - GHD 2017 Human Health Criteira - MW Fish Consumption																
FSANZ - PFAS Recreational water quality guideline																
ADWG 2015 Aesthetic for recreational purposes					600				1	0.3		0.1			3	
Modified Recreational Primary Contact*						0.1	0.02		20		0.1	5	0.01	0.2		
NEPM 2013 Table 1A(4) HSL A/B Res GW for Vapour Intrusion, Clay 2-4m																NL
NEPM 2013 Table 1C GILs, Fresh Waters							0.0002		0.0014		0.0034	1.9	6E-05	0.011	0.008	16
NEPM 2013 Table 1C GILs, Marine Waters							0.0007		0.0013		0.0044		0.0001	0.007	0.015	50
Field ID	**Date**	**Matrix Type**														
GWP6_PFC	5/12/2017	Water	<10	<5	3,700	<0.001	<0.0002	<0.001	<0.001	0.12	<0.001	0.63	0.0002	0.003	<0.005	<10
P1	4/12/2017	Water	<10	6.2	1,100	0.002	<0.0002	<0.001	0.005	<0.05	<0.001	<0.005	<0.0001	0.003	<0.005	<10
P6	4/12/2017	Water	<10	<5	2,500	<0.001	<0.0002	<0.001	<0.001	<0.05	<0.001	<0.005	<0.0001	<0.001	0.006	<10
P10	5/12/2017	Water	<10	<5	9,200	<0.001	<0.0002	<0.001	<0.001	<0.05	<0.001	0.035	<0.0001	<0.001	<0.005	<10
P12	5/12/2017	Water	<10	<5	3,000	<0.001	<0.0002	<0.001	0.002	<0.05	<0.001	0.051	<0.0001	0.001	0.008	<10
P13	5/12/2017	Water	<10	<5	3,800	<0.001	<0.0002	0.003	<0.001	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P14	5/12/2017	Water	<10	<5	3,600	<0.001	<0.0002	0.001	0.001	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P15	6/12/2017	Water	<10	<5	2,900	<0.001	<0.0002	0.001	<0.001	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P16	4/12/2017	Water	16	<5	1,500	<0.001	<0.0002	<0.001	<0.001	<0.05	<0.001	<0.005	<0.0001	0.002	0.005	<10
P18	4/12/2017	Water	<10	<5	1,100	<0.001	<0.0002	<0.001	<0.001	0.10	<0.001	0.15	<0.0001	0.003	0.008	<10
P19	5/12/2017	Water	<10	<5	32,000	0.001	<0.0002	0.002	0.002	<0.05	<0.001	0.005	<0.0001	<0.001	<0.005	<10
P20	5/12/2017	Water	<10	<5	20,000	0.002	<0.0002	<0.001	0.002	<0.05	<0.001	0.022	<0.0001	<0.001	<0.005	<10
P21	5/12/2017	Water	<10	<5	8,900	<0.001	<0.0002	<0.001	0.002	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P22	6/12/2017	Water	<10	<5	7,200	<0.001	<0.0002	<0.001	<0.001	<0.05	<0.001	0.007	<0.0001	<0.001	0.006	<10
P23	6/12/2017	Water	<10	<5	5,100	<0.001	<0.0002	0.002	0.002	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P24	5/12/2017	Water	<10	<5	3,300	<0.001	<0.0002	0.003	0.002	<0.05	<0.001	0.005	<0.0001	<0.001	<0.005	<10
P25	5/12/2017	Water	<10	<5	3,600	<0.001	<0.0002	0.002	<0.001	<0.05	<0.001	0.020	<0.0001	<0.001	0.007	<10
P26	5/12/2017	Water	<10	<5	4,700	<0.001	<0.0002	0.002	<0.001	<0.05	<0.001	0.012	<0.0001	<0.001	0.006	<10
P27	5/12/2017	Water	<10	<5	4,500	<0.001	<0.0002	0.002	<0.001	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P28	5/12/2017	Water	<10	<5	8,600	<0.001	<0.0002	<0.001	0.001	<0.05	<0.001	0.10	<0.0001	0.001	<0.005	<10
P29	6/12/2017	Water	<10	11	11,000	<0.001	<0.0002	<0.001	0.001	<0.05	<0.001	0.014	<0.0001	<0.001	0.014	<10
P30	6/12/2017	Water	<10	<5	4,900	<0.001	<0.0002	<0.001	<0.001	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P31	6/12/2017	Water	<10	<5	4,600	<0.001	<0.0002	<0.001	0.002	<0.05	<0.001	<0.005	<0.0001	<0.001	<0.005	<10
P32	5/12/2017	Water	<10	<5	11,000	<0.001	<0.0002	<0.001	0.002	<0.05	<0.001	0.017	<0.0001	<0.001	0.006	<10

* Guideline derived from ADWG 2015 Health Guideline x 10
NL - HSL is non-limiting

Table 3
Groundwater Analytical Results

			TRH - NEPM 2013						TRH - NEPM 1999					BTEX					
			C6-C10 minus BTEX (F1)	C6 - C10 Fraction	>C10-C16 minus Naphthalene (F2)	>C10 - C16 Fraction	>C16 - C34 Fraction (F3)	>C34 - C40 Fraction (F4)	C6 - C 9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 (Sum of Total)	Benzene	Toluene	Ethylbenzene	Xylene (o)	Xylene (m & p)	Xylene Total
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			20	20	50	50	100	100	20	50	100	50	50	1	1	1	1	2	2
Airservices - GHD 2017 Human Health Criteira - MW Fish Consumption																			
FSANZ - PFAS Recreational water quality guideline																			
ADWG 2015 Aesthetic for recreational purposes															25	3			20
Modified Recreational Primary Contact*														10	8000	3000			6000
NEPM 2013 Table 1A(4) HSL A/B Res GW for Vapour Intrusion, Clay 2-4m			NL		NL									5,000	NL	NL			NL
NEPM 2013 Table 1C GILs, Fresh Waters														950			350		
NEPM 2013 Table 1C GILs, Marine Waters														500					
Field ID	**Date**	**Matrix Type**																	
GWP6_PFC	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P1	4/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P6	4/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P10	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P12	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P13	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P14	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P15	6/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P16	4/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P18	4/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P19	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P20	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P21	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P22	6/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P23	6/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P24	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P25	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P26	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P27	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P28	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P29	6/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P30	6/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P31	6/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3
P32	5/12/2017	Water	<20	<20	<50	<50	<100	<100	<20	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3

* Guideline derived from ADWG 2015 Health Guideline x 10
NL - HSL is non-limiting

Table 3
Groundwater Analytical Results

			PFAS					Acidity & Alkalinity	Major Ions						Nutrients		
			Perfluorohexane sulfonic acid (PFHxS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluorooctane sulfonic acid (PFOS)	PFHxS and PFOS (Sum of Total) - Lab Calc	Bicarbonate Alkalinity as CaCO3	Calcium	Chloride	Magnesium	Potassium	Sodium	Ammonia as N	Nitrate (as N)	Sulphate as S
			µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.01	0.05	0.01	0.01	0.01	1	0.5	1	0.5	0.5	0.5	0.01	0.02	5
Airservices - GHD 2017 Human Health Criteira - MW Fish Consumption			0.001		0.0082	0.001	0.001									
FSANZ - PFAS Recreational water quality guideline			0.7		5.6	0.7	0.7									
ADWG 2015 Aesthetic for recreational purposes										250			180			
Modified Recreational Primary Contact*																
NEPM 2013 Table 1A(4) HSL A/B Res GW for Vapour Intrusion, Clay 2-4m																
NEPM 2013 Table 1C GILs, Fresh Waters														0.9		
NEPM 2013 Table 1C GILs, Marine Waters																
Field ID	**Date**	**Matrix Type**														
GWP6_PFC	5/12/2017	Water	46	<0.05	2.7	180	226	660	110	1,800	160	19	1,300	<0.01	<0.02	83
P1	4/12/2017	Water	0.10	<0.05	<0.01	0.41	0.51	590	11	250	8.6	5.6	390	<0.01	0.09	8.7
P6	4/12/2017	Water	1.8	<0.05	0.07	4.5	6.3	500	28	1,200	37	9.0	880	<0.01	1.6	65
P10	5/12/2017	Water	0.08	<0.05	<0.01	<0.01	0.08	840	130	3,900	270	30	2,500	<0.01	0.04	160
P12	5/12/2017	Water	13	<0.05	0.54	70	83	490	57	1,400	80	11	910	<0.01	2.1	36
P13	5/12/2017	Water	3.6	<0.05	0.19	6.5	10.1	760	120	1,900	150	17	980	<0.01	2.1	69
P14	5/12/2017	Water	0.93	<0.05	0.05	0.91	1.84	350	110	1,900	160	18	960	0.05	0.85	73
P15	6/12/2017	Water	3.4	<0.05	0.11	2.1	5.5	510	56	1,400	110	16	800	<0.01	0.57	55
P16	4/12/2017	Water	1.1	<0.05	0.04	2.6	3.7	540	11	400	13	6.0	500	<0.01	0.33	34
P18	4/12/2017	Water	0.38	<0.05	0.03	1.1	1.48	500	82	310	81	13	170	<0.01	0.03	16
P19	5/12/2017	Water	<0.01	<0.05	<0.01	<0.01	<0.01	500	76	21,000	240	63	18,000	<0.01	3.5	790
P20	5/12/2017	Water	<0.01	<0.05	<0.01	<0.01	<0.01	790	35	9,800	110	30	14,000	<0.01	2.5	710
P21	5/12/2017	Water	<0.01	<0.05	<0.01	<0.01	<0.01	610	98	3,800	230	25	2,600	<0.01	0.47	270
P22	6/12/2017	Water	<0.01	<0.05	<0.01	<0.01	<0.01	500	170	3,700	340	28	2,100	<0.01	0.22	240
P23	6/12/2017	Water	<0.01	<0.05	<0.01	<0.01	<0.01	490	95	2,500	190	22	1,600	<0.01	0.97	140
P24	5/12/2017	Water	0.78	<0.05	0.04	0.65	1.43	330	81	1,700	120	18	1,000	<0.01	2.1	59
P25	5/12/2017	Water	1.4	<0.05	0.07	1.5	2.9	330	110	1,800	160	19	1,000	<0.01	2.3	64
P26	5/12/2017	Water	4.6	<0.05	0.10	1.9	6.5	370	140	2,300	180	19	1,200	<0.01	2.1	97
P27	5/12/2017	Water	<0.01	<0.05	<0.01	<0.01	<0.01	390	50	2,400	83	18	1,500	<0.01	0.90	76
P28	5/12/2017	Water	0.11	<0.05	<0.01	<0.01	<0.01	380	250	3,600	440	32	18,000	<0.01	1.2	140
P29	6/12/2017	Water	0.04	<0.05	<0.01	<0.01	<0.01	660	180	6,800	350	44	6,800	<0.01	3.2	440
P30	6/12/2017	Water	0.03	<0.05	<0.01	<0.01	<0.01	500	79	2,400	160	23	1,600	<0.01	1.5	130
P31	6/12/2017	Water	0.22	<0.05	<0.01	0.05	0.27	530	59	2,400	120	21	1,600	<0.01	0.13	110
P32	5/12/2017	Water	0.34	<0.05	<0.01	0.05	0.39	660	65	4,800	270	41	3,100	<0.01	0.36	210

* Guideline derived from ADWG 2015 Health Guideline x 10
NL - HSL is non-limiting

LEGEND

Roads

Site Area

Paper Size A4

0 40 80 160 240 320

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Parafield Airport Business Park Investigation
Environmental and Geotechnical Investigation

Job Number	33-18216
Revision	A
Date	23 Feb 2018

Site location plan

Figure 1

4/211 Victoria Square, Adelaide SA 5000, Australia **T** 61 8 8111 6600 **F** 61 8 8111 6699 **E** adlmail@ghd.com **W** www.ghd.com

N:\AU\Adelaide\Projects\33\18216\GIS\Maps\Deliverables\33_18216_Z010_PARAFIELD_SiteLocationPlan.mxd

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Data source: Roads: SA DPTI GHD; Satellite Imagery: Esri World Imagery Basemap 2018. Created by:kqvelasco

LEGEND

- Groundwater well
- Environmental boreholes
- Environmental and geotechnical boreholes
- Roads
- Site Area

Paper Size A4

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Adelaide Airport Limited
Parafield Airport Business Park Investigation
Environmental and Geotechnical Investigation

Job Number	33-18216
Revision	A
Date	23 Feb 2018

Site 1 layout plan

Figure 2

4/211 Victoria Square, Adelaide SA 5000, Australia T 61 8 8111 6600 F 61 8 8111 6699 E adlmail@ghd.com W www.ghd.com

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Data source: Roads: SA DPTI GHD; Satellite Imagery: Esri World Imagery Basemap 2018. Created by:kqvelasco

LEGEND

Environmental boreholes

Roads

Site Area

Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Parafield Airport Business Park Investigation
Environmental and Geotechnical Investigation

Job Number	33-18216
Revision	A
Date	23 Feb 2018

Site 2 Rivergum Homes site layout plan

Figure 3

4/211 Victoria Square, Adelaide SA 5000, Australia **T** 61 8 8111 6600 **F** 61 8 8111 6699 **E** adlmail@ghd.com **W** www.ghd.com

C:\Users\kqvelasco\Documents\33\GIS\Maps\Deliverables\33_18216_Z012_PARAFIELD_Site2RivergumHomesSiteLayoutPlan.mxd

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Data source: Roads: SA DPTI GHD; Satellite Imagery: Esri World Imagery Basemap 2018. Created by:kqvelasco

			PFAS																															
			N-Methyl perfluorooctane sulfonamidoethanol MeFOSA	N-Ethyl perfluorooctane sulfonamidoacetic acid	Perfluoroheptane sulfonic acid	10:2 Fluorotelomer sulfonic acid	4:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	N-Methyl perfluorooctane sulfonamidoacetic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	PFHxS and PFOS (Sum of Total) - Lab Calc	8:2 Fluorotelomer sulfonic acid	N-Ethyl perfluorooctane sulfonamide	N-Ethyl perfluorooctane sulfonamidoethanol	N-Methyl perfluorooctane sulfonamide	N-Methyl perfluorooctane sulfonamidoethanol	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluoropentane sulfonic acid	Perfluorobutanoic acid	Perfluorodecanoic acid	Perfluorodecane sulfonic acid	Perfluorododecanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorononanoic acid	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctane sulfonamide (FOSA)	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFAS (Sum of Total)	PFAS (Sum of Total)(WA DER List)
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL			0.0005	0.0002	0.0002	0.0005	0.0005	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.005	0.0005	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002
FSANZ - Tolerable daily intake guideline												0.14							1.12															
Location Code	Field ID	Date																																
BH01	BH01_0.5	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	BH02_1.0	24/01/2018	<0.0005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
BH03	BH03_1.0	24/01/2018	<0.0005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
BH04	BH04_0.5	24/01/2018	<0.0005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
BH05	BH05_0.5	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06	BH06_0.5	24/01/2018	<0.0005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
BH07	BH07_1.0	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH08	BH08_1.0	24/01/2018	<0.0005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
BH09	BH09_1.0	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH10	BH10_0.5	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	BH11_0.5	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	BH12_0.5	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	BH12_1.0	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	BH13_0.5	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	BH13_1.0	24/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	BH14_0	1/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	BH14_0.5	1/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	BH15_0.5	1/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	BH15_1.0	1/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P33	P33_0.2-0.4	30/11/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P33	P33_0.5-0.7	30/11/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P33	P33_4.0-4.2	30/11/2017	-	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01

			PFAS			
			Perfluorohexane sulfonic acid (PFHxS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluorooctane sulfonic acid (PFOS)
			µg/L	µg/L	µg/L	µg/L
EQL			0.01	0.05	0.01	0.01
FSANZ - PFAS Recrational water quality guideline			0.7		5.6	0.7
Location Code	**Field ID**	**Date**				
P33	P33	10/01/2018	<0.01	<0.05	<0.01	<0.01

LEGEND

- Parafield Airport
- Off-Site Investigation Area
- Roads
- Railways
- Watercourses

