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PATTLE DELAMORE PARTNERS LTD

NZDF PFAS Investigation – Summary Report: RNZAF Base Woodbourne Stage 1

New Zealand Defence Force

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Prepared for

New Zealand Defence Force

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The information contained within this report applies to sampling undertaken on the dates stated in this report, or if none is stated, the date of this report. With time, the site conditions and environmental standards could change so that the reported assessment and conclusions are no longer valid. Accordingly, the report should not be used to refer to site conditions and environmental standards applying at a later date without first confirming the validity of the report's information at that time.

Executive Summary

This report documents a sampling investigation undertaken on private properties adjacent to the Royal New Zealand Air Force (RNZAF) Base Woodbourne (the 'site') for the New Zealand Defence Force (NZDF) to investigate the potential for surface water and groundwater contamination relating to the use of per- and poly-fluoroalkyl substances (PFAS) at the site.

Sampling and laboratory analysis of groundwater (from 67 locations), and surface water (from three locations) has confirmed the presence of PFAS at some locations.

Groundwater

Groundwater sampling was undertaken at 67 locations over three weeks, from 7 December to 20 December, 2017.

Of the 67 groundwater samples collected:

- PFAS was detected by the laboratory in 22 samples (33%) (from 16 properties).
- PFAS was detected at 12 locations (13 wells) where water is used for drinking water purposes, with two samples exceeding the interim drinking water guidelines (MoH, 2017).
- 14 samples (21%) reported concentrations of PFAS above the screening value for milk consumption (home grown) (stock watering and fodder irrigation).
- 12 samples (18%) reported concentrations of PFAS above the screening value for milk consumption (home grown) (stock watering only).

Surface Water

Surface water samples were collected from three locations.

Of the three surface water samples collected:

- PFAS was reported in one sample.
- All surface water samples reported concentrations of PFAS below the adopted guideline criteria.

Recommended Stage 2 Investigation Area

Based on the results of this sampling investigation, and knowledge of the site and surrounding area, a recommended Stage 2 investigation area is proposed. This area includes additional sample locations that are outside the original Stage 1 sampling investigation extent. A detailed assessment of water use within the Stage 2 investigation area is also recommended.

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1.0 Introduction

Pattle Delamore Partners Ltd (PDP), in conjunction with a number of other Environmental Consultancies, has been engaged by the New Zealand Defence Force (NZDF) to undertake a sampling investigation to assess the potential for surface water and groundwater contamination by per- and poly-fluoroalkyl substances (PFAS) at properties adjacent to the Royal New Zealand Air Force (RNZAF) Base Woodbourne.

Sample results for landowners of adjacent properties have been reported in individual landowner reports, with recommendations regarding ongoing use of the water. This summary report provides a summary of these water sampling results in the context of the entire investigation area, along with recommendations for follow up work.

1.1 Project Objectives

The key project objectives for this sampling investigation were:

- To assess groundwater and surface water from sites adjacent to Base Woodbourne and determine if PFAS compounds are present,
- To compare the concentrations of PFAS compounds present against interim drinking water guideline values and applicable screening values, and
- Provide preliminary estimates of the extent of PFAS above the laboratory limit of reporting (LOR) in groundwater.

1.2 Scope of Summary Report

The scope of work undertaken to achieve the project objectives involved:

- Collecting representative samples of groundwater and surface water from adjacent sites and analyses of these samples for PFAS.
- Comparison of the laboratory results to guideline and screening value criteria.
- Update of the Woodbourne sampling investigation area.
- Provide recommendations for ongoing monitoring and sampling.

2.0 Background

PFAS compounds, such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are a group of manufactured chemicals used since the 1950s. PFAS have been and continue to be used in a wide range of industrial and commercial products including aqueous film forming foam (AFFF) used for fighting fuel fires. Recently PFAS have gained increasing scientific and regulatory

interest due to their widespread use, their environmental persistence and because some PFAS (primarily PFOS and PFOA) display bioaccumulative and toxic properties to humans and wildlife (CONCAWE, 2016).

PFAS are emerging contaminants. NZDF is investigating the potential for contamination of ground and water associated with the use and storage of AFFF containing PFAS at its camps and bases. Investigations at Woodbourne have identified PFAS in the water on the base.

Woodbourne is surrounded by productive land, predominantly vineyards. Shallow (and deep) groundwater is used relatively extensively surrounding the base for water supply. A description of the geology and hydrogeology for the area is contained within Appendix A.