Paper Size A3

0 125 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Offsite Groundwater Bore Use Survey and
Additional Groundwater Investigation

Job Number	33-19051
Revision	A
Date	28 Mar 2019

Water Survey Area Locations

Figure 3

N:\AU\Sydney\GIS\Admin\Temp\KatrinaVelasco\Projects\3319051\GIS\Maps\Deliverables\33_19051_Z001_WaterSurveyAreaLocations.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

LEGEND

- Phase 1 Groundwater Monitoring Wells
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Groundwater Contours (mAHD)
- Roads
- Railways
- Watercourses

Paper Size A3

0 130 260 520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Offsite Groundwater Bore Use Survey and Additional Groundwater Investigation

Job Number	33-19051
Revision	A
Date	28 Mar 2019

Groundwater Contour Plan

Figure 5

N:\AU\Sydney\GIS\Admin\Temp\KatrinaVelasco\Projects\3319051\GIS\Maps\Deliverables\33_19051_Z008_GWContours_March19GME.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

Analytical Results Tables
Table 1 - Phase 1 Groundwater Results

				PFAS											
				Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluoro-n-hexadecanoic acid (PFHxDA)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL				0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.005	0.002	0.001	0.001	0.001
PFAS NEMP 2018 Freshwater 95%								0.13							220
PFAS NEMP 2018 Health Drinking Water						0.07		0.07							0.56
PFAS NEMP 2018 Health Recreational Water						0.7		0.7							5.6
Date	**Field ID**	**Sample Type**	**Matrix Type**												
15/11/2018	P9	Normal	Water	0.004	0.0016	0.027	<0.001	0.013	<0.001	<0.002	<0.005	<0.002	<0.001	<0.001	<0.001
6/12/2018	P34	Normal	Water	0.014	0.014	0.12	0.0017	0.030	<0.001	<0.002	<0.005	0.0024	0.015	0.0014	0.0023
6/12/2018	P35	Normal	Water	0.0042	0.0030	0.027	<0.001	0.037	<0.001	<0.002	0.0075	<0.002	0.0028	0.0014	0.0063
6/12/2018	P36	Normal	Water	0.015	0.0078	0.085	0.0013	0.055	<0.001	<0.002	0.017	0.019	0.021	0.012	0.024
6/12/2018	P37	Normal	Water	0.0052	0.0043	0.037	<0.001	0.043	<0.001	<0.002	<0.005	<0.002	0.0037	0.0025	0.0028
6/12/2018	P38	Normal	Water	0.011	0.0027	0.019	<0.001	0.013	<0.001	<0.002	0.013	0.0023	0.0035	0.0022	0.0041
6/12/2018	P39	Normal	Water	0.0048	0.0015	0.0094	<0.001	0.0035	<0.001	<0.002	0.010	0.021	0.029	0.0066	0.0098

				PFAS											
				Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL				0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.002	0.002	0.005	0.005	0.002
PFAS NEMP 2018 Freshwater 95%															
PFAS NEMP 2018 Health Drinking Water															
PFAS NEMP 2018 Health Recreational Water															
Date	**Field ID**	**Sample Type**	**Matrix Type**												
15/11/2018	P9	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
6/12/2018	P34	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
6/12/2018	P35	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
6/12/2018	P36	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
6/12/2018	P37	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
6/12/2018	P38	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
6/12/2018	P39	Normal	Water	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002

				PFAS						
				N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Sum of PFHxS and PFOS	Perfluorooctadecanoic acid (PFODA)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL				0.002	0.001	0.001	0.001	0.001	0.001	0.005
PFAS NEMP 2018 Freshwater 95%										
PFAS NEMP 2018 Health Drinking Water									0.07	
PFAS NEMP 2018 Health Recreational Water									0.7	
Date	**Field ID**	**Sample Type**	**Matrix Type**							
15/11/2018	P9	Normal	Water	<0.002	<0.001	<0.001	<0.001	<0.001	0.04	<0.005
6/12/2018	P34	Normal	Water	<0.002	<0.001	0.048	<0.001	<0.001	0.15	<0.005
6/12/2018	P35	Normal	Water	<0.002	<0.001	0.044	<0.001	<0.001	0.064	<0.005
6/12/2018	P36	Normal	Water	<0.002	<0.001	0.013	<0.001	<0.001	0.14	<0.005
6/12/2018	P37	Normal	Water	<0.002	<0.001	0.086	<0.001	<0.001	0.08	<0.005
6/12/2018	P38	Normal	Water	<0.002	<0.001	0.093	<0.001	<0.001	0.032	<0.005
6/12/2018	P39	Normal	Water	<0.002	<0.001	0.13	<0.001	<0.001	0.0129	<0.005

Analytical Results Tables
Table 2 - Phase 2 (February) Groundwater Results

				PFAS											
				Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluoro-n-hexadecanoic acid (PFHxDA)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL				0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.005	0.002	0.001	0.001	0.001
PFAS NEMP 2018 Freshwater 95%								0.13							220
PFAS NEMP 2018 Health Drinking Water						0.07		0.07							0.56
PFAS NEMP 2018 Health Recreational Water						0.7		0.7							5.6
Date	**Sample ID**	**Sample Type**	**Matrix Type**												
7/02/2019	P40	Normal	Water	0.0037	0.0029	0.037	<0.002	0.020	<0.001	<0.002	0.018	0.024	0.035	0.013	0.030
7/02/2019	P41	Normal	Water	0.0092	0.0095	0.074	<0.002	0.032	<0.001	<0.002	0.0084	0.0076	0.010	0.0036	0.0048
7/02/2019	P42	Normal	Water	0.0074	0.0072	0.075	<0.002	0.043	<0.001	<0.002	0.026	0.0079	0.014	0.0037	0.0055
7/02/2019	P43	Normal	Water	0.0039	0.0040	0.050	0.0033	0.24	<0.001	<0.002	0.0071	<0.002	0.0047	<0.002	0.0031
7/02/2019	P44	Normal	Water	0.11	0.16	1.3	0.013	0.072	<0.001	<0.002	0.029	0.038	0.26	0.033	0.051

	PFAS											
	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.002	0.002	0.005	0.005	0.002
PFAS NEMP 2018 Freshwater 95%												
PFAS NEMP 2018 Health Drinking Water												
PFAS NEMP 2018 Health Recreational Water												

Date	Sample ID	Sample Type	Matrix Type	PFNA	PFDA	PFUnDA	PFDoDA	PFTrDA	PFTeDA	FOSA	MeFOSA	EtFOSA	MEFOSE	EtFOSE	MeFOSAA
7/02/2019	P40	Normal	Water	<0.002	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
7/02/2019	P41	Normal	Water	<0.002	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
7/02/2019	P42	Normal	Water	<0.002	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
7/02/2019	P43	Normal	Water	<0.002	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002
7/02/2019	P44	Normal	Water	<0.002	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.005	<0.005	<0.002

				PFAS						
				N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Sum of PFHxS and PFOS	Perfluorooctadecanoic acid (PFODA)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL				0.002	0.001	0.001	0.001	0.001	0.001	0.005
PFAS NEMP 2018 Freshwater 95%										
PFAS NEMP 2018 Health Drinking Water									0.07	
PFAS NEMP 2018 Health Recreational Water									0.7	
Date	Sample ID	Sample Type	Matrix Type							
7/02/2019	P40	Normal	Water	<0.002	<0.001	0.020	<0.001	<0.001	0.057	<0.005
7/02/2019	P41	Normal	Water	<0.002	<0.001	0.033	<0.001	<0.001	0.106	<0.005
7/02/2019	P42	Normal	Water	<0.002	<0.001	0.0043	<0.001	<0.001	0.118	<0.005
7/02/2019	P43	Normal	Water	<0.002	<0.001	0.13	<0.001	<0.001	0.29	<0.005
7/02/2019	P44	Normal	Water	<0.002	<0.001	0.017	<0.001	<0.001	1.372	<0.005

				PFAS										
				PFNS (68259-12-1)	8:2 Polyfluoroalkyl phosphate diester (8:2 diPAP)	FOUEA (2H-Perfluoro-2-decenoic acid (8:2))	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluoro-n-hexadecanoic acid (PFHxDA)	Perfluorobutanoic acid (PFBA)
				ug/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL					0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.005
PFAS NEMP 2018 Freshwater 95%											0.13			
PFAS NEMP 2018 Health Drinking Water									0.07		0.07			
PFAS NEMP 2018 Health Recreational Water									0.7		0.7			
Date	**Sample ID**	**Sample Type**	**Matrix Type**											
14/03/2019	GWP1-PFC	Normal	Water	<0.001	<0.02	<0.001	0.0056	0.0051	0.039	<0.001	0.011	<0.001	<0.002	<0.005
14/03/2019	GWP2-PFC	Normal	Water	<0.001	<0.02	<0.001	0.0082	0.0075	0.068	<0.001	0.039	<0.001	<0.002	<0.005
14/03/2019	GWP3-PFC	Normal	Water	<0.001	<0.02	<0.001	0.0018	0.0011	0.0065	<0.001	0.018	<0.001	<0.002	0.0083
14/03/2019	P9	Normal	Water	<0.001	<0.02	<0.001	0.0037	0.0017	0.019	<0.001	0.0057	<0.001	<0.002	<0.005
14/03/2019	P34	Normal	Water	<0.001	<0.02	<0.001	0.018	0.017	0.14	0.0019	0.025	<0.001	<0.02	<0.005
14/03/2019	P35	Normal	Water	<0.01	<0.02	<0.01	<0.01	<0.01	0.024	<0.01	0.037	<0.01	<0.02	<0.05
14/03/2019	P36	Normal	Water	<0.001	<0.02	<0.001	0.015	0.0088	0.084	0.0012	0.05	<0.001	<0.002	0.016
14/03/2019	P40	Normal	Water	<0.001	<0.02	<0.001	0.0035	0.0027	0.038	<0.001	0.032	<0.001	<0.02	0.018
14/03/2019	P41	Normal	Water	<0.001	<0.02	<0.001	0.0097	0.0096	0.082	0.0011	0.021	<0.001	<0.02	0.0081
14/03/2019	P42	Normal	Water	<0.001	<0.05	<0.001	0.0084	0.0077	0.077	0.0016	0.035	<0.001	<0.02	0.0068
14/03/2019	P43	Normal	Water	<0.001	<0.02	<0.001	0.0035	0.0034	0.023	<0.001	0.029	<0.001	<0.02	<0.005
14/03/2019	P44	Normal	Water	<0.001	<0.02	<0.001	0.12	0.17	1.6	0.017	0.058	<0.001	<0.02	0.028

Analytical Results Tables
Table 3 - Phase 2 (March) Groundwater Results

			PFAS												
			Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.002	0.002
PFAS NEMP 2018 Freshwater 95%						220									
PFAS NEMP 2018 Health Drinking Water						0.56									
PFAS NEMP 2018 Health Recreational Water						5.6									
Date	**Sample ID**	**Sample Type**													
14/03/2019	GWP1-PFC	Normal	<0.002	0.0037	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.02	<0.02
14/03/2019	GWP2-PFC	Normal	<0.002	0.0033	0.0011	0.0015	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002
14/03/2019	GWP3-PFC	Normal	<0.002	<0.001	<0.001	0.0015	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.02	<0.02
14/03/2019	P9	Normal	<0.002	<0.001	0.0063	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.02	<0.02
14/03/2019	P34	Normal	0.0029	0.015	0.0011	0.0012	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.02
14/03/2019	P35	Normal	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01	<0.02	<0.02
14/03/2019	P36	Normal	0.023	0.027	0.019	0.019	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002
14/03/2019	P40	Normal	0.028	0.037	0.012	0.028	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.02
14/03/2019	P41	Normal	0.0096	0.0097	0.0072	0.004	<0.001	<0.001	<0.001	<0.001	<0.002	<0.02	<0.001	<0.02	<0.02
14/03/2019	P42	Normal	0.0059	0.011	0.0036	0.0074	<0.001	<0.001	<0.001	<0.001	<0.002	<0.02	<0.001	<0.02	<0.02
14/03/2019	P43	Normal	<0.002	<0.001	<0.001	0.0013	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.02	<0.02
14/03/2019	P44	Normal	0.043	0.29	0.035	0.05	<0.001	<0.001	<0.001	<0.001	<0.002	<0.02	<0.001	<0.02	<0.02

			PFAS									
			N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Sum of PFHxS and PFOS	Perfluorooctadecanoic acid (PFODA)
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			0.005	0.005	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.005
PFAS NEMP 2018 Freshwater 95%												
PFAS NEMP 2018 Health Drinking Water											0.07	
PFAS NEMP 2018 Health Recreational Water											0.7	
Date	**Sample ID**	**Sample Type**										
14/03/2019	GWP1-PFC	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.0057	<0.001	<0.001	0.05	<0.005
14/03/2019	GWP2-PFC	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.019	<0.001	<0.001	0.107	<0.005
14/03/2019	GWP3-PFC	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.023	<0.001	<0.001	0.0245	<0.005
14/03/2019	P9	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.0078	<0.001	<0.001	0.0247	<0.005
14/03/2019	P34	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.0087	<0.001	<0.001	0.165	<0.005
14/03/2019	P35	Normal	<0.05	<0.05	<0.01	<0.01	<0.01	0.065	<0.01	<0.01	0.061	<0.05
14/03/2019	P36	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	0.134	<0.005
14/03/2019	P40	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.25	<0.001	<0.001	0.07	<0.005
14/03/2019	P41	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.19	<0.001	<0.001	0.103	<0.005
14/03/2019	P42	Normal	<0.005	<0.05	<0.002	<0.02	<0.001	0.024	<0.001	<0.001	0.112	<0.05
14/03/2019	P43	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.0061	<0.001	<0.001	0.052	<0.05
14/03/2019	P44	Normal	<0.005	<0.005	<0.002	<0.002	<0.001	0.031	<0.001	<0.001	1.658	<0.05

Analytical Results Tables
Table 4 - Phase 2 (May) Groundwater Results

				PFAS													
				Perfluorobutane sulfonic acid (PFBS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL				0.02	0.02	0.01	0.1	0.02	0.02	0.02	0.01	0.05	0.05	0.05	0.05	0.01	0.01
PFAS NEMP 2018 Freshwater 95%						0.13					220						
PFAS NEMP 2018 Health Drinking Water						0.07					0.56					0.07	
PFAS NEMP 2018 Health Recreational Water						0.7					5.6					0.7	
Date	**Sample ID**	**Sample Type**	**Matrix Type**														
13/05/2019	GWP1-PFC	Normal	water	<0.02	0.04	0.02	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.06	0.06
13/05/2019	GWP2-PFC	Normal	water	<0.02	<0.02	0.03	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.03	0.03
13/05/2019	GWP3-PFC	Normal	water	<0.02	0.07	0.05	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.12	0.12
13/05/2019	P34	Normal	water	0.03	0.14	0.04	<0.1	<0.02	0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.18	0.23
13/05/2019	P35	Normal	water	<0.02	0.03	0.04	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.07	0.07
13/05/2019	P36	Normal	water	0.03	0.10	0.07	<0.1	0.02	0.03	<0.02	0.02	<0.05	<0.05	<0.05	<0.05	0.17	0.27
13/05/2019	P37	Normal	water	<0.02	0.04	0.04	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.08	0.08
13/05/2019	P40	Normal	water	<0.02	0.03	0.03	<0.1	0.03	0.05	<0.02	0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.19
13/05/2019	P41	Normal	water	0.02	0.12	0.05	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.17	0.19
13/05/2019	P42	Normal	water	0.02	0.09	0.07	<0.1	<0.02	<0.02	<0.02	0.02	<0.05	<0.05	<0.05	<0.05	0.16	0.20
13/05/2019	P43	Normal	water	<0.02	0.03	0.04	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.07	0.07
13/05/2019	P44	Normal	water	0.14	1.74	0.13	<0.1	0.05	0.37	0.05	0.08	<0.05	<0.05	<0.05	<0.05	1.87	2.56

			Inorganics				Metal	PFAS					
			pH (Initial)	pH (Final)	TCLP Fluid	Soil pH	Total Solids	PFNS (68259-12-1)		8:2 Polyfluoroalkyl phosphate diester (8:2 diPAP)		FOUEA (2H-Perfluoro-2-decenoic acid (8:2))	
			pH Units	pH Units	PH	PH	mg/kg	mg/kg	ug/L	mg/kg	µg/L	mg/kg	µg/L
EQL							1,000			0.002		0.001	
PFAS NEMP 2018 Health Drinking Water													
PFAS NEMP 2018 Health Industrial/Commercial													
Location Code	**Date**	**Field ID**											
HA01	14/03/2019	HA-0-0.1	5	5	4.93	5	948,000	<0.001	<0.01	<0.002	<0.02	<0.001	<0.01
HA01	14/03/2019	HA-0.1-0.2	5	5	4.93	5	928,000	<0.001	<0.01	<0.002	<0.02	<0.001	<0.01

			Perfluorobutane sulfonic acid (PFBS)		Perfluoropentane sulfonic acid (PFPeS)		Perfluorohexane sulfonic acid (PFHxS)		Perfluoroheptane sulfonic acid (PFHpS)		Perfluorooctane sulfonic acid (PFOS)		Perfluorodecanesulfonic
			mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
EQL			0.001		0.001		0.001		0.001		0.002		
PFAS NEMP 2018 Health Drinking Water								0.07				0.07	
PFAS NEMP 2018 Health Industrial/Commercial							20				20		
Location Code	**Date**	**Field ID**											
HA01	14/03/2019	HA-0-0.1	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.002	<0.02	<0.001
HA01	14/03/2019	HA-0.1-0.2	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.002	0.024	<0.001

			PFAS										
			acid (PFDS)	Perfluoro-n-hexadecanoic acid (PFHxDA)		Perfluorobutanoic acid (PFBA)		Perfluoropentanoic acid (PFPeA)		Perfluorohexanoic acid (PFHxA)		Perfluoroheptanoic acid (PFHpA)	
			µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL				0.002				0.002		0.001		0.001	
PFAS NEMP 2018 Health Drinking Water													
PFAS NEMP 2018 Health Industrial/Commercial													
Location Code	**Date**	**Field ID**											
HA01	14/03/2019	HA-0-0.1	<0.01	<0.002	<0.02	<0.002	<0.05	<0.002	<0.02	<0.001	<0.01	<0.001	<0.01
HA01	14/03/2019	HA-0.1-0.2	<0.01	<0.002	<0.02	0.0027	<0.05	<0.002	<0.02	<0.001	<0.01	<0.001	<0.01

			PF										
			Perfluorooctanoic acid (PFOA)		Perfluorononanoic acid (PFNA)		Perfluorodecanoic acid (PFDA)		Perfluoroundecanoic acid (PFUnDA)		Perfluorododecanoic acid (PFDoDA)		Perfluorotridecanoic acid
			mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
EQL			0.001		0.001		0.001		0.002		0.002		0.002
PFAS NEMP 2018 Health Drinking Water				0.56									
PFAS NEMP 2018 Health Industrial/Commercial			50										
Location Code	**Date**	**Field ID**											
HA01	14/03/2019	HA-0-0.1	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.002	<0.01	<0.002	<0.01	<0.002
HA01	14/03/2019	HA-0.1-0.2	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.002	<0.01	<0.002	<0.01	<0.002

			AS										
			(PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)		Perfluorooctane sulfonamide (FOSA)		N-Methyl perfluorooctane sulfonamide (MeFOSA)		N-Ethyl perfluorooctane sulfonamide (EtFOSA)		N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	
			µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL				0.002		0.001		0.002		0.002		0.005	
PFAS NEMP 2018 Health Drinking Water													
PFAS NEMP 2018 Health Industrial/Commercial													
Location Code	**Date**	**Field ID**											
HA01	14/03/2019	HA-0-0.1	<0.02	<0.002	<0.02	<0.001	<0.01	<0.002	<0.02	<0.002	<0.02	<0.005	<0.05
HA01	14/03/2019	HA-0.1-0.2	<0.02	<0.002	<0.02	<0.001	<0.01	<0.002	<0.02	<0.002	<0.02	<0.005	<0.05

	PFAS										
	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)		N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)		N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)		4:2 Fluorotelomer sulfonic acid (4:2 FTS)		6:2 Fluorotelomer Sulfonate (6:2 FTS)		8:2 Fluorotelomer
	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
EQL	0.005		0.002		0.002		0.001		0.001		0.001
PFAS NEMP 2018 Health Drinking Water											
PFAS NEMP 2018 Health Industrial/Commercial											

Location Code	Date	Field ID											
HA01	14/03/2019	HA-0-0.1	<0.005	<0.05	<0.002	<0.01	<0.002	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001
HA01	14/03/2019	HA-0.1-0.2	<0.005	<0.05	<0.002	<0.01	<0.002	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001

			sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)		Sum of PFHxS and PFOS		Perfluorooctadecanoic acid (PFODA)	
			µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL				0.002				0.005	
PFAS NEMP 2018 Health Drinking Water							0.07		
PFAS NEMP 2018 Health Industrial/Commercial						20			
Location Code	**Date**	**Field ID**							
HA01	14/03/2019	HA-0-0.1	<0.01	<0.002	<0.01	<0.002	<0.02	<0.005	<0.05
HA01	14/03/2019	HA-0.1-0.2	<0.01	<0.002	<0.01	<0.002	0.024	<0.005	<0.05

Analytical Results Tables
Table 9 - Historical Groundwater Results

			PFOS/PFHxS (µg/L)	PFOS (µg/L)	PFOA (µg/L)
Criteria	NEMP Drinking Water		0.07		0.56
	NEMP Recreational		0.7		5.6
	Interim Freshwater 95%			0.13	220
Well I.D.	Date	Firm			
BGW3	15/08/2016	GHD	<0.01	<0.01	<0.01
	23/11/2016	GHD	0.01	0.01	<0.01
BGW4	15/08/2016	GHD	0.03*	<0.01	<0.01
GWP1-PFC	27/05/2016	EP	0.061	0.014	<0.005
	31/08/2018	Golder	0.058*	<0.02	<0.01
	14/03/2019	GHD	0.05	0.011	0.0011
	13/05/2019	GHD	0.06	0.02	0.02
GWP2-PFC	27/05/2016	EP	0.055	0.044	<0.005
	31/08/2018	Golder	0.042*	0.032	<0.01
	14/03/2019	GHD	0.107	0.039	0.0015
	24/04/2019	EP	0.0361		0.0036
	13/05/2019	GHD	0.03	0.03	0.03
GWP3-PFC	27/05/2016	EP	0.102	0.03	<0.005
	7/12/2016	GHD	0.11	0.04	<0.01
	13/07/2017	Golder	0.11	0.04	<0.02
	31/08/2018	Golder	0.114*	0.032	<0.01
	14/03/2019	GHD	0.0245	0.018	0.0015
	24/04/2019	EP	0.121		0.004
	13/05/2019	GHD	0.12	0.05	0.05
GWP4-PFC	27/05/2016	EP	0.0057	<0.005	<0.005
GWP5-PFC	15/08/2016	GHD	0.03*	<0.01	<0.01
GWP6-PFC	15/08/2016	GHD	97.7	72.8	1.28
	15/08/2016	GHD	97.7	72.8	1.28
	23/11/2019	GHD	88.7	67.3	1.36
	5/12/2017	GHD	226	180	2.7
P1	14/06/2016	GHD	0.11*	<0.01	0.09
	22/11/2016	GHD	7.99	5.33	0.08
	4/12/2017	GHD	0.51	0.41	<0.01
P3	14/06/2016	GHD	0.25	0.04	<0.01
	22/11/2016	GHD	0.55	0.25	<0.01
P6	14/06/2016	GHD	1.68	0.48	0.05
	15/08/2016	GHD	6.58	4.35	0.05
	23/11/2016	GHD	5.27	3.63	0.05
	4/12/2017	GHD	6.3	4.5	0.07
P8	17/03/2016	EP	0.081	0.013	<0.005
	15/08/2016	GHD	0.07	0.01	<0.01
	22/11/2016	GHD	0.11	0.04	<0.01
P9	15/08/2016	GHD	0.06	0.02	<0.01
	23/11/2016	GHD	0.12	0.06	<0.01
	31/08/2018	Golder	0.04*	<0.02	<0.01
	6/12/2018	GHD	0.04	0.013	<0.001
	14/03/2019	GHD	0.0247	0.0057	<0.001

Analytical Results Tables
Table 9 - Historical Groundwater Results

			PFOS/PFHxS (µg/L)	PFOS (µg/L)	PFOA (µg/L)
Criteria	NEMP Drinking Water		**0.07**		**0.56**
	NEMP Recreational		**0.7**		**5.6**
	Interim Freshwater 95%			**0.13**	**220**
Well I.D.	**Date**	**Firm**			
P10	15/08/2016	GHD	<0.05	<0.05	<0.05
	22/11/2016	GHD	0.1	0.02	<0.01
	5/12/2017	GHD	0.08	<0.01	<0.01
P11	15/08/2016	GHD	7.35	3.44	0.06
	23/11/2016	GHD	15.1	5.65	0.2
	13/07/2017	Golder	5.7	2.8	0.049
P12	24/11/2016	GHD	80.9	65.7	0.79
	5/12/2017	GHD	83	70	0.54
P13	24/11/2016	GHD	33	22.7	0.67
	5/12/2017	GHD	10.1	6.5	0.19
P14	24/11/2016	GHD	3.52	1.52	0.08
	13/07/2017	Golder	1.7	0.84	0.034
	5/12/2017	GHD	1.84	0.91	0.05
P15	24/11/2016	GHD	11.3	6.44	0.16
	13/07/2017	Golder	3.64	0.84	0.066
	6/12/2017	GHD	5.5	2.1	0.11
P16	24/11/2016	GHD	5.22	3.72	0.06
	4/12/2017	GHD	3.7	2.6	0.04
P17	24/11/2016	GHD	<0.01	<0.01	<0.01
	31/08/2018	Golder	0.03*	<0.02	<0.01
P18	24/11/2016	GHD	5.24	3.51	0.05
	13/07/2017	Golder	1.38	0.84	0.022
	4/12/2017	GHD	1.48	1.1	0.03
	31/08/2018	Golder	0.91	0.52	<0.01
P19	5/12/2017	GHD	<0.01	<0.01	<0.01
	31/08/2018	Golder	0.041*	0.031	<0.01
	24/11/2019	GHD	<0.05	<0.05	<0.05
P20	25/11/2016	GHD	<0.05	<0.05	<0.05
	5/12/2017	GHD	<0.01	<0.01	<0.01
P21	25/11/2019	GHD	<0.05	<0.05	<0.05
	5/12/2017	GHD	<0.01	<0.01	<0.01
P22	6/12/2017	GHD	<0.01	<0.01	<0.01
P23	6/12/2017	GHD	<0.01	<0.01	<0.01
P24	5/12/2017	GHD	1.43	0.65	0.04
P25	5/12/2017	GHD	2.9	1.5	0.07
P26	5/12/2017	GHD	6.5	1.9	0.1
P27	5/12/2017	GHD	<0.01	<0.01	<0.01
P28	5/12/2017	GHD	<0.01	<0.01	<0.01
P29	6/12/2017	GHD	<0.01	<0.01	<0.01
P30	6/12/2017	GHD	<0.01	<0.01	<0.01
P31	6/12/2017	GHD	0.27	0.05	<0.01
P32	5/12/2017	GHD	0.39	0.05	<0.01

Figure 2

Sample Location Plan

Tiger Moth Lane,
Parafield SA 5106

Job name: Parafield Airport GME

Prepared for: Adelaide Airport Limited (AAL)

Job number: 19040.01

Drawn: AN
Date: 12/04/2019
Rev: A

environmental projects

Level 3, 117 King William Street,
Adelaide 5000
www.environmentalprojects.com.au

		Perfluorinated Compounds																
		Perfluoroheptane sulfonic acid (PFHpS)	EtPerfluorooctanesulf- amidoacetic acid	4:2 FTS	8:2 FTS	Perfluorobutane sulfonic acid (PFBS)	Perfluorobutanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid	Perfluorooctanesulfonic acid PFOS	Perfluoropentanoic acid	Sum of PFAS (WA DER List)	Sum of PFHxS and PFOS	MePerfluorooctanesulf- amidoacetic acid	N-Et perfluorooctanesulfonamidoethanol	N-Ethyl perfluorooctanesulfonamide	N-Me perfluorooctanesulfonamidoethanol	N-Methyl perfluorooctane sulfonamide
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.0005	0.0005	0.001	0.001	0.0005	0.002	0.0005	0.0005	0.0003	0.0005	0.0003	0.0003	0.0005	0.001	0.001	0.001	0.001
PFAS NEMP 2018 Table 1 Health Drinking Water													0.07					
PFAS NEMP 2018 Table 1 Health Recreational Water													0.7					
PFAS NEMP 2018 Table 5 Freshwater 80%										31								
PFAS NEMP 2018 Table 5 Freshwater 90%										2								
PFAS NEMP 2018 Table 5 Freshwater 95%										0.13								
PFAS NEMP 2018 Table 5 Freshwater 99%										0.00023								
Field ID	**Date**																	
GWP2-PFC	10/04/2019	0.0008	<0.0005	<0.001	<0.001	0.002	<0.002	0.0008	0.0009	0.0267	0.0026	0.0470	0.0361	<0.0005	<0.001	<0.001	<0.001	<0.001
GWP3-PFC	10/04/2019	0.0031	<0.0005	<0.001	<0.001	0.0106	<0.002	0.0014	0.0054	0.0514	0.0010	0.148	0.121	<0.0005	<0.001	<0.001	<0.001	<0.001
P44	10/04/2019	0.0014	<0.0005	<0.001	<0.001	0.006	<0.002	<0.0005	0.0050	0.0162	<0.0005	0.0713	0.0570	<0.0005	<0.001	<0.001	<0.001	<0.001

Environmental Standards

HEPA, Jan 2018, PFAS NEMP 2018 Table 1 Health Drinking Water

HEPA, Jan 2018, PFAS NEMP 2018 Table 1 Health Recreational Water

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 80%

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 90%

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 95%

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 99%

Field ID	Date	Perfluorinated Compounds													
		Perfluorodecanesulfonic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluorononanoic acid	Perfluorooctane sulfonamide	Perfluoropentanesulfonic acid	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFHxS (355-46-4)	Sum of PFAS	10:2 FTS	Perfluorooctanoate (PFOA)	6:2 Fluorotelomer Sulfonate (6:2 FtS)
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	ug/L	ug/L	µg/L	µg/L	µg/L
EQL		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.001	0.0005	0.001
PFAS NEMP 2018 Table 1 Health Drinking Water														0.56	
PFAS NEMP 2018 Table 1 Health Recreational Water														5.6	
PFAS NEMP 2018 Table 5 Freshwater 80%														1824	
PFAS NEMP 2018 Table 5 Freshwater 90%														632	
PFAS NEMP 2018 Table 5 Freshwater 95%														220	
PFAS NEMP 2018 Table 5 Freshwater 99%														19	
GWP2-PFC	10/04/2019	<0.0005	0.0020	<0.0005	0.0013	0.0005	0.0015	<0.0005	<0.0005	<0.0005	0.0094	0.0531	<0.001	0.0036	0.001
GWP3-PFC	10/04/2019	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	0.0092	<0.0005	<0.0005	<0.0005	0.0698	0.16	<0.001	0.004	0.004
P44	10/04/2019	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0068	<0.0005	<0.0005	<0.0005	0.0408	0.0795	<0.001	0.0033	<0.001

Environmental Standards

HEPA, Jan 2018, PFAS NEMP 2018 Table 1 Health Drinking Water

HEPA, Jan 2018, PFAS NEMP 2018 Table 1 Health Recreational Water

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 80%

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 90%

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 95%

HEPA, Jan 2018, PFAS NEMP 2018 Table 5 Freshwater 99%

LEGEND

- Phase 1 Groundwater Monitoring Wells
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Groundwater Contours (mAHD)
- Roads
- Railways
- Watercourses

Paper Size A3

0 130 260 520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Additional Groundwater Investigation - July 2019