3.0 Methodology

Groundwater and surface water sampling was undertaken in groundwater supply wells and surface water at selected locations adjacent to the base following the methodology outlined in the *Sampling Protocols for Monitoring Per and Poly-fluorinated Compounds in Groundwater and Surface Water for New Zealand Defence Force* (PDP, 2017) and the guidance documents referenced therein.

Sampling was undertaken over three weeks, from 7 December to 20 December, 2017. All samples were sent to AsureQuality laboratories, Wellington and analysed for their PFAS suite.

4.0 Guidelines

The interim guidelines for drinking water and non-potable water/contact recreation currently used in New Zealand to compare with the water sample data collected during this project are presented in Table 1. Additional screening criteria have been prepared by NZDF consultants EnRisks, for water supply for animals/products grown and consumed at home (home-grown produce).

Guidelines are provided for three PFAS compounds only. These compounds are known to be associated with certain types of AFFF. Henceforth results are discussed for these three compounds only. Results for the full analytical suite of 28 PFAS are available in the laboratory reports. These are provided in a separate electronic file.

Table 1: Environmental and Human Health Guidelines

Media	Sum of Total PFOS + PFHxS	PFOA	Total PFHxS	Total PFOS	Source
Drinking Water	0.07 µg/L	0.56 µg/L	-	-	MoH[1], AGDoH [2]
Non-potable water/contact recreation	0.7 µg/L	5.6 µg/L	-	-	AGDoH [2]
Stock Watering Only (home grown consumption)	-	Beef 150 µg/L	Beef 0.1 µg/L	Beef 0.1 µg/L	EnRisks [3]
	-	Milk 30 µg/L	Milk 0.02 µg/L	Milk 0.02 µg/L	
	-	Eggs 4 µg/L	Eggs 0.2 µg/L	Eggs 0.09 µg/L	
Stock Watering and Fodder Irrigation (home grown consumption)	-	Beef 60 µg/L	Beef 0.06 µg/L	Beef 0.05 µg/L	EnRisks [3]
	-	Milk 14 µg/L	Milk 0.008 µg/L	Milk 0.008 µg/L	

Notes:

1. *Ministry of Health (MoH, 2017) Interim Guidance Level for Drinking Water, PFOA, PFOS and PFHxS.*
2. *Australian Government Department of Health (AGDoH, 2017) Health Based Guidance Values for PFAS for Use in Site Investigations in Australia.*
3. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017. Screening values calculated using a scenario of 10% of the tolerable daily intake. This is the most conservative scenario developed.*

5.0 QA/QC

5.1 Project Data Quality Objectives

The project data quality objectives (DQOs) were to:

1. Determine the presence or absence (less than 0.005 µg/L) of PFASs in groundwater from groundwater bores.
2. Determine the presence or absence (less than 0.005 µg/L) of PFASs in surface water.

To determine if the DQOs were met, the internal quality assurance/quality control (QA/QC) function ('QAChecker') in the Environmental database software ESdat was used to calculate relative percent differences between sample duplicates and to check for detections of PFAS in blanks.

The results of the QA/QC check indicate that all samples meet the DQOs.

This is with the exception of four rinsate samples (reported concentrations of 6:2FTS above the LOR) and one trip blank sample (reported concentrations of PFBA above the LOR). The results of these five samples are slightly above the LOR in most cases, with the maximum reported concentration being two times the LOR, and are therefore not statistically significantly different from the stated LOR.

A summary of the QA/QC check is provided in Appendix B. Additional information relating to the QA/QC results can be provided upon request.

6.0 Results

A total of 67 groundwater samples and three surface water samples were collected during this sampling investigation. An electronic file containing the laboratory reports is appended as a separate document.

Tabulated data for all sample results for the PFAS compounds total PFOS, PFOA, total PFHxS, and sum of total PFHxS + PFOS above the LOR are attached in Appendix C. All other PFAS compounds are not discussed in this report.

The groundwater and surface water results are presented in Sections 6.1 and 6.2.

6.1 Groundwater Samples

A summary of the groundwater sample results is presented below along with a comparison of the results to the interim drinking water guidelines, the non-potable guidelines and the screening values for stock watering and fodder irrigation developed by EnRisks (2017). Screening values defined for beef would also be conservative for the consumption of home-grown sheep meat (EnRisks, 2017).