Job Number	33-19051
Revision	A
Date	25 Jul 2019

Groundwater Contour Plan - July 2019

Figure 4

N:\AU\Sydney\GIS\Admin\Temp\KatrinaVelasco\Projects\3319051\GIS\Maps\Deliverables\July 2019\33_19051_Z008_GWContours_July2019.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

	PFAS							
	Perfluorohexane sulfonic acid (PFHxS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	Sum of US EPA PFAS (PFOS + PFOA)*
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PFAS NEMP 2018 Freshwater 95%		0.13	220					
PFAS NEMP 2018 Health Drinking Water			0.56				0.07	
PFAS NEMP 2018 Health Recreational Water			5.6				0.7	
Field ID								
P45	1.1	0.03	0.02	<0.01	<0.01	1.1	1.1	0.06
P46	0.01	0.03	<0.01	<0.01	<0.01	0.04	0.04	0.03
P47	0.03	0.03	<0.01	<0.01	<0.01	0.06	0.06	0.03
P48	0.12	0.02	<0.01	<0.01	<0.01	0.14	0.14	0.02

Analytical Results Tables
Table 9 - Historical Groundwater Results

			PFOS/PFHxS (µg/L)	PFOS (µg/L)	PFOA (µg/L)
Criteria	NEMP Drinking Water		0.07		0.56
	NEMP Recreational		0.7		5.6
	Interim Freshwater 95%			0.13	220
Well I.D.	Date	Firm			
P33	3/05/2018	EP	0.84	0.57	0.023
	31/08/2018	Golder	0.57	0.29	<0.01
P34	6/12/2018	GHD	0.15	0.03	0.0023
	14/03/2019	GHD	0.165	0.025	0.0012
	13/05/2019	GHD	0.18	0.04	0.04
P35	6/12/2018	GHD	0.064	0.037	0.0063
	14/03/2019	GHD	0.061	0.037	<0.01
	13/05/2019	GHD	0.07	0.04	0.04
P36	6/12/2018	GHD	0.14	0.055	0.024
	14/03/2019	GHD	0.134	0.05	0.019
	13/05/2019	GHD	0.17	0.07	0.07
P37	6/12/2018	GHD	0.08	0.043	0.0028
	13/05/2019	GHD	0.08	0.04	0.04
P38	6/12/2018	GHD	0.032	0.013	0.0041
P39	6/12/2018	GHD	0.0129	0.0035	0.0098
P40	7/02/2019	GHD	0.057	0.02	0.03
	14/03/2019	GHD	0.07	0.032	0.028
	13/05/2019	GHD	0.06	0.03	0.03
P41	7/02/2019	GHD	0.106	0.032	0.0048
	14/03/2019	GHD	0.103	0.021	0.004
	13/05/2019	GHD	0.17	0.05	0.05
P42	7/02/2019	GHD	0.118	0.043	0.0055
	14/03/2019	GHD	0.112	0.035	0.0074
	13/05/2019	GHD	0.16	0.07	0.07
P43	7/02/2019	GHD	0.29	0.24	0.0031
	14/03/2019	GHD	0.052	0.029	0.0013
	13/05/2019	GHD	0.07	0.04	0.04
P44	7/02/2019	GHD	1.372	0.072	0.051
	14/03/2019	GHD	1.658	0.058	0.05
	24/04/2019	EP	0.057		<0.001
	13/05/2019	GHD	1.87	0.13	0.13

* = One or more results reported below LOR. Results below LOR were given the value of the LOR.

LEGEND

- Groundwater Wells Installed August 2019 (P49 – P52)
- Phase 1 Groundwater Monitoring Wells
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Roads
- Railways
- Watercourses

Paper Size A3

0 137.5 275 550

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Parafield Airport Well Installation and Sampling
August – September 2019

Job Number	33-19051
Revision	A
Date	17 Sep 2019

Groundwater Monitoring Well Locations

Figure 2

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\33_19051_Z005_GroundwaterMonitoringWellLocations.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

LEGEND

- Groundwater Wells Installed August 2019 (P49)
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Roads
- Railways
- Watercourses

Paper Size A3

0 15 30 60

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Parafield Airport Well Installation and Sampling
August – September 2019

Job Number	33-19051
Revision	A
Date	17 Sep 2019

Groundwater Monitoring Well Locations

Figure 2a

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\33_19051_Z005a_GroundwaterMonitoringWellLocations.mxd

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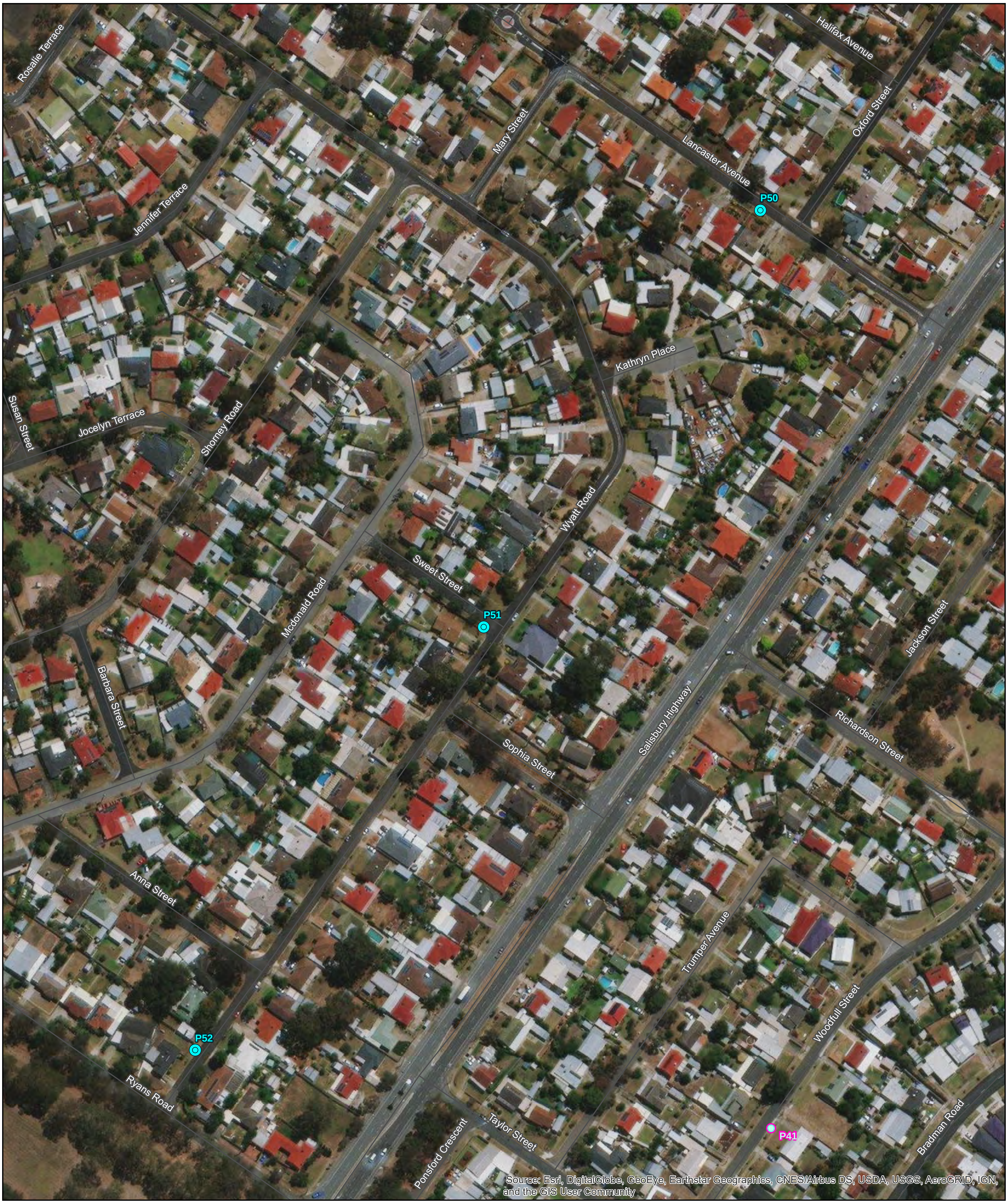
Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin



LEGEND

- Groundwater Wells Installed August 2019 (P50-P52)
- Roads
- Phase 2 Groundwater Monitoring Wells

Paper Size A3

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Parafield Airport Well Installation and Sampling
August – September 2019

Job Number	33-19051
Revision	A
Date	17 Sep 2019

Groundwater Monitoring Well Locations

Figure 2b

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\33_19051_Z005b_GroundwaterMonitoringWellLocations.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

Table 1
Groundwater Analytical Results

Parafield Airport

		PFAS							
		Perfluorohexane sulfonic acid (PFHxS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	Sum of US EPA PFAS (PFOS + PFOA)*
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PFAS NEMP 2018 Health Drinking Water				0.56				0.07	
PFAS NEMP 2018 Health Recreational Water				5.6				0.7	
PFAS NEMP 2018 Freshwater & Interim Marine 95%			0.13	220					
Field ID	**Date**								
P49	3/09/2019	0.38	0.05	0.03	<0.01	<0.01	0.45	0.42	0.07
P50	3/09/2019	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01
P51	3/09/2019	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01
P52	3/09/2019	0.02	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01

LEGEND

- Groundwater Wells Installed October 2019 (P53 - P55)
- Groundwater Wells Installed August 2019 (P49 – P52)
- Phase 1 Groundwater Monitoring Wells
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Roads
- Railways
- Watercourses

Paper Size A3

0 140 280 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Parafield Airport SAQP Groundwater Well Installation
and Sampling October - November 2019

Job Number	33-19051
Revision	A
Date	06 Nov 2019

Groundwater Monitoring Well Locations

Figure 2

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\November 2019\33_19051_Z005_GroundwaterMonitoringWellLocations.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

LEGEND

- Groundwater Wells Installed October 2019 (P53 - P55)
- Groundwater Wells Installed August 2019 (P49)
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Roads
- Railways
- Watercourses

Paper Size A3

0 15 30 60

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Parafield Airport Groundwater Well Installation and Sampling
October - November 2019

Groundwater Monitoring Well Locations (zoomed)

Job Number	33-19051
Revision	A
Date	06 Nov 2019

Figure 2a

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\November 2019\33_19051_Z016_GroundwaterMonitoringWellLocationsZoom.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

		PFAS							
		Perfluorohexane sulfonic acid (PFHxS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	Sum of US EPA PFAS (PFOS + PFOA)*
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PFAS NEMP 2018 Health Drinking Water				0.56				0.07	
PFAS NEMP 2018 Health Recreational Water				5.6				0.7	
PFAS NEMP 2018 Freshwater and Interim Marine 95%			0.13	220					
Date	**Field ID**								
1/11/2019	P53	0.02	0.04	<0.01	<0.01	<0.01	0.06	0.06	0.04
1/11/2019	P54	0.13	0.06	0.01	<0.01	<0.01	0.20	0.19	0.07
1/11/2019	P55	0.02	0.03	<0.01	<0.01	<0.01	0.05	0.05	0.03

LEGEND

- Groundwater Wells Installed December 2019 (P56 - P57)
- Groundwater Wells Installed October 2019 (P53 – P55)
- Groundwater Wells Installed August 2019 (P49 – P52)
- Phase 1 Groundwater Monitoring Wells
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Roads
- Railways
- Watercourses

Paper Size A3

0 137.5 275 550

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Parafield Airport SAQP Groundwater Well Installation
and Sampling December 2019

Job Number	33-19051
Revision	A
Date	06 Jan 2020

Groundwater Monitoring Well Locations

Figure 2

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\December 2019\33_19051_Z005_GroundwaterMonitoringWellLocations.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

LEGEND

- Groundwater Wells Installed December 2019 (P56 - P57)
- Groundwater Wells Installed October 2019 (P53 - P55)
- Groundwater Wells Installed August 2019 (P49)
- Phase 2 Groundwater Monitoring Wells
- Existing Groundwater Wells
- Roads
- Railways
- Watercourses

Paper Size A3

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Parafield Airport Groundwater Well Installation and Sampling December 2019

Groundwater Monitoring Well Locations (zoomed)

Job Number	33-19051
Revision	A
Date	06 Jan 2020

Figure 2a

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\December 2019\33_19051_Z016_ProposedMonitoringWellLocationsZoom.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

		PFAS							
		Perfluorohexane sulfonic acid (PFHxS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	Sum of US EPA PFAS (PFOS + PFOA)*
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PFAS NEMP 2018 Health Drinking Water				0.56				0.07	
PFAS NEMP 2018 Health Recreational Water				10				2	
PFAS NEMP 2018 Freshwater 95%			0.13	220					
Date	**Field ID**								
13/12/2019	P56	0.18	0.04	0.01	<0.01	<0.01	0.24	0.22	0.06
13/12/2019	P57	0.20	0.05	0.01	<0.01	<0.01	0.26	0.25	0.07

LEGEND

Groundwater Wells Installed February 2020 (P58 - P59)	Groundwater Wells Installed October 2019 (P53 - P55)	Phase 1 Groundwater Monitoring Wells
Groundwater Wells Sampled February 2020 (MW15)	Groundwater Wells Installed August 2019 (P49 – P52)	Phase 2 Groundwater Monitoring Wells
Groundwater Wells Installed December 2019 (P56 - P57)		Existing Groundwater Wells

Roads
Railways
Watercourses

Paper Size A3

0 137.5 275 550

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Adelaide Airport Limited
Parafield Airport Groundwater Well Installation and Sampling February 2020

Job Number 33-19051
Revision A
Date 11 Mar 2020

Groundwater Monitoring Well Locations

Figure 2

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\February 2020\33_19051_Z005_GroundwaterMonitoringWellLocations.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

LEGEND

- Groundwater Wells Installed February 2020 (P58 - P59)
- Groundwater Wells Sampled February 2020 (MW15)
- Groundwater Wells Installed December 2019 (P56 - P57)
- Roads
- Railways

Paper Size A3

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Parafield Airport

Adelaide Airport Limited
Parafield Airport Groundwater Well Installation and Sampling February 2020

Groundwater Monitoring Well Locations (zoomed)

Job Number	33-19051
Revision	A
Date	04 Mar 2020

Figure 2a

N:\AU\Adelaide\Projects\33\19051\GIS\Maps\Deliverables\February 2020\33_19051_Z005_GroundwaterMonitoringWellLocationsZoom.mxd

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Data source: Aerial Imagery - Esri Imagery Basemap (Extracted 12 November 2018). Adelaide Airport Limited, Lot boundaries and Showroom and Convenience Supermarket Building locations, 2016. Created by:dbbanatin

Table 1
Groundwater Analytical Results February 2020

		PFAS													
		Perfluorobutane sulfonic acid (PFBS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanoic acid (PFHxA)	Perfluorooctanoic acid (PFOA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.02	0.02	0.01	0.1	0.02	0.02	0.02	0.01	0.05	0.05	0.05	0.05	0.01	0.01
PFAS NEMP 2018 Freshwater 95%				0.13					220						
PFAS NEMP 2018 Health Drinking Water									0.56					0.07	
NHMRC 2019 Health Recreational Water									10					2	
Date	**Field ID**														
25/02/2020	MW15	<0.02	<0.02	0.01	<0.1	<0.02	<0.02	<0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.01	0.01
25/02/2020	P58	0.02	0.12	0.03	<0.1	<0.02	<0.02	0.04	<0.01	<0.05	<0.05	<0.05	<0.05	0.15	0.21
25/02/2020	P59	<0.02	0.08	0.04	<0.1	<0.02	<0.02	0.02	<0.01	<0.05	<0.05	<0.05	<0.05	0.12	0.14

Environmental Standards
HEPA, January 2018, PFAS NEMP 2018 Freshwater 95%
HEPA, January 2018, PFAS NEMP 2018 Health Drinking Water
HEPA, January 2018, PFAS NEMP 2018 Health Recreational Water

Groundwater PFOS + PFHxS

- Non detect
- Below FSANZ DW (0.07µg/L)
- Below FSANZ recreational (0.7µg/L)
- Below enRisks derived incidental contact (7µg/L)
- Exceeds 7µg/L

Chemical Table

		PFAS																	
		Perfluoroheptane sulfonic acid (PFHpS)	EtPerfluorooctanesulf-amid oacetic acid	4:2 FTS	8:2 FTS	Perfluorobutane sulfonic acid (PFBS)	Perfluorobutanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid	Perfluorooctanesulfonic acid PFOS	Perfluoropentanoic acid	Sum of PFAS (WA DER List)	Sum of PFHxS and PFOS	MePerfluorooctanesulf-amid oacetic acid	N-Et perfluorooctanesulfonamid oethanol	N-Ethyl perfluorooctanesulfon amide	N-Me perfluorooctanesulfonamid oethanol	N-Methyl perfluorooctane sulfonamide	Perfluorodecanesulfonic acid
		mg/kg	µg/L	µg/L	µg/L	ug/m3	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.00001	0.02	0.01	0.02	10	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.05	0.05	0.05	0.05	0.02
PFAS NEMP 2018 Table 1 Health Drinking Water													0.07						
PFAS NEMP 2018 Table 1 Health Recreational Water													0.7						
PFAS NEMP 2018 Table 5 Freshwater 80%										31									
PFAS NEMP 2018 Table 5 Freshwater 90%										2									
PFAS NEMP 2018 Table 5 Freshwater 95%										0.13									
PFAS NEMP 2018 Table 5 Freshwater 99%										0.00023									
Field ID	**Date**																		
P59	2/07/2020	<0.00002	<0.02	<0.05	<0.05	<20	<0.1	<0.02	0.02	0.06	<0.02	0.18	0.16	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02
P61	2/07/2020	0.00003	<0.02	<0.05	<0.05	20	<0.1	0.03	0.04	0.33	<0.02	0.97	0.66	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02

Chemical Table

			PFAS												Other
		Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluorononanoic acid	Perfluorooctane sulfonamide	Perfluoropentanesulfonic acid	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFHxS (355-46-4)	Sum of PFAS	Total Positive PFOS & PFOA	10:2 FTS	Perfluorooctanoate	6:2 Fluorotelomer Sulfonate (6:2 FtS)
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	ug/L	mg/kg	µg/L	µg/L	mg/L	mg/L
EQL		0.02	0.02	0.01	0.02	0.01	0.05	0.02	0.02	0.01	0.00001	0.01	0.02	0.00001	0.00001
PFAS NEMP 2018 Table 1 Health Drinking Water														0.00056	
PFAS NEMP 2018 Table 1 Health Recreational Water														0.0056	
PFAS NEMP 2018 Table 5 Freshwater 80%														1.82	
PFAS NEMP 2018 Table 5 Freshwater 90%														0.632	
PFAS NEMP 2018 Table 5 Freshwater 95%														0.22	
PFAS NEMP 2018 Table 5 Freshwater 99%														0.019	
Field ID	**Date**														
P59	2/07/2020	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.02	0.10	0.00018		<0.05	<0.00001	<0.00005
P61	2/07/2020	<0.02	<0.02	<0.02	<0.02	0.02	<0.05	<0.02	<0.02	0.33	0.00102		<0.05	0.00022	<0.00005

PART 2. fillets v whole fish.

Goonan, Peter (EPA)

From: Crough, Robert [Robert.Crough@measurement.gov.au]
Sent: Friday, 2 November 2012 3:40 PM
To: Thomas, Shaun (EPA); Goonan, Peter (EPA)
Cc: dioxins
Subject: Certificates DAU12_185, DAU12_186, DAU12_195 & DAU12_196 for the PFC analysis of your fish samples received 31 May 2012 & 28 June 2012. [SEC=DLM-ONLY:For-Official-Use-Only]
Attachments: DAU12_185.pdf; DAU12_186.pdf; DAU12_196.pdf; DAU12_195.pdf

Use data from 5/11 as includes better < DLs for some low-level results but detects not changed

≡ Removed PFBA for results as too poor recovery to accept

Dear Peter,
I have attached the electronic version of our Certificates DAU12_185, DAU12_186, DAU12_195 & DAU12_196 for the PFASs analyses of your fish samples received 31 May 2012 & 28 June 2012. If you have any queries or questions on the results contained within these certificates then please do not hesitate to contact me.

We will send the original certificates and an invoice for this work in the next few days. X paid already

Thank you for using the services of the National Measurement Institute.
Regards,

= Urban stormwater with likely mostly obtained detection + ample range!

ng/g units.

	Fillets	Frames
PAT	1B PFDoA 0.8 PFOS 0.9 2B PFDoA 0.9	1A PFDoA 5.1 PFOS 3.7 2A PFDoA 4.0
WR	X	1A PFDoA 1.7 2A X

Robert

Robert Crough
Chemist
Dioxin Analysis Unit
Chemical & Biological Metrology Branch
National Measurement Institute
Department of Industry, Innovation, Science, Research and Tertiary Education

= All other results < detection levels reported

National Measurement Institute
105 Delhi Rd, Riverside Corporate Park, North Ryde NSW 2113, Australia
PO Box 138, North Ryde NSW 1760, Australia
Ph: 61-2-9449 0114 Fax: 61-2-9449 1653
Email: robert.crough@measurement.gov.au
Internet: http://www.measurement.gov.au
ABN 74 599 608 295

PFDoA = stain proof coating breakdown product

NMI PYMBLE HAS MOVED!
Please use the new delivery address, 105 Delhi Rd, North Ryde, NSW 2113

PFOS = original Scotchguard active ingredient

****

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Compound	Abbreviation	Method detection limit ng/g	Detections (n)	Range (detection concentrations)
PFDoA	PFDoA		2F, 3WF = 5	
PFOS			1F, 1F	

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****

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015834X

Client Sample Ref. PAT1B
Matrix Fish Fillets
Description Patawalonga, ACA BUT (29/05/2012)
Date Extracted 25-Sep-12
DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<1
PFPeA	<1
PFHxA	<0.5
PFHpA	<0.5
PFOA	<0.5
PFNA	<0.5
PFDA	<0.5
PFUdA	<0.5
PFDoA	0.84
PFOS	0.94

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015836X

Client Sample Ref. PAT2B
Matrix Fish Fillets
Description Patawalonga, ACA BUT (11/05/2012 +
Date Extracted 25-Sep-12
DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<1
PFPeA	<1
PFHxA	<0.5
PFHpA	<0.5
PFOA	<0.5
PFNA	<0.5
PFDA	<0.5
PFUdA	<0.5
PFDoA	0.87
PFOS	<0.8

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015834DUP

Client Sample Ref. Duplicate
Matrix Fish Fillets
Description Duplicate Sample
Date Extracted 25-Sep-12
DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<1
PFPeA	<1
PFHxA	<0.5
PFHpA	<0.5
PFOA	<0.5
PFNA	<0.5
PFDA	<0.5
PFUdA	<0.5
PFDoA	1.0
PFOS	0.97

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015834SPK

Client Sample Ref. Spike
Matrix Fish Fillets
Description Spiked Sample - 50 ng/g
Date Extracted 25-Sep-12
DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	18
PFPeA	66
PFHxA	51
PFHpA	75
PFOA	52
PFNA	56
PFDA	50
PFUdA	51
PFDoA	51
PFOS	53

Results : Job No. EPA05/120531

Laboratory Reg. No. BLK L822

Client Sample Ref. Lab Blank
Matrix Blank
Description Lab Blank Batch L822
Date Extracted 25-Sep-12
DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<0.6
PFPeA	<0.3
PFHxA	<0.2
PFHpA	<0.1
PFOA	<0.1
PFNA	<0.07
PFDA	<0.05
PFUdA	<0.07
PFDoA	<0.06
PFOS	<0.005

Australian Government
National Measurement Institute

CERTIFICATE OF ANALYSIS # DAU12_195

Client	South Australian Environmental Protection Authority GPO Box 2607 Adelaide, SA 5001	**Job No.**	EPA05/120531
		Sampled by	Client
		Date Sampled	various
Contact	Peter Goonan	**Date Received**	31-May-12

The results relate only to the sample(s) tested.

Method AUTL_07 **Date Reported** 1-Nov-12

Details

The method is for determination of Perfluoroalkyl substances (PFASs) in biota samples by High Performance Liquid Chromatography tandem Mass Spectrometry (UPLC-MSMS). All results are corrected for labelled surrogates and are reported on a fresh weight basis.

Prior to extraction the sample is spiked with a range of isotopically labelled surrogate standards. Extraction is by organic solvent, with purification using activated silica gel. An aliquot of extract is injected onto the UPLC and detected using mass spectrometry.

Authorisation

Gavin Stevenson
Manager
Dioxin Analysis Unit

Robert Crough
Chemist
Dioxin Analysis Unit

Sample Details : Job No. EPA05/120531			
Laboratory Reg. No.	Client Sample Ref.	Matrix	Description
N12/015825X	WLK1A	Fish Frames	West Lakes, ACA BUT (03/05/2012)
N12/015827X	WLK2A	Fish Frames	West Lakes, ACA BUT (30/04/2012 + 15/05/2012)
N12/015829X	PTR1A	Fish Frames	Port River, ACA BUT (02/05/2012)
N12/015831X	PTR2A	Fish Frames	Port River, ACA BUT (15/05/2012)
N12/015833X	PAT1A	Fish Frames	Patawalonga, ACA BUT (29/05/2012)
N12/015835X	PAT2A	Fish Frames	Patawalonga, ACA BUT (11/05/2012 + 29/05/2012)
N12/015833DUP	Duplicate	Fish Frames	Duplicate Sample
N12/015833SPK	Spike	Fish Frames	Spiked Sample - 50 ng/g
BLK L827	Lab Blank	Blank	Lab Blank Batch L827

Project Details

Project Name	*Not specified*
Project Number	*Not specified*

Key

Analytes		Isotopically labelled surrogate
PFHxA	Perfluoro-n-hexanoic acid	Perfluoro-n-[1,2-$^{13}C_2$]hexanoic acid Surrogate
PFHpA	Perfluoro-n-heptanoic acid	Perfluoro-n-[1,2,3,4-$^{13}C_4$]octanoic acid Surrogate
PFOA	Perfluoro-n-octanoic acid	
PFNA	Perfluoro-n-nonanoic acid	Perfluoro-n-[1,2,3,4,5-$^{13}C_5$]nonanoic acid Surrogate
PFDA	Perfluoro-n-decanoic acid	Perfluoro-n-[1,2-$^{13}C_2$]decanoic acid Surrogate
PFUdA	Perfluoro-n-undecanoic acid	Perfluoro-n-[1,2-$^{13}C_2$]undecanoic acid Surrogate
PFDoA	Perfluoro-n-dodecanoic acid	Perfluoro-n-[1,2-$^{13}C_2$]dodecanoic acid Surrogate
PFOS	Perfluoro-n-octanesulfonate	Perfluoro-n-[1,2,3,4-$^{13}C_4$]octanesulfonate Surrogate

Units & Abbreviations

ng/g	nanograms per gram
<	level less than limit of quantitation (LOQ)

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015833X

Client Sample Ref. PAT1A
Matrix Fish Frames
Description Patawalonga, ACA BUT (29/05/2012)
Date Extracted 19-Oct-12
DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<3
PFHpA	<3
PFOA	<3
PFNA	<1
PFDA	<0.5
PFUdA	<0.5
PFDoA	5.1
PFOS	3.7

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015835X

Client Sample Ref. PAT2A
Matrix Fish Frames
Description Patawalonga, ACA BUT (11/05/2012 + 29/05/2012)
Date Extracted 19-Oct-12
DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<3
PFHpA	<3
PFOA	<3
PFNA	<1
PFDA	<0.5
PFUdA	<0.5
PFDoA	4.0
PFOS	<2

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015833DUP

Client Sample Ref. Duplicate
Matrix Fish Frames
Description Duplicate Sample
Date Extracted 19-Oct-12
DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<3
PFHpA	<3
PFOA	<3
PFNA	<1
PFDA	<0.5
PFUdA	<0.5
PFDoA	4.8
PFOS	3.9

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015833SPK

Client Sample Ref. Spike
Matrix Fish Frames
Description Spiked Sample - 50 ng/g
Date Extracted 19-Oct-12
DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	15
PFHpA	36
PFOA	16
PFNA	15
PFDA	13
PFUdA	14
PFDoA	17
PFOS	16

Results : Job No. EPA05/120531

Laboratory Reg. No. BLK L827

Client Sample Ref. Lab Blank
Matrix Blank
Description Lab Blank Batch L827
Date Extracted 19-Oct-12
DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<0.07
PFHpA	<0.02
PFOA	<0.1
PFNA	<0.02
PFDA	<0.03
PFUdA	<0.08
PFDoA	<0.04
PFOS	<0.02

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015833SPK

Client Sample Ref. Spike
Matrix Fish Frames
Description Spiked Sample - 16 ng/g
Date Extracted 19-Oct-12
DB5 Analysis 29-Oct-12

PFHxA	15
PFHpA	36
PFOA	16
PFNA	15
PFDA	13
PFUdA	14
PFDoA	17
PFOS	16

Appendix B Derivation of Water RBC

Human health water criteria have been derived on the same basis as presented in the NEPM for workers (NEPC 1999 amended 2013e).

The risk-based criteria (RBC) for water have been derived for PFOS + PFHxS and PFOA on the basis of a threshold approach. Where this is the case the criteria for an exposure pathway (x), can be back-calculated by setting the estimated intake for a chemical (i) to the acceptable intake allowable from soil for that chemical (i), then rearranging the equation as follows:

$$RBC_{x,i}\left(\frac{mg}{L}\right) = \frac{\text{Acceptable Intake}}{\text{Intake from Contamination}} = \frac{\text{acceptable intake from water x body weight x averageing time}}{\text{ingestion rate x exposure frequency x exposure duration}}$$

Equation 1

Similarly, criteria can be derived for other pathways of exposure, with the final RBC calculated by combining the pathway-specific RBC as noted below:

$$RBC\left(mg/L\right) = \frac{\mathbf{1}}{\left[\frac{\mathbf{1}}{RBC_{ingestion}}\right] + \left[\frac{\mathbf{1}}{RBC_{dermal}}\right]}$$

Equation 2

where:

$RBC_{ingestion}$	= derived water guideline associated with incidental ingestion of water by adult workers, refer to **Equation 3**
RBC_{dermal}	= derived water guideline associated with dermal absorption of contaminant in water by adult workers, refer to **Equation 4**

This approach assumes that the pathways of exposure are all complete and are additive, and that the toxicological end point considered for all pathways of exposure are the same or additive.

The following outlines the equations used to calculate the pathway specific RBC. **Table B1** presents a summary of the exposure assumptions adopted for the calculations

$$RBC_{ingestion}\ (mg/L) = \frac{(TDI_o(100\% - BI_o)) \times BW_A \times AT_T}{IR_W \times BA_o \times EF \times ED}$$

Equation 3

$$RBC_{dermal}\ (mg/L) = \frac{(TDI_D(100\% - BI_o)) \times BW_A \times AT_T}{SA_A \times ET\ x\ DP \times CF \times EF \times ED}$$

Equation 4

where:

TDI_o	= TDI relevant for the quantification of oral and dermal intakes, (as mg/kg/day for threshold contaminants) (refer to **Section 5**)
BI_o	= background intakes relevant to oral/dermal or inhalation exposures (from sources other than soil, which include food, water, air and consumer products where relevant) (as % of the TDIo)
IR_W	= ingestion rate of water by adult workers (mg/day)
BA_o	= oral bioavailability (unitless, expressed as a fraction of 1)
SA_A	= exposed skin surface area for adult workers (cm^2)
DP	= dermal permeability of chemical (cm/hr)
CF	= conversion factor of $1x10^{-3}$ (L/cm^3)
EF	= exposure frequency (days/year)
ED	= exposure duration for adult workers (years)
BW_A	= body weight of adult workers (kg)
AT_T	= averaging time for threshold contaminants (days, = ED x 365 days)

Table B1: Exposure Parameters Adopted for Calculation of Water RBC

Exposure	**Workers**
Exposure Duration	30 years (conservative value). (Note, as PFOS and PFOA act via a threshold mechanism, the assumption of a 1 year or 30-year exposure duration does not affect the risk calculations as this value cancels out).
Exposure Frequency	96 days per year (assumes a worker is in contact with PFAS water 2 days per week – for working weeks on the airport) (conservative assumption based on professional judgement).
Body weight	78 kg (average adult body weight) (enHealth 2012b)
Averaging Time (non-carcinogenic)	Exposure duration x 365 days
Bioavailability	100% (maximum possible)
Incidental Direct Contact with Water	
Gastrointestinal Absorption	100% (maximum possible)
Ingestion Rate	0.005 L/day (industry standard value for contaminated site risk assessments in Australia, assumes 5 mL of water or 1 teaspoon is ingested including water droplets/mist in air)
Time Spent Wet	2 hrs/day (assumed time workers may be wet)
Skin Surface Area	4,750 cm^2 for hands and forearms (enHealth 2012b)
Dermal Permeability to Water	$3.25x10^{-5}$ cm/hour, dermal permeability value for PFOA from ATSDR (2015) for mouse skin (more conservative than human skin), adopted for PFOS + PFHxS and PFOA in the absence of chemical specific data

On the basis of the above, the following RBC have been derived for PFAS in water.