6.1.1 Drinking Water

Of the 67 groundwater samples collected:

- PFAS was detected in 22 samples (33%).
- Two samples (3%) exceeded the interim drinking water guideline for the sum of total PFOS + PFHxS (MoH, 2017).
- 20 samples (30%) returned concentrations of the sum of total PFOS + PFHxS above the LOR but below the interim drinking water guideline (MoH, 2017).

- 45 samples (67%) were reported as less than the LOR for the sum of total PFOS + PFHxS.
- Concentrations of PFOA were reported above the LOR in 14 samples (21%).
- No groundwater samples were found to exceed the interim drinking water guideline for PFOA.

6.1.2 Non-potable, Stock Watering and Fodder Irrigation

Of the 67 samples tested:

- 14 samples (21%) reported concentrations of PFAS above the screening value for milk consumption (home grown) (stock watering and fodder irrigation).
- 12 samples (18%) reported concentrations of PFAS above the screening value for milk consumption (home grown) (stock watering only).
- No samples reported concentrations above the screening value for non-potable/contact recreation, beef consumption (home grown) (stock watering only), beef consumption (home grown) (stock watering and fodder irrigation), or egg consumption (home grown) (stock watering only).

6.1.3 Groundwater Results Summary Table

Table 2: Guideline and Screening Value Exceedences – Groundwater Samples (n=67)

Guideline	Number Exceeding the Relevant Guideline	Percent Exceeding the Relevant Guideline	Source
Interim Drinking Water Guidelines	2	3%	MoH[1]
Non-potable water/contact recreation	0	0%	AGDoH [2]
Site Specific Screening Value – Beef Consumption (home grown)			
Stock Watering and Fodder Irrigation	0	0%	EnRisks [3]
Stock Watering Only	0	0%	EnRisks [3]
Site Specific Screening Value – Milk Consumption (home grown)			
Stock Watering and Fodder Irrigation	14	21%	EnRisks [3]
Stock Watering Only	12	18%	EnRisks [3]
Site Specific Screening Value – Egg Consumption (home grown)			
Stock Watering Only	0	0%	EnRisks [3]

Notes:

1. *Ministry of Health (MoH, 2017) Interim Guidance Level for Drinking Water, PFOA, PFOS and PFHxS.*
2. *Australian Government Department of Health (AGDoH, 2017) Health Based Guidance Values for PFAS for Use in Site Investigations in Australia.*
3. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017.*

6.2 Surface Water Samples

A summary of the surface water sample results is presented below. It is likely that surface water sampled within the investigation area is not used for drinking water. Therefore, results have been compared to the non-potable guideline and the stock watering and fodder irrigation screening values.

Of the three surface water samples collected:

- Concentrations of total PFHxS, total PFOS, and the sum of total PFHxS + PFOS were above the LOR in one sample (SW4) (33%).

- Surface water samples collected up-gradient of RNZAF Base Woodbourne (SW2 and SW3) did not show concentrations of total PFHxS, total PFOS, and the sum of total PFHxS + PFOS above the LOR.
- PFOA was not detected above the LOR in any surface water sample.
- PFAS concentrations of all surface water samples were below the adopted guideline values.

7.0 Discussion

Results from this groundwater and surface water sampling investigation indicate that a 'plume' of PFAS contaminated groundwater exists to the east of the RNZAF Base Woodbourne. Albeit the majority of sample results were below the adopted guideline values, 33% of samples tested in this investigation showed detectable concentrations of PFAS compounds, in a predominantly easterly direction beyond the RNZAF Base.

7.1 Groundwater Users

7.1.1 Drinking Water

Of the 67 groundwater samples tested, 22 samples (33%) reported concentrations of PFAS above the LOR. Of these 22 samples, landowners/occupants at 13 sampling sites have indicated the water is used for potable or domestic supply; six sites have not specified water usage, and three sites are not used for drinking water purposes.

Groundwater sampled from two locations east of the RNZAF Base reported a concentration of the sum of total PFOS + PFHxS exceeding the interim drinking water guidelines (MoH, 2017). Levels of PFOA for these two samples were below the interim drinking water guidelines. Landowners/occupants at these two locations have indicated that groundwater from these sampling points is used for potable water on-site.