Derivation of Water Criteria
Worker Exposures

Summary of Exposure Parameters		Abbreviation	units	Parameter	References/Notes
Water Ingestion Rate	- Adults	IRW	L/day	0.005	Assume incidental ingestion of 5 mL per day (1 teaspoon)
Surface Area of Skin	- Adults	SA_A	cm^2/day	4750	Hands and forearms (enHealth 2012a)
Time Spent Wet		ET	hours	2	Assumed
Body weight	- Adults	BW_C	kg	78	Average for adults as per enHealth (2012a)
Exposure Frequency		EF	days/year	96	Assumes contact with surface water 2 days per working week
Exposure Duration	- Adults	ED_C	years	30	Schedule B7, Table 5
Averaging Time (noncarcinogenic)		AT_T	days	ED*365	Calculated based on ED

Threshold Calculations - Adult Worker												
Compound	**Toxicity Reference Value Oral (TRV_O)** (mg/kg/day)	**GI Absorption (GAF)** (unitless)	**Toxicity Reference Value Dermal (TRV_D)** (mg/kg/day)	**Oral Bioavailability BA_O (%)**	**Dermal Permeability (DP)** (unitless)	**Background Intake Oral/Dermal (BI_O)** (% of TDI)	**Toxicity Reference Value Inhalation (TRV_I)** (mg/m^3)	**Background Intake Inhalation (BIi)** (% of TC)	**Pathway Specific HILs (mg/L)**		**Derived Water RBC (not rounded)** (mg/L)	**Derived Water RBC (to 1 or 2 s.f.)** (mg/L)
									Water Ingestion	**Dermal**		
PFOS + PFHxS	0.00002	1	0.00002	100%	3.25E-05	80%			2.4E-01	3.8E+00	0.22	**0.2**
PFOA	0.00016	1	0.00016	100%	3.25E-05	80%			1.9E+00	3.1E+01	1.8	**1.8**

Appendix C Toxicity Summary for PFOS and PFHxS

C1 PFOS

This toxicity summary has been based on information sourced from the US Department of Health and Human Services Agency for Toxic Substances and Disease Control (ATSDR 2018) and Food Standards Australia New Zealand (FSANZ 2017a) unless otherwise indicated.

Properties and Uses

PFAS are a family of man-made fluorine-containing chemicals that do not occur naturally in the environment. The have unique properties to make materials stain- and stick-resistant because they repel oil, grease and water. PFAS are often described as being “ubiquitous in the environment”. They have been widely used in man-made products such as surface protection products (e.g. carpet and clothing treatments) and coatings for cardboard and packaging. Some PFAS are, or were also historically used in fire-fighting foams.

There are hundreds of different PFAS; the most common and well-studied compounds are PFOS and PFOA as these PFAS were manufactured at the highest rate. PFOS is a completely fluorinated compound with eight carbons and a sulfonate group. PFOA is a completely fluorinated compound with seven carbons and a carboxyl functional group. Both PFOS and PFOA are metabolically and environmentally stable (i.e. persistent), bioaccumulative and toxic (PBT). Perfluoroalkyl carboxylates and sulfonates are made up of a long perfluorocarbon tail that is both hydrophobic and oleophobic, and a charged end that is hydrophilic.

In addition, many of the PFAS compounds break down to give PFOS or PFOA when released into the environment. Degradation stops at PFOS and PFOA which is why these compounds are commonly found to have accumulated in organisms. These compounds are mobile in soil and leach into groundwater.

Exposure

<u>Oral</u>

PFOS is readily absorbed via the oral route of exposure. The bioavailability of PFOS is estimated to be >93% within 24 hours (based on studies with rats).

<u>Dermal</u>

When an individual (adult or child) comes into direct contact with impacted soil or water, exposure is often assumed to occur via incidental ingestion and dermal contact. However, there is scientific evidence to suggest that the dermal absorption of PFOS is limited in comparison to the ingestion pathway.

The dermal absorption of a chemical depends on the area of skin in contact with the impacted media/chemical, the concentration of chemical in the media, the duration of contact with the media, how tightly the chemical is bound into the media and the ability of the chemical to penetrate the skin. Anionic surfactants (e.g. PFOS), are generally thought to penetrate the whole skin poorly. Experimental values (Scala et. al. 1968) confirm that even at the highest surfactant concentrations studied (0.03 M or 1%), non-detectable concentrations of ionic surfactants passed through the skin in the first two hours of exposure. Diffusion curves were observed to be non–linear (exponential), with surfactant able to be measured on the underside of the skin four hours following exposure.

Dermal exposures of rats to ammonium PFOA has been shown to produce systemic (e.g., liver, immunotoxicity) effects in animals confirming that the absorption of PFOA by animal skin is possible however estimates of the amount or rates of dermal absorption in humans or animals have not been reported. In addition, experimental studies with rat, mouse and human skin indicate that rat and mouse skin may be more permeable to PFOA than human skin. As would be expected given the physicochemical properties of PFOS and PFOA, dermal permeability was sensitive to pH and was higher when the skin was buffered at pH 2.5 ($5.5x10^{-2}$ cm/hour) compared to pH 5.5 ($4.4x10^{-5}$ cm/hour), well above the pKa for the terminal carboxylic acid of PFOA. This suggests that permeability of the unionized acid is greater than that of the dissociated anion (noting that at environmental pH, PFOS, PFOA and PFHxS will be in the ionised form)

Following application of the ammonium salt of PFOA to isolated human or rat epidermis, approximately 0.048% of the dose was absorbed across human epidermis and 1.44% was absorbed across rat epidermis. When applied at the same dose and for the same time frame, 1.44% of the applied dose of PFOA was absorbed across the isolated rat skin however only 0.048% of the dose was absorbed across the isolated human skin. The estimated dermal penetration coefficient was $9.49x10^{-7}$ cm/hour in the isolated human epidermis and $3.25x10^{-5}$ cm/hour in the isolated rat epidermis.

Default dermal permeability co-efficients for PFOS are not available (RAIS). This may be because the measurement of the n-octanol / water partition (a critical parameter for estimating the dermal permeability co-efficient) is not practicable via the standard methodology for PFOS as this chemicals form a separate layer when mixed with hydrocarbons and water.

In summary, the existing evidence in the scientific literature indicates that the dermal absorption of PFAS following direct contact is limited in comparison to the ingestion pathway.

<u>Vapour Inhalation</u>

PFOS is not volatile at environmental pH (it exists as an anion), hence vapour inhalation exposures have not been considered further in this HHERA. The potential health risks associated with the inhalation of dust have however been considered.

Distribution

Unlike other compounds that have PBT characteristics (e.g. organochlorine pesticides, PCBs or dioxins), PFOS is highly water soluble and bioaccumulate by attaching to proteins in the blood rather than accumulating in lipids (USEPA 2014). It has been shown that 99.7% of these chemicals in humans and 97.3% of these chemicals in rats and monkeys is bound to the albumin. Following oral exposure in rats, PFOS is found mainly in the blood, liver, lungs and kidneys. PFOA is found mainly in the blood, liver, testis, spleen, lungs, kidney and brain. In post mortem human studies, most of the PFOS is found in the lungs, kidneys, liver and blood. Most of the PFOA has been found in the lungs, kidneys, liver, blood and bone

PFOS binds to the fatty acid binding protein in the liver and has a medium to high binding affinity for other proteins including the human serum thyroid hormone transport protein, transthyretin, low density lipoproteins and / or alpha-globulins. Transporters, including organic anion transporters, and likely to be involved in the absorption, distribution and excretion of PFOS. PFOS is able to cross the placenta and have been found in breast milk.

Metabolism and Excretion

There is no evidence (from studies with rats and monkeys) that PFOS is metabolised in the body.

Excretion primarily occurs via the kidneys (in the urine) in rats. Lactation and menstruation are also relevant routes of excretion in women and mice.

The elimination half-life for PFOS is 5.4 years in humans and 121, 48 and 37 days in monkeys, rats and mice respectively. Half-lives are generally consistent between males and females.

Health Effects

The database relating to the toxicity of PFOS in animals includes acute and short term studies with mice, rats and monkeys, sub-chronic studies with rats and monkeys, chronic studies with rats and reproductive / developmental studies with mice, rats and rabbits. The critical effects identified from these studies and used by international agencies to develop TRVs include the following:

- Rats: mortality, increased liver weights, decreased body weight, decreased body weight gain, decreased serum cholesterol, increased alanine aminotransferase, hepatocellular hypertrophy and hepatocellular vacuolation, delayed eye-opening, reduced pup viability and weight / weight gain, reduced gestation length;
- Monkeys: mortality, reduced body weight gain, increased liver weight and liver histopathological changes and reduced serum cholesterol;
- Rabbits: lower maternal body weight gain (with no corresponding effect on food ingestion rate), lower foetal weight and abortions; and
- Mice: increased relative liver weight, reduced serum triglycerides, increased foetal liver weight, delayed eye-opening; reduced SBRC plaque forming cell response, impaired learning and memory and increased apoptosis in hippocampal cells.

Data from epidemiological studies with occupationally exposed workers at 3M manufacturing facilities (Alabama, USA and Belgium), communities exposed to contaminated drinking water (USA) and general populations (USA, UK and Scandinavia) are also available. It is noted that concentrations of PFAS in occupationally exposed workers are 100 to 1,000-fold higher than those in the general populations. Despite this, epidemiology studies have generally failed to draw conclusive links between exposure to PFOS and adverse health effects. Associations between exposure to PFOS and the following health effects have been suggested:

- Changes in serum lipid levels e.g. increase total cholesterol levels;
- Changes in serum liver enzymes levels;
- Kidney disease;
- Effects on fertility, pregnancy and birth outcomes; and
- Effects on thyroid and immune function

Overall, the evidence for adverse effects on humans following PFOS exposure from the epidemiological studies is inconsistent. In addition, the biological significance of some of the observed effects has been questioned (i.e. just because an effect is observed it does not mean it is, or will lead to, an adverse effect) and there is the potential that observed effects may be due to confounding factors e.g. exposure to other contaminants or diet.

Due to the above factors, it has been concluded by all regulatory agencies and bodies (including FSANZ) that the available epidemiological data is unsuitable for use in establishing a TRV for PFOS.

Classification

EFSA and the USEPA (2016) have concluded that PFOS is not genotoxic based on negative findings *in in vitro* and *in vivo* tests (FSANZ 2017a).

The carcinogenic risk of PFOS has also been recently reviewed (Arrieta-Cortes et al. 2017). The review considered the available animal and human toxicity studies in the context of the process adopted by the International Agency for Research on Cancer (IARC). The review concluded that there was inadequate evidence of carcinogenicity in human and animal studies and PFOS should be classified as *not classifiable as to its carcinogenicity to humans (Group 3)*.

With respect to the overall information available relating to the potential for exposure to PFAS to cause cancer:

- The literature evidence is often contradictory (or vague), even within the same reference;
- Associations with kidney, testicular, liver and bladder cancers have been reported for workers in epidemiological studies, however these studies may include a small number of participants, high occupational exposure and confounding factors (e.g. the study may not be controlled for other cancer causing exposures such as smoking); and
- Some observed effects attributed to causing cancer are reversible, hence are not necessarily adverse. In addition, associations are not causations.

As noted above, there are two general groups of carcinogens (NEPC 1999 amended 2013a):

- Genotoxic carcinogens for which, in theory, any level of exposure could result in a response as the chemical has the ability to interact directly with DNA; and
- Non-genotoxic carcinogens, for which there is a threshold below which exposure is not expected to result in adverse health effects.

PFAS do not possess the chemical / physical properties typically associated with direct genotoxicity and this is supported by an understanding of the mode of action for tumour formation in humans, and differences between humans and animals.

Overall, the weight of evidence is that, if they are carcinogenic, PFOS is a non-genotoxic threshold "carcinogen" (deWitt. J.C. 2015).

Toxicity Reference Values

On the basis that PFOS and PFOA is not considered to be a genotoxic carcinogen, it has been assessed based on a threshold approach in this HHERA. The following threshold chronic values are available from Level 1 Australian and International sources (**Table C1**):

Table C1: Summary of Toxicity Information for PFOS

Source	PFOS	
	TRV (µg/kg/d)	Basis/Comments
Australian		
Food Standards Australia New Zealand (FSANZ), Australian Drinking Water Guidelines (ADWG) (NHMRC 2011 Updated 2016, 2011 updated 2018)	0.02	HBGV based on PBPK modelling for 4 selected pivotal toxicity studies (1 with monkeys and 3 with rats). The final HBGV was derived based on a POD (HED) of 0.6 µg/kg/day associated with decreased pup body weight in a two-generation reproductive toxicity study with rats and an UF of 30 (10 for intraspecies variability and 3 for interspecies variability). HBGVs calculated for the other studies were in the range 0.02 to 0.1 µg/kg/day.
International		
WHO Drinking Water Guidelines	No guideline value	--
United Kingdom Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT 2006)	0.3	Provisional TDI based on a POD (NOAEL) of 30 µg/kg/day associated with decreased serum T3 levels in a 26-week study with cynomolgus monkeys and an UF of 100 for inter- and intra-species variability.
European Food Safety Authority (EFSA 2018)	0.002	Based on an increase in serum cholesterol levels where the median $BMDL_5$ levels from 3 studies correspond to an estimated chronic daily intake of 1.7-2.0 (median 1.8) ng/kg bw/d, as calculated with a PBPK model for humans. EFSA subsequently established a Tolerable Weekly Intake (TWI) is 13 ng/kg-bw/week. No additional UF applied as the BMD modelling was based on large epidemiological studies from the general population, including sensitive sub-groups.
United States Environmental Protection Agency (USEPA 2016a, 2016b) (Final)	0.02	RfD based on PBPK modelling on for data from 6 subchronic, developmental / neurodevelopmental and reproductive toxicity studies with rats for which measured serum PFOS concentrations were available. Critical effects included increased levels of alanine aminotransferase and blood urea nitrogen, decreased pup body weight and survival rate and increased motor activity / decreased habituation. The adopted UF varied depending on the study and were in the range 30 to 100. Candidate RfDs were in the range 0.02 to 0.05 µg/kg/day.
Agency for Toxic Substances and Disease Registry (ATSDR 2018)	0.002	Intermediate MRL based on a POD (HED) of 0.515 µg/kg/day associated with delayed eye opening and decreased pup weight in rats. The adopted UF was 300. ATSDR concluded there was insufficient data to derive a chronic MRL.
Danish Ministry for the Environment (Danish Ministry of the Environment 2015)	0.03	TDI based on a POD ($BMDL_{10}$) of 33 µg/kg/day associated with hepatotoxicity (liver toxicity) in a chronic toxicity/carcinogenicity study with rats and an UF of 1,230 (3 for possible differences in pharmacodynamics, 41 for differences in pharmacokinetics and 10 for intraspecies differences).
Minnesota Department of Health (MDH 2009a, 2009b)	0.08	TRV based on a POD (HED) of 2.5 µg/kg/day associated with decreased cholesterol and changes in thyroid hormones in rats and a UF of 30.
German Drinking Water Commission (GDWC 2006)	0.1	TRV based on a POD of 25 µg/kg/day which was the lowest POD for rats from a range of studies with rats and monkeys. The adopted UF was 300.