7.1.2 Non-potable Stock Watering and Fodder Irrigation

Sample results have been compared to the site specific screening values (EnRisks, 2017) (refer Table 2). These screening values are used to assess the risk of on-farm consumption of farm grown products (e.g. home kill) only, which is a more conservative exposure pathway given the potential for consumption of larger quantities of beef, milk or eggs from a single animal. These screening values and are not applicable for produce supplied to the general market. Screening values defined for beef would also be a conservative screening value for the consumption of sheep meat (EnRisks, 2017).

Fourteen samples reported concentrations above the screening value for milk consumption (home grown) (stock watering and fodder irrigation). Of these 14

samples, one site indicated use for irrigation, two for irrigation and potable supply, six for potable supply, one for non-potable supply, and four sites did not specify water usage. Sampling teams noted the presence of stock (cows) at one of these locations during sampling.

12 samples reported concentrations above the screening value for milk consumption (home grown) (stock watering only). Of these 12 sites, one indicated use for irrigation, two for irrigation and potable supply, seven for potable supply, one for non-potable supply, and one site did not specify water usage. Sampling teams noted the presence of stock (cows) at one of these locations during sampling.

7.1.3 Vineyard Irrigation

No guideline values exist in regard to vineyards using PFAS contaminated irrigation water, or the products of vineyards exposed to PFAS contamination. Of the 22 samples which reported concentrations of PFAS above the LOR, sampling teams noted the presence of vineyards at eight locations. Due to the nature of the surrounding Woodbourne area, testing of produce (grapes, grapevine plants) should be considered in subsequent stages of investigation.

7.2 Surface Water Receptors

PFAS concentrations of all surface water samples were below the adopted guideline values. It is noted that during the sampling round, unusually dry conditions were encountered. This influenced the number of surface water samples able to be collected within the external sampling campaign; several sites where drains or small streams were indicated by site owners were unable to be sampled due to a lack of surface water. It is recommended that dry streams within the investigation area be revisited and sampled in wet conditions.

7.3 Current Estimate of Detection of PFAS in Groundwater

Based on the results of the samples collected in this sampling investigation, the highest concentrations of the sum of total PFHxS and PFOS beyond the RNZAF Base Woodbourne have been found in an easterly direction:

- Bores within 1,600 m of the eastern boundary of RNZAF Base Woodbourne, including two bores just to the north of Middle Renwick Road, show concentrations of 0.0016 - 0.035 µg/L. These bores have screen depths recorded from 17.1 m – 21.8 m deep.
- More distant bores located 1,800 – 2,600 m east, in the vicinity of Bells Road show higher PFHxS + PFOS concentrations of 0.035 – 0.078 µg/L. These bores have screen depths recorded from 7 m - 16.5 m deep.

The distribution of these bores suggest a general easterly direction of contaminant migration with the groundwater drainage effect of Old Fairhall

Creek and the Fairhall Co-op Drain, likely contributing to the spread of the PFHxS + PFOS concentrations in the vicinity of Bells Road. The slightly lower concentrations closer to the RNZAF Base Woodbourne may simply reflect the greater depth of those bores, with higher concentrations likely to occur in shallower groundwater.

A single surface water sample (SW4) on the eastern (downgradient) side of the RNZAF Base Woodbourne was collected from the Fairhall Co-op Drain, where it crosses Bells Road and shows a low sum of total PFHxS + PFOS concentration of 0.0025 µg/L. This is significantly lower than the concentrations in groundwater to the north, most likely due to the dilution from other groundwater and surface water entering the drain, particularly from the south side.

Very low detections (sum of total PFHxS + PFOS < 0.005 µg/L) have also occurred in three locations:

- An isolated detection at GW19 at the north-west corner of the RNZAF Base Woodbourne.
- Four bores (GW10, GW51, GW62 and GW53) near the intersection of Burnside Avenue and Old Renwick Road.
- A single detection at GW60 to the east of more elevated concentrations on the north side of the Fairhall Co-op drain.

Such low detections, as highlighted above, may not be a real presence of PFAS in the groundwater but may reflect uncertainty of measurement or sampling and/or analysis error. These should be confirmed by re-sampling.

The results of this sampling investigation, and hydrogeological information for the Woodbourne area, were used to estimate the potential extent of PFHxS + PFOS above the LOR in groundwater.

7.3.1 Detection Out of Sampling Area

Bore GW17 (168 m deep) near the south western corner of RNZAF Base Woodbourne, reported concentrations of perfluoroundecanoic acid (PFUnDA) slightly above the LOR (0.0011 µg/L). All other PFAS compounds were below the LOR. This bore has been excluded from the Recommended Stage 2 Investigation Area, however, to determine the source of PFAS, or if this result is a product of laboratory error, it is recommended that GW17 should be re-sampled.

All sampling sites from this investigation to the north, west and south (up gradient) of the RNZAF Base Woodbourne have been excluded from the recommended Stage 2 Investigation Area based on all PFAS compounds reporting concentrations below the LOR (excluding GW17).

7.3.2 Estimated Limit of Detection Limitations

Due to their physiochemical properties, the fate and transport of PFAS is complicated and poorly understood. As such, extrapolation of these results, particularly to locations down-gradient, is uncertain and may not represent the actual conditions present. On this basis any assessment of risk to receptors located outside the current investigation area is limited.

8.0 Recommendations

8.1 Recommended Stage 2 Investigation

The detection of elevated concentrations of PFAS away from RNZAF Base Woodbourne warrants further monitoring and assessment to determine the extent and variability of concentrations.

It is recommended that any bores with concentrations above the detection limits and neighbouring bores in the general, or downgradient easterly direction should be sampled on a minimum of three occasions approximately as follows:

- February – to coincide with annual low-flow conditions.
- Late March - June – to coincide with 'first flush' of wet weather and potentially associated with higher PFAS concentrations.
- August/September – to coincide with annual groundwater high.

Furthermore it is recommended that the spring-fed streams that flow through the area should be sampled at both upstream (near Bells Road) and downstream locations (in the vicinity of Battys Road and Murphys Road).

An expanded investigation area (the 'Recommended Stage 2 Investigation Area'), is recommended. Outside of this area, the current information suggests that bores to the west, north and south would not be expected to be affected by PFAS chemicals. The extent of the possible migration further to the east is uncertain, but the expanded Stage 2 Investigation area in that direction will help to further define the estimated plume extent.

It is recommended that detailed information on water use is collected for all Stage 2 sampling locations.

All results from this additional sampling should be reviewed after each sampling round to determine what further monitoring and/or mitigation action is required.

9.0 References

AGDoH, 2017. *Final Health Based Guidance Values for PFAS for use in site investigations in Australia.* The Department of Health, Australian Government, Canberra, Australia. Sourced 15/05/2017 https://www.health.gov.au/internet/main/publishing.nsf/Content/2200FE086D480353CA2580C900817CDC/$File/fs-Health-Based-Guidance-Values.pdf

CONCAWE, 2016. *Environmental Fate and Effects of Poly- and Perfluoroalkyl Substances (PFAS)*. Report No. 8/16. 23 June 2016.

EnRiskS, 2017. *Livestock Uptake Modelling and Screening Criteria Development for PFAS, draft.* Revision C. Environmental Risk Sciences Pty Ltd. 1 November 2017.

MoH, 2017. *Poly-fluoroalkyl substances (PFASs), also called perfluoroalkyl substances (PFASs)* draft, Ministry of Health November 2017.

Appendix A

Site Description

Appendix A: Site Description

Geology – the Wairau Plain

RNZAF Base Woodbourne occurs on the Wairau Plain, which is an extensive deposit of unconsolidated sediments formed by glacial and river processes and derived primarily from the sediments of the Wairau River Valley, with smaller contributions from the valleys along the southern margin of the Wairau Plain.

The deposited sediments are originally derived from the erosion of rock fragments from mountainous catchments, and therefore cover a wide range of particle sizes, from gravels and larger sizes down to sands, silts and clay sized particles.

The Wairau Plain has built up over deposits formed throughout the ice ages over the last several hundred thousands of years, which comprised a successive sequence of colder glacial periods, separated by warmer interglacial periods. During the glacial periods, large volumes of gravel, sand, silt and clay were eroded from the Wairau River's mountainous catchment in the south-west and deposited as a poorly sorted mixture of grain sizes over the area by the alluvial processes of gravel bed rivers. During the interglacial periods, the contribution of new sediment to the plain was significantly less and many of the glacial deposits were reworked by the gravel bed river processes of the Wairau River and the Southern Valley rivers.

These gravel bed rivers are characterised by multiple, interlinking braided channels of flowing water within a broad active bed. Course changes over time periods of hundreds of thousands of years have built up the Wairau Plain, which contain gravelly strata extending to thicknesses of a few hundred metres.