Notes for Table C1:

BMDL = Benchmark Dose Level, HBGV = Health Based Guideline Value, HED = Human Equivalent Dose, MRL = Minimal Risk Level, NOAEL = No Observed Adverse Effect Level, PBPK = Physiologically Based Pharmacokinetic, POD = Point of Departure, RfD = Reference Dose, TDI = Tolerable Daily Intake, UF = Uncertainty Factor.

Table C1 indicates that available TRVs for PFOS range from 0.002 to 0.15 µg/kg/day (i.e. a range of 75 times). The differences between the available TRVs are mainly due to the following:

- The selection of the critical study and the point of departure (POD) from the available toxicity studies;
- The application of different uncertainty factors (UFs). The application of significantly different UFs by various agencies is largely due to the toxicokinetics related issues (i.e. clearance), as well as the application of additional UFs because the available studies were less than lifetime for the estimated POD;
- The use (or not) of PBPK modelling; and
- The use of epidemiological data by EFSA (2018) as compared to animal toxicity data by other organisations (including Australia).

In April 2017, FSANZ released TRVs for PFOS, and PFHxS in the form of TDIs (called HBGVs) (FSANZ 2017a). The FSANZ TRVs are the final values for use in Australia and hence the TRVs for PFOS and PFOA have been adopted in this HHERA:

- PFOS: 0.02 µg/kg/day.

It is noted that the FSANZ (2017) assessment predates the ATSDR (2018) and EFSA (2018) assessments, where lower TDIs for PFOS and PFOA were derived (by an order of magnitude). FSANZ has indicated that "*EFSA is reviewing its scientific opinion together with a consideration of the safety of other PFAS chemicals in 2019. Until that time both the conclusions and tolerable weekly intakes are considered provisional and may change*" and "*FSANZ will review the EFSA report to see whether it contains any new information that would warrant a need to reconsider the tolerable daily intakes it published in 2017*".[11] Until this time, the adoption of the FSANZ (2017) TDIs are appropriate for an Australian HHERA, in line with the recommendations of the ASC NEPM. It is also noted that the ATSDR and EFSA TDIs are equivalent to background intakes of PFAS.

Background Intake

In the HHERA, the background intake of PFOS + PFHxS has been assumed to be 7% of the toxicity value.

The background intakes are based on a literature review of PFOS concentrations in blood serum as undertaken by ToxConsult (ToxConsult 2016) as part of assessment works at other Defence sites. It is noted that blood levels of PFAS are reflective of all intakes from consumer products, drinking water and the environment in general, including PFOS in food that the general population may be exposed to away from PFAS impacted sites. This is because PFOS accumulates in the blood serum.

[11] http://www.foodstandards.gov.au/consumer/chemicals/Pages/Perfluorinated-compounds.aspx

For PFOS, the information reviewed by ToxConsult indicated that background intakes in the Australian population were in the order of 0.0008 µg/kg/day (average) and 0.0014 µg/kg/day (upper estimate). This equates to 4% and 7% of the TRV (0.02 µg/kg/day). The upper estimate of 7% has been adopted in this HHERA.

FSANZ (2017b) indicates that there is currently insufficient information to estimate total dietary exposure to PFOS for the general population as the majority of the available information relates to contaminated sites. However, the limited data from the 24th Australian Total Diet Survey, alongside information in the scientific literature and further research on PFOS concentrations in fish purchased from Sydney retail outlets by the NSW Food Authority, indicates that dietary exposure from the general food supply is likely to be low. Hence, the adoption of 7% background contribution for PFOS is considered appropriately conservative.

C2 PFHxS

PFHxS is a completely fluorinated compound with six carbons and a sulfonate group and is the next most well-known PFAS after PFOS and PFOA. In addition, PFHxS is considered to be structurally similar to PFOS (having the same functional group with less carbons) and as a result is often considered of similar potential toxicity as PFOS.

Like PFOS and PFOA, PFHxS is readily absorbed following oral exposure (with a bioavailability of close to 100% within 24 hours in rats) and binds strongly to serum proteins. The highest PFHxS concentrations have generally been reported in the liver and kidney, with elimination occurring primarily in the urine in experimental animals. The is evidence that PFHxS can cross the placenta and PFHxS has been detected in breast milk. The elimination half-life of PFHxS in humans in estimated to be in the range 7.3 to 8.5 years.

There is limited information available relating to the toxicity of PFHxS:

- It has been shown to be a moderate activator of PPARα;
- There was no evidence of developmental or reproductive toxicity at the highest dose tested in one study with rats; and
- A number of epidemiological studies have reported associations between PFHxS exposure and health effects including physician diagnosed asthma, cholesterol levels, sperm quality, birth weight and learning difficulties. However, the results of these epidemiological studies are complicated by the factors present in the studies for PFOS and PFOA (as discussed above).

The comparative toxicity of PFHxS (and other PFAS) was recently investigated in a cumulative health risk assessment for 17 PFAS compounds (Borg et.al. 2013). A summary of the POD for hepatotoxicity and reproductive toxicity for the PFAS investigated in the health risk assessment are provided in **Table C2**.

Table C2: Summary of Toxicity Data for PFAS (Borg et.al. 2013)

PFAS	POD					
	Hepatotoxicity		Reproductive Toxicity		Other	
	External Dose (mg/kg/day)	Internal Dose (µg/mL serum)	External Dose (mg/kg/day)	Internal Dose (µg/mL serum)	External Dose (mg/kg/day)	Internal Dose (µg/mL serum)
PFBS	**100**	67 [1]	**300**	>45 [1]	**60** [4]	--
PFHxS	**1**	**89**	**>10**	**>60**	**0.3** [2,4]	**44** [2,4]
PFOS [6]	*0.025*	*4.04*	*0.1*	*4.9*	--	--
PFOSA	0.024 [1]	4.03 [1]	0.1 [1]	4.9 [1]	--	--
PFDS	0.029 [1]	4.85 [1]	0.1 [1]	5.9 [1]	--	--
PFBA	**6.0**	**14**	**175**	**4.4**	**3** [5]	--
PFPeA	0.04 [1]	4.5 [1]	0.55 [1]	10.0 [1]	--	--
PFHxA	**20**	5.4 [1]	**100**	11.9 [1]	--	--
PFHpA	**20**	6.2 [1]	0.76 [1]	13.8 [1]	--	--
PFOA [6]	*0.06*	*7.1*	*0.86*	*15.7*	--	--
PFNA	**0.83** [2]	**28.5**	**0.83**	**8.9**	--	--
PFDA	**1.2**	31.6 [1]	**3.0**	9.9 [1]	--	--
PFUnA	1.01 [1]	34.6 [1]	1.01 [1]	10.8 [1]	--	--
PFDoA	0.02 [1]	37.7 [1]	1.10 [1]	11.8 [1]	--	--
6:2 FTS	0.020 [1]	3.45 [1]	0.085 [1]	4.2 [1]	**15** [3]	--

Notes:

1 = Read-across on a molar basis from PFOA, PFOS or PFHxS of PFNA (for PFDA and PFUnA). Borg et. al. (2013) indicates that "f*or congeners lacking data, read-across extrapolation from the closest most conservative congener on a molar basis has been performed*". Read-across is the process where endpoint information for one chemical is used to predict the same endpoint for another chemical which is considered to be similar in some way (e.g. structurally similar). PFTriDA and PFTeDA were also evaluated on this basis

2 = Lowest Observed Adverse Effect Level (LOAEL)

3 = Critical effect is nephrotoxicity

4 = Critical effect is decrease in haemoglobin levels

5 = Critical effect decrease in serum cholesterol

6 = Based on an independent review of toxicity data by the study authors which may consider different PODs to those selected by other jurisdictions for the development of guideline values and hence, may differ to the information presented above. The information presented by the study authors has been replicated here to ensure a consistent approach is adopted for the review of the toxicity data for PFOS / PFOA as compared to other PFAS compounds.

-- = No data available

Table C2 indicates that where chemical specific information is available and evaluated on a consistent basis (values shown in bold; other values have been estimated via read across from PFOS, PFOA or PFHxS), PODs for other PFAS are 10 to 100 times higher than that for PFOS and PFOA. This means these PFAS compounds are 10 to 100 times less toxic than PFOS and PFOA.

The exceptions are:

- PFNA which has reproductive toxicity and hepatotoxicity PODs (external dose) of 0.83 mg/kg/day; and
- PFHxS which has a haematology toxicity POD (external dose) of 0.3 mg/kg/day which is similar to PFOS and PFOA.

In their recent review (FSANZ 2017b), FSANZ concluded that structure of PFOS and PFHxS are similar, and there is some evidence of similar potency in the activation of PPARα which may at least partially mediate the toxicity of some PFAS.

Given this, the TRVs for PFOS of 0.02 µg/kg/day has been adopted for PFHxS in this HHERA. In practical terms, this means that concentrations of PFOS and PFHxS are evaluated together (as a sum) in the HHERA calculations.

Appendix D Risk Calculations – On-Airport

Exposure to Chemicals via Incidental Ingestion of Groundwater - GWP6-PFC

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Ingestion Rate (Irw, L/day)	0.005	Incidental ingestion of 5 ml (1 tsp) of water per day
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)		NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
PFOS + PFHxS		2.0E-05	10%	1.8E-05	0.226		2.7E-06	--		0.147	100%
							TOTAL	**--**		**0.15**	

Dermal Exposure to Chemicals via Contact with Groundwater - GWP6-PFC

$$Daily\ Chemical\ Intake_{DW} = C_W \bullet \frac{SAw \bullet ET \bullet DP \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad (mg/kg/day)$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Surface Area (Saw, cm2)	6300	As per NEPM (1999 amended 2013)
Exposure Time (ET, hr/day)	2	Assumed period of time users may be wet each day
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data						Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (DP) (cm/hr)	Concentration in Water (Cw) (mg/L)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	3.20E-5	0.226		2.1E-07	--		0.0119	100%
									--		0.012	

Appendix E Risk Calculations – Off-Airport

E1 General

This section outlines the approach used to assess the uptake of PFAS (specifically PFOS and PFHxS) into:

- Eggs where chickens are exposed to soil and/or water containing PFAS; and
- Fruit abd vegetables where soil and/or water containing PFAS is used to grow these plants.

There are several steps required to estimate intakes by humans and these steps are outlined below.

E2 Calculating Intake from Water by Chickens

Estimating the intake of PFAS for chickens uses the same generic equation as is used for people. This approach was originally outlined by the USEPA (USEPA 1989). The basic methodology outlined in the early years of contaminated sites risk assessment (i.e. 1980s) is still relevant today.

The generic equation (or a modified version for a specific type of exposure) is included in the enHealth guidance on risk assessment for Australia. The generic equation is:

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$

Where:
$Intake_m$ = Daily intake of PFAS i.e. from water consumed by chickens (µg/kg/day)
C_m = Concentration in PFAS impacted media i.e. in water consumed by chickens (µg/L)
IR_m = Ingestion rate (kg/day or L/day)
FI = Fraction ingested from contaminated source (unitless)
B_o = Oral bioavailability (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time (days)
BW = Body weight (kg)

To assess the risks to health from PFAS, the uptake of the PFAS into the chickens is estimated. The intake of these chemicals can then be converted into an estimate of the concentration that may be in the part of the animal people consume i.e. the eggs. Once the concentrations in eggs are estimated, the potential risks to human health can be estimated based on how many eggs are consumed.

There are a number of ways in which chickens can be exposed to PFAS – ingestion of water that contains PFAS, ingestion of soil (incidental when grazing) that contains PFAS and ingestion of grass or food fodder that may contain PFAS because it has been grown in affected soil or irrigated with affected water. This HHERA considers the situation where groundwater is extracted and provided as a water source for chickens.

The values used for the parameters in this equation are listed in **Table E1**.

Table E1. Exposure Parameters for Estimating Intake by Chickens

Parameter	Units	Value for Chickens	Basis / Comment
IR_w	L/d	0.32	Average daily consumption from Table 9.3.1 Australian and New Zealand Guidelines for Fresh and Marine Water Volume 3 – Primary Industries (ANZECC/ARMCANZ 2000)
FI	unitless	1	Assumed 100% of soil, water and fodder exposure is to affected media
B_O	unitless	1	Assumed to be 100% bioavailable in all media
EF	d/y	365	Assumed exposed daily
ED	y	8	Personal Communication from NZ agriculture, Agriculture Victoria and owners of backyard chickens
AT	d	2,920	Calculated as the ED x 365 days/year
BW	kg	2.8	Average body weight from Table 9.3.2 Australian and New Zealand Guidelines for Fresh and Marine Water Volume 3 – Primary Industries (ANZECC/ARMCANZ 2000)

E3 Transfer from Intake by Chickens to Eggs

Only one study was identified that examined the uptake of PFOS, PFHxS or PFOA in eggs, although this report was in German (Kowalczyk 2014). This study was used in the initial assessment that was undertaken as part of the HHRA for RAAF Base Williamtown. The study indicates a percentage of chemical transferred into egg which was were reported as 0.55 (i.e. 55% of what they ingest moves into the eggs)[12].

A more recent study was conducted as part of the Williamtown HHRA released in December 2017 (AECOM 2017). This study involved the collection of eggs from chickens fed water containing PFAS. The exposure period was 9 weeks followed by an elimination phase, and eggs were collected on a daily basis. Chickens were exposed to water with PFAS concentrations in the order of 0, 0.3, 3, 30 and 300 µg/L (actual concentrations of 0, 0.2, 2.6, 26.7 and 264 µg/L). The study estimated the transfer factors using the more commonly used approach, taking into account the laying rate of the hen (i.e. a hen does not lay eggs every day):

- PFOS: 1.0 µg/edible egg-d/µg/d hen intake; and
- PFHxS: 0.58 to 0.87 (average of 0.69) µg/edible egg-d/µg/d hen intake.

The average weight of a bird in the study was 2.1 kg and the average weight of edible egg per day was 0.056 kg. **Table E2** shows these transfer factors converted into ones that can be used in this assessment.

Table E2: Intake to Egg Transfer Factors for Chickens

Chemical	Converted Transfer Factors (µg/kg egg/µg/kg bw-d)
PFOS	37.5
PFHxS	25.9

The above transfer factors have been used in the HHRA.

[12] It is difficult to check the % transfer reported in this study given that the original paper is in German. Given this lack of clarity, the transfer factors determined from the more recent work have been adopted for this assessment.

E4 Transfer from Water to Fruit and Vegetables

Understanding how fruit and vegetables may accumulate PFAS from water they are grown with is essential for understanding uptake by humans.

Calculating the uptake of PFAS into plants involves the use of a transfer factor, which is a mathematical term that indicates the relationship between PFAS in irrigation water and PFAS in different parts of the fruit or vegetable (e.g. root or leaf), including those parts that may be consumed. Further information on the relevant transfer factors is provided below.

There are 9 studies that investigate the uptake of PFAS into fruit, vegetables and pasture crops from water (AECOM 2017; Blaine et al. 2014; Felizeter, and & de Voogt 2014; Felizeter, S, McLachlan & de Voogt 2012; García-Valcárcel et al. 2014; Wen et al. 2013; Zhang et al. 2019; Zhao et al. 2013; Zhao et al. 2016). **Table E3** lists the transfer factors developed from the above studies.

For the Wen et. al. (2013), Zhao et. al. (2013) and Zhang et. al. (2019) studies, the experimental water concentrations are much higher than would be expected in an environmental situation and/or the data to calculate transfer factors has not been included in the paper. Hence, these results have not been used in this assessment.

The AECOM (2017) study was a 120-day greenhouse trial that investigated the uptake of PFAS into 7 horticultural crops comprising alfalfa, beet, cucumber, radish, lettuce, strawberry and tomatoes. These products are primarily consumed by humans however alfalfa is a common pasture grass for livestock. The crops were housed in 4 different greenhouses and were irrigated with test solutions containing 0 µg/L, 1 µg/L, 10 µg/L and 100 µg/L of PFOS, PFHxS, PFOA and PFHxA, with a further sample of produce irrigated with groundwater sourced from downgradient of the AACO and Williamtown sites (total PFAS concentrations of 37 and 138 µg/L respectively). The aim of the study was to derive transfer factors for the uptake of PFAS into fruit and vegetables.