As a result of these processes, the Wairau Plain is comprised of a complex mixture of gravels, sand, silt and clay originating from the higher catchment areas to the west and south of the Plain. These sediments are sorted to varying degrees ranging from poorly sorted mixtures of all grain sizes, through to better sorted deposits with gravels and coarse sand (with a lesser amount of finer sized particles) in some zones and fine sand, silt and clays in other zones.

Geological units in the vicinity of, and downgradient of, Woodbourne

The upper 50 m of strata in the Woodbourne area comprises three geologic formations – the older Speargrass Formation, and the overlying Early Rapaura Formation and Late Rapaura Formation.

The Speargrass Formation represents sediments that are generally of a lower permeability compared to the overlying, better sorted Rapaura Formation. The Speargrass Formation has a thickness of around 40 m in the area east of Woodbourne. Some of the older sedimentary deposits on the Wairau Plain were

reworked by river processes to form the Rapaura Formation which varies from around 0–15 m thick in the area east of Woodbourne.

The shallowest geological unit in the area is the recent gravel deposits associated with the present day river channels.

Hydrogeology

With regard to groundwater flow, more rapid movement occurs through the more permeable coarser grained well-sorted zones of strata, whilst slower movement occurs through the sandy and silty zones.

Due to the nature of the river depositional processes these strata typically have a greater permeability in the direction of flowing water at the time of sediment deposition, with a lower permeability at right angles to the direction of deposition and the lowest permeability in the vertical direction.

These river-derived zones of strata are laid down in lenses parallel to the topography at the time of deposition (i.e. roughly horizontal). The lenses of finer grained sand and silt restrict the vertical permeability, but do not totally inhibit it, due to their lack of consistency and lateral continuity. This depositional behaviour encourages lateral groundwater flow through the strata, particularly in the direction in which the strata were deposited.

Due to the meandering pattern of many of these river processes, there can be variable orientations of the deposited strata on a small to medium scale (e.g. less than around 200 m). However, on a larger scale of a few hundred metres and more, the general direction of the highest permeability is expected to coincide with the direction of strata deposition.

Hydrology

The rate and direction of groundwater flow through these gravel deposits is determined by the location and rate of inflow to the aquifer (recharge), the location and rate of discharge from the aquifer and the hydraulic conductivity (related to permeability) of the strata through which the groundwater flows between the recharge and discharge areas.

At the eastern (downgradient) end of the Woodbourne Road area, the groundwater originates from seepage losses from surface waterways and infiltration of rainfall on the gravel plain. Sources of river seepage come primarily from the Southern Valley outflows from the Omaka River, Mill Stream, the Fairhall River, Golf Course Creek and Doctors Creek. Surface flows in these rivers readily infiltrate water to the aquifers and the length of flowing water in the surface channel varies depending on the amount of flow in the upper catchment and the groundwater level surrounding the river channel.

At a more localised scale, seasonal variations in groundwater flow direction will occur. Davidson and Wilson (2011) address seasonally varying groundwater flow

directions entering the Woodbourne area. During wetter months, the groundwater flow direction reflects the contour of the land, i.e. south-west to north-east. During summer months, the source of recharge to the Woodbourne area changes from the south-west to the north-west, creating a more easterly groundwater flow direction.

A further influence to groundwater flow direction is the springfed streams that typically emerge east of Bells Road. These flow at rates of a few tens of L/s to 100s of L/s and act as drains which draw groundwater towards them.

Consequently the typical groundwater flow direction leaving RNZAF Base Woodbourne, as determined by groundwater elevations and the orientation of the strata is expected to be in a general easterly direction with the potential for variations due to heterogeneity of the strata and the variable influences of streams, seasonal variations and pumping bores.

References

Davidson, P and Wilson, S, 2011, Groundwaters of Marlborough, ISBN 978-1-927159-03-3, Published by Marlborough District Council.