AECOM (2017) concluded that uptake of PFAS into plants was directly correlated to PFAS concentration in water (with a linear relationship) where irrigation water was artificially modified with PFAS. However, when groundwater from the AACO and Williamtown sites was used to irrigate produce the same relationship was not observed, especially for beet leaf and alfalfa leaf. This was compounded by the saltiness of the groundwater used for irrigation which adds additional uncertainty. There were also some experimental issues with raising the tomatoes, strawberries and cucumbers which means that the transfer factors are not statistically significant for strawberries and cucumbers and no transfer factors were derived for tomatoes. For this reason, transfer factors derived for the AECOM (2017) experiments with groundwater have not been considered in this HHRA.

Data presented in the supplementary material for Blain et. al. (2014) has also been reviewed and used to calculate transfer factors as shown in **Table E4**. Similarly, data presented in the supplementary material for Felizeter, McLachlan and Voogt (2012) has been reviewed and used to calculate transfer factors as shown in **Table E5**. Supplementary data from Felizeter, McLachlan and Voogt (2014) was reviewed by Senversa (2017) as part of the investigation at the Defence RAAF East Sale Base (the report for which is publicly available) and used to calculate transfer factors. The calculated transfer factors have been reviewed by enRiskS and are correct.

Table E3. Transfer Factors for Water to Fruit and Vegetables Considered in HHRA

Plant Type	Reference	Transfer Factor[2] (µg/kg plant (ww)/µg/L water)	
		PFOS	PFHxS
Green and Fruiting Vegetables			
Lettuce leaves/foliage	Blain et. al. (2014)[1]	1.3 – 4.2	2.0 – 8.0
	Felizeter et. al. (2012)	0.3 – 2.2	0.45 – 1.1
	AECOM (2017) (spiked water)	0.1 – 2.9 (1.0)	0.1 – 3.9 (1.5)
Cabbage head	Felizeter et. al. (2014)	0.2	0.27
Radish leaf	AECOM (2017) (spiked water)	0.6 – 14.8 (8.1)	1.4 – 9.7 (4.8)
Tomato	Felizeter et. al. (2014)	0.03	0.06
Cucumber	AECOM (2017) (spiked water)	0.03 – 0.2 (0.08)	0.1 – 0.9 (0.4)
Zucchini	Felizeter et. al. (2014)	0.32	0.27
	Average of Maximum Values Adopted in HHRA	***2.0***	***2.1***
Root Vegetables			
Beet	AECOM (2017) (spiked water)	0.6 – 2.7 (1.2)	2.6 – 7.2 (5.4)
Radish root	AECOM (2017) (spiked water)	0.7- 3.5 (1.5)	0.3 – 2.2 (0.8)
	Maximum Value Adopted in HHRA	***3.5***	***7.2***
Fruits or Fruiting Vegetables			
Strawberry	Blain et. al. (2014)	Not Detected	Not Detected
	AECOM (2017) (spiked water)	0.03 – 0.8 (0.3)	0.04 – 1.5 (0.3)
	Maximum Value Adopted in HHRA	***0.8***	***1.5***

Notes:
NA = PFAS not detected in strawberry fruit.
1 = Concentration in dw converted to concentration in ww based on a conversion factor of 0.1 (assumes that lettuce is 90% water).
2 = Average value provided in parenthesis.
3 = Includes data from Felizeter, McLachlan and Voogt (2014).

Table E4. Calculation of Transfer Factors for Water to Lettuce and Strawberry (Blain et. al. 2014) (Used in Table E3)

Plant Type	Water Concentration (µg/L)		Plant Concentration (µg/kg dw)		Transfer Factor (µg/kg plant (dw)/µg/L water)	
	PFOS	PFHxS	PFOS	PFHxS	PFOS	PFHxS
Lettuce leaves	0.065	0.092	1.44	ND	22	NA
	0.097	0.186	4.05	5.24	42	28
	0.262	0.473	3.28	9.25	13	20
	0.488	0.991	17.3	32.6	35	33
	1.00	1.91	31.1	56.3	31	29
	1.36	4.01	57.4	188	42	47
	3.45	8.48	73.1	417	21	49
	7.94	15.6	279	1,250	35	80
Strawberry fruit	0.065	0.092	ND	ND	NA	NA
	0.097	0.186	ND	ND	NA	NA
	0.262	0.473	ND	ND	NA	NA
	0.488	0.991	ND	ND	NA	NA
	1.00	1.91	ND	ND	NA	NA
	1.36	4.01	ND	ND	NA	NA
	3.45	8.48	ND	ND	NA	NA
	7.94	15.6	ND	ND	NA	NA

Notes:
ND = Not detected.
NA = Not applicable.

Table E5: Calculation of Transfer Factors for Water to Lettuce (Felizeter, McLachlan and Voogt 2014) (Used in Table E3)

Plant Type	Water Concentration (µg/L)		Plant Concentration (µg/kg ww)		Transfer Factor (µg/kg plant (ww)/µg/L water)	
	PFOS	PFHxS	PFOS[1]	PFHxS	PFOS	PFHxS
Lettuce foliage	0.055	0.011	0.016	0.014	0.29	1.1
	0.035	0.079	0.05	0.05	1.4	0.45
	0.47	1.06	0.5	0.55	1.1	0.54
	4.4	9.4	9.6	5.8	2.2	0.66

Notes:
ND = Not detected.
NA = Not applicable, no analysis for PFAS.
1 = Values are for linear PFOS as concentrations of linear PFOS were higher than branched PFOS

Table E6. Transfer Factors for Water to Fruit and Vegetables Not Considered in HHRA

Plant Type	Reference	Transfer Factor[1] (µg/kg plant (ww)/µg/L water)	
		PFOS	PFHxS
Lettuce leaves/foliage	AECOM (2017) (groundwater)	0.1 – 6.1 (1.1)	0.1 – 3.9 (1.4)
Radish leaf	AECOM (2017) (groundwater)	0.6 – 40.4 (11.0)	1.4 – 9.7 (5.3)
Cucumber	AECOM (2017) (groundwater)	0.03 – 0.2 (0.08)	0.1 – 0.9 (0.4)
Beet	AECOM (2017) (groundwater)	0.6 – 7.6 (2.7)	2.6 – 17.6 (6.9)
Radish root	AECOM (2017) (groundwater)	0.7- 8.9 (2.7)	0.3 – 5.1(1.3)
Strawberry	AECOM (2017) (groundwater)	0.03 – 0.8 (0.3)	0.04 – 1.5 (0.3)

Notes:
1 = Average value provided in parenthesis.

E5 Estimating Intake by Humans

As discussed in **Section E1**, the generic equation (or a modified version for a specific type of exposure) is included in the enHealth guidance on risk assessment for Australia. The generic equation is:

$$Intake_m = \frac{C_m \text{ x } IR_m \text{ x } FI \text{ x } B_o \text{ x } EF \text{ x } ED}{BW \text{ x } AT}$$

Where:
$Intake_m$ = Daily intake of PFAS i.e. from beef meat for humans (µg/kg/day)
C_m = Concentration of PFAS in meat (muscle) (µg/kg or µg/L)
IR_m = Ingestion rate (kg/day or L/day)
FI = Fraction ingested from contaminated source (unitless)
B_o = Oral bioavailability (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time (days)
BW = Body weight (kg)

The adopted exposure assumptions are presented in the body of the assessment.

The risk calculation spreadsheets are provided below.

Intake of Chemicals by Chickens (stock watering with groundwater containing PFAS)

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

	PFOS	PFHxS	units
Egg to intake ratio as per study =	1	0.69	mg/edible egg-d/mg/d
Adjusted egg to intake ratio =	37.5	25.9	ug/kg (egg)/ug/kg bw-d

Chickens

Exposure Parameters	
Chicken water ingestion rate (L/day)	0.32
Fraction of produce from site in diet (FI)	1
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	8
Body Weight (BW, kg)	2.8
Bioaccessibility (B)	1
Averaging Time - Threshold (Atn, days)	2920

Well ID	**Estimation of Uptake and Intake of PFOS + PFHxS**							
	Concentration in Soil (µg/kg)	**Concentration in Water** (µg/L)	**Concentration in Pasture** (µg/kg ww)	**Livestock Intake from Soil** (µg/kg/day)	**Livestock Intake from Water** (µg/kg/day)	**Livestock Intake from Pasture** (µg/kg ww per day)	**Total Livestock Intake** (µg/kg/day)	**PFOS + PFHxS in Egg** (µg/kg)
P43								
PFOS	0	0.24	0	0.0E+00	2.7E-02	0.0E+00	2.7E-02	1.0E+00
PFHxS	0	0.05	0	0.0E+00	5.7E-03	0.0E+00	5.7E-03	1.5E-01

Exposure to Chemicals via Ingestion of Eggs

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	100% Consumption of Eggs
Ingestion Rate of Eggs (IR_p, kg/day)	0.06
Fraction of produce from site in diet (FI)	100%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFOS+PFHxS	Toxicity Data			PFOS + PFHxS in Egg	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/kg)	(µg/kg/day)	(unitless)
P43						
PFOS	2.0E-02	7%	1.9E-02	1.0E+00	8.8E-04	0.0474
PFHxS	2.0E-02	7%	1.9E-02	1.5E-01	1.3E-04	0.007
TOTAL						**0.05**

Child

Exposure Parameters	100% Consumption of Eggs
Ingestion Rate of Eggs (IR_p, kg/day)	0.06
Fraction of produce from site in diet (FI)	100%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFOS+PFHxS	Toxicity Data			PFOS + PFHxS in Eggs	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/kg)	Worst-Case (µg/kg/day)	Worst-Case (unitless)
P43						
PFOS	2.0E-02	7%	1.9E-02	1.0E+00	4.1E-03	0.221
PFHxS	2.0E-02	7%	1.9E-02	1.5E-01	5.9E-04	0.032
TOTAL						**0.25**

Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.86 Fruit FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P43								
PFOS	2.0E-02	7%	1.9E-02	0.24	0.8	0.19	2.4E-04	0.0127
PFHxS	2.0E-02	7%	1.9E-02	0.05	1.5	0.08	9.2E-05	0.0050
TOTAL								**0.02**

Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.59 Fruit FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)					
	(µg/kg/day)		(µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P43								
PFOS	2.0E-02	7%	1.9E-02	0.24	0.8	0.19	7.6E-04	0.0406
PFHxS	2.0E-02	7%	1.9E-02	0.05	1.5	0.08	3.0E-04	0.016
TOTAL								**0.06**

Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.27 Root and Tuber Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P43								
PFOS	2.0E-02	7%	1.9E-02	0.24	3.5	0.84	3.2E-04	0.0174
PFHxS	2.0E-02	7%	1.9E-02	0.05	7.2	0.36	1.4E-04	0.007
TOTAL								**0.02**

Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.16 Root and Tuber Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P43								
PFOS	2.0E-02	7%	1.9E-02	0.24	3.5	0.84	9.0E-04	0.0482
PFHxS	2.0E-02	7%	1.9E-02	0.05	7.2	0.36	3.8E-04	0.021
TOTAL								**0.07**

Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.37 Green and Fruiting Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P43								
PFOS	2.0E-02	7%	1.9E-02	0.24	2.0	0.48	2.5E-04	0.0136
PFHxS	2.0E-02	7%	1.9E-02	0.05	2.1	0.11	5.6E-05	0.0030
TOTAL								**0.02**

Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.3 Green and Fruiting Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P43								
PFOS	2.0E-02	7%	1.9E-02	0.24	2.0	0.48	9.6E-04	0.0516
PFHxS	2.0E-02	7%	1.9E-02	0.05	2.1	0.11	2.1E-04	0.011
TOTAL								**0.06**

Intake of Chemicals by Chickens (stock watering with groundwater containing PFAS)

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

	PFOS	PFHxS	units
Egg to intake ratio as per study =	1	0.69	mg/edible egg-d/mg/d
Adjusted egg to intake ratio =	37.5	25.9	ug/kg (egg)/ug/kg bw-d

Chickens

Exposure Parameters	
Chicken water ingestion rate (L/day)	0.32
Fraction of produce from site in diet (FI)	1
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	8
Body Weight (BW, kg)	2.8
Bioaccessibility (B)	1
Averaging Time - Threshold (Atn, days)	2920

Well ID	Estimation of Uptake and Intake of PFOS + PFHxS							PFOS + PFHxS in Egg (µg/kg)
	Concentration in Soil (µg/kg)	Concentration in Water (µg/L)	Concentration in Pasture (µg/kg ww)	Livestock Intake from Soil (µg/kg/day)	Livestock Intake from Water (µg/kg/day)	Livestock Intake from Pasture (µg/kg ww per day)	Total Livestock Intake (µg/kg/day)	
P54								
PFOS	0	0.06	0	0.0E+00	6.9E-03	0.0E+00	6.9E-03	2.6E-01
PFHxS	0	0.13	0	0.0E+00	1.5E-02	0.0E+00	1.5E-02	3.8E-01

Exposure to Chemicals via Ingestion of Eggs

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	100% Consumption of Eggs
Ingestion Rate of Eggs (IR_p, kg/day)	0.06
Fraction of produce from site in diet (FI)	100%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFOS+PFHxS	Toxicity Data			PFOS + PFHxS in Egg	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/kg)	(µg/kg/day)	(unitless)
P54						
PFOS	2.0E-02	7%	1.9E-02	2.6E-01	2.2E-04	0.0118
PFHxS	2.0E-02	7%	1.9E-02	3.8E-01	3.3E-04	0.018
TOTAL						**0.03**

Child

Exposure Parameters	100% Consumption of Eggs
Ingestion Rate of Eggs (IR_p, kg/day)	0.06
Fraction of produce from site in diet (FI)	100%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFOS+PFHxS	Toxicity Data			PFOS + PFHxS in Eggs	Daily Intake Worst-Case	Calculated HQ Worst-Case
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/kg)	(µg/kg/day)	(unitless)
P54						
PFOS	2.0E-02	7%	1.9E-02	2.6E-01	1.0E-03	0.055
PFHxS	2.0E-02	7%	1.9E-02	3.8E-01	1.5E-03	0.083
TOTAL						**0.14**

Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.86 Fruit FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P54								
PFOS	2.0E-02	7%	1.9E-02	0.06	0.8	0.05	5.9E-05	0.0032
PFHxS	2.0E-02	7%	1.9E-02	0.13	1.5	0.20	2.4E-04	0.0129
TOTAL								**0.02**

Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.59 Fruit FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)					
	(µg/kg/day)		(µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P54								
PFOS	2.0E-02	7%	1.9E-02	0.06	0.8	0.05	1.9E-04	0.0102
PFHxS	2.0E-02	7%	1.9E-02	0.13	1.5	0.20	7.7E-04	0.041
TOTAL								**0.05**

Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.27 Root and Tuber Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P54								
PFOS	2.0E-02	7%	1.9E-02	0.06	3.5	0.21	8.1E-05	0.0044
PFHxS	2.0E-02	7%	1.9E-02	0.13	7.2	0.94	3.6E-04	0.019
TOTAL								**0.02**

Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.16 Root and Tuber Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)					
	(µg/kg/day)		(µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P54								
PFOS	2.0E-02	7%	1.9E-02	0.06	3.5	0.21	2.2E-04	0.0120
PFHxS	2.0E-02	7%	1.9E-02	0.13	7.2	0.94	1.0E-03	0.054
TOTAL								**0.07**

Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$Intake_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$ (µg/kg/day)

Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.37 Green and Fruiting Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P54								
PFOS	2.0E-02	7%	1.9E-02	0.06	2.0	0.12	6.3E-05	0.0034
PFHxS	2.0E-02	7%	1.9E-02	0.13	2.1	0.27	1.4E-04	0.0078
TOTAL								**0.01**

Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR_p, kg/day)	0.3 Green and Fruiting Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)	(µg/L)	µg/kg plant (ww)/µg/L water	(µg/kg)	(µg/kg/day)	(unitless)
P54								
PFOS	2.0E-02	7%	1.9E-02	0.06	2.0	0.12	2.4E-04	0.0129
PFHxS	2.0E-02	7%	1.9E-02	0.13	2.1	0.27	5.5E-04	0.029
TOTAL								**0.04**