Appendix B

Quality Assurance / Quality Control Summary

ESDAT QA Checker
Project:Combined Database
Filter: SDG in('AO2744105 WBN','AO2744105 (WBN)')

Overview Summary
- Count of Samples
- Count of Results

Holding Times

Blanks
- Detects in Blanks (5)

Duplicates
- Field and Interlab Duplicates
- Lab Duplicates with high RPDs (0)
- Duplicate Samples with incorrect or missing Parent Samples (0)

Lab Control Samples
- SDG's without a Laboratory Control Sample (0)
- Laboratory Control Samples, Error > 25% (0)

Contents

Count of Samples

Matrix Type	Water
First Sample Date	7/12/2017
Last Sample Date	20/12/2017
Sampling Period (days)	14
Number of Samples Submitted	126
Number of Non QA Samples Submitted	70
Number of Field Blanks	14
Number of Trip Blanks	16
Number of Rinsates	11
Number of Field Duplicates	15
Number of Trip Spikes	0
Number of Lab Duplicates	2
Number of LCSs	0
Number of CRMs	0
Number of Method Blanks	3
Number of Storage Blanks	0
Number of Matrix Spikes	0
Number of Matrix Spike Dupes	0

Contents

Detects in Blanks

SDG	Lab_Report_Number	Matrix_Type	SampleCode	Field_ID	Depth	Sampled_Date-Time	Sample_Type	Compound	Prefix	Result	Extraction_Date
AO2744105 WBN	987782	Water	AO02744105 (WBN)_WBN_ADJ_GWM_1_081217	WBN_ADJ_GWM_1_081217		8/12/2017	Rinsate	6:2 FTS		6.6 ng/L	13/12/2017
AO2744105 WBN	969551	Water	AO2744105 WBN_WBN_ADJ_GWS_1_081217	WBN_ADJ_GWS_1_081217		8/12/2017	Rinsate	6:2 FTS		10 ng/L	13/12/2017
AO2744105 WBN	988852	Water	AO2744105 WBN_WBN_ADJ_GWBB_1_181217	WBN_ADJ_GWBB_1_181217		18/12/2017	Rinsate	6:2 FTS		4.8 ng/L	27/12/2017
AO2744105 WBN	988858	Water	AO2744105 WBN_WBN_ADJ_GWBA_1_181217	WBN_ADJ_GWBA_1_181217		18/12/2017	Trip_B	PFBA		5.7 ng/L	27/12/2017
AO2744105 WBN	988924	Water	AO2744105 WBN_WBN_ADJ_GWI_1_081217	WBN_ADJ_GWI_1_081217		8/12/2017	Rinsate	6:2 FTS		5.3 ng/L	13/12/2017

Appendix C

Results Tables – Samples Above LOR Only

Table C-1: Groundwater Sampling Results - Per- and Poly-Fluoroalkyl Substances (PFAS) Detections Only - Drinking Water [1]

			Sum PFHxS+PFOS (1) [3]	PFOA
Limit of Reporting			0.001	0.001
Interim Guidance Level for Drinking Water, MoH 2017 [2]			0.07	0.56
Sample Name	**Location**	**Date Sampled**		
WBN_ADJ_GW6_1_071217	GW6	7/12/2017	0.065	0.0034
WBN_ADJ_GW10_1_081217	GW10	8/12/2017	0.0014	-
WBN_ADJ_GW19_1_111217	GW19	11/12/2017	0.0037	-
WBN_ADJ_GW20_1_121217	GW20	12/12/2017	0.018	0.0015
WBN_ADJ_GW21_1_121217	GW21	12/12/2017	0.032	0.0018
WBN_ADJ_GW23_1_121217	GW23	12/12/2017	0.035	0.0029
WBN_ADJ_GW25_1_121217	GW25	12/12/2017	0.028	0.0016
WBN_ADJ_GW27_1_121217	GW27	12/12/2017	0.017	0.0013
WBN_ADJ_GW32_1_121217	GW32	12/12/2017	0.078	0.0038
WBN_ADJ_GW34_1_131217	GW34	13/12/2017	0.043	0.0019
WBN_ADJ_GW35_1_131217	GW35	13/12/2017	0.038	0.0012
WBN_ADJ_GW36_1_131217	GW36	13/12/2017	0.039	0.0013
WBN_ADJ_GW37_1_131217	GW37	13/12/2017	0.037	0.002
WBN_ADJ_GW45-1_131217	GW45	13/12/2017	0.0029	-
WBN_ADJ_GW51_1_141217	GW51	14/12/2017	0.0033	-
WBN_ADJ_GW53_1_141217	GW53	14/12/2017	0.0032	-
WBN_ADJ_GW55_1_141217	GW55	14/12/2017	0.0016	-
WBN_ADJ_GW56_1_141217	GW56	14/12/2017	0.075	0.0048
WBN_ADJ_GW57_1_141217	GW57	14/12/2017	0.035	0.0023
WBN_ADJ_GW60_1_151217	GW60	15/12/2017	0.004	-
WBN_ADJ_GW62_1_181217	GW62	18/12/2017	0.0019	-
WBN_ADJ_GW69_1_191217	GW69	19/12/2017	0.067	0.0034
Statistical Summary				
Number of Results			22	14
Minimum Concentration			0.0014	0.0012
Maximum Concentration			0.078	0.0048
Median Concentration			0.03	0.00195
Number of Guideline Exceedances			2	0

Notes:

1. Values in µg/L (parts per billion).

2. Interim Guidance Level for Drinking Water, MoH 2017. Sourced from Australian Government Department of Health - Health Based Guidance Values for PFAS accessed 01/06/2017 (https://www.health.gov.au/internet/main/publishing.nsf/Content/2200FE086D480353CA2580C900817CDC/$File/fs-Health-Based-Guidance-Values.pdf).

3. Summations are made by adding compounds Total PFOS (7), Total PFHxS (3) together. Where one compound is below detection, it is not included in the summation.

-	Less than the laboratory level of reporting

Table C-2: Groundwater Sampling Results - Per- and Poly-Fluoroalkyl Substances (PFAS) Detections Only - Non-potable, Stock Water and Fodder Irrigation [1]

	Sum PFHxS+PFOS (1) [4]	PFOA	Total PFHxS (3) [5]	Total PFOS (7) [5]
Limit of Reporting	0.001	0.001	0.001	0.001
Non Potable Water / Contact Recreation Guideline [2]	0.7	5.6	No GL	No GL
SSSV - Beef Consumption (home grown) (Stock Watering and Fodder Irrigation) [3]	No GL	**60**	**0.06**	**0.05**
SSSV - Beef Consumption (home grown) (Stock Watering Only) [3]	No GL	150	0.1	0.1
SSSV - Egg Consumption (home grown) (Stock Watering Only) [3]	No GL	*4*	*0.2*	*0.09*
SSSV - Milk Consumption (home grown) (Stock Watering and Fodder Irrigation) [3]	No GL	14	0.008	0.008
SSSV - Milk Consumption (home grown) (Stock Watering Only) [3]	No GL	30	0.02	0.02

Sample Name	Location	Date Sampled				
WBN_ADJ_GW6_1_071217	GW6	7/12/2017	0.065	0.0034	0.026	0.039
WBN_ADJ_GW10_1_081217	GW10	8/12/2017	0.0014	-	-	0.0014
WBN_ADJ_GW19_1_111217	GW19	11/12/2017	0.0037	-	-	0.0037
WBN_ADJ_GW20_1_121217	GW20	12/12/2017	0.018	0.0015	0.0098	0.0083
WBN_ADJ_GW21_1_121217	GW21	12/12/2017	0.032	0.0018	0.02	0.012
WBN_ADJ_GW23_1_121217	GW23	12/12/2017	0.035	0.0029	0.022	0.013
WBN_ADJ_GW25_1_121217	GW25	12/12/2017	0.028	0.0016	0.02	0.0077
WBN_ADJ_GW27_1_121217	GW27	12/12/2017	0.017	0.0013	0.0079	0.0091
WBN_ADJ_GW32_1_121217	GW32	12/12/2017	0.078	0.0038	0.056	0.022
WBN_ADJ_GW34_1_131217	GW34	13/12/2017	0.043	0.0019	0.032	0.011
WBN_ADJ_GW35_1_131217	GW35	13/12/2017	0.038	0.0012	0.025	0.013
WBN_ADJ_GW36_1_131217	GW36	13/12/2017	0.039	0.0013	0.025	0.014
WBN_ADJ_GW37_1_131217	GW37	13/12/2017	0.037	0.002	0.015	0.022
WBN_ADJ_GW45-1_131217	GW45	13/12/2017	0.0029	-	0.0029	-
WBN_ADJ_GW51_1_141217	GW51	14/12/2017	0.0033	-	0.001	0.0023
WBN_ADJ_GW53_1_141217	GW53	14/12/2017	0.0032	-	0.0012	0.002
WBN_ADJ_GW55_1_141217	GW55	14/12/2017	0.0016	-	0.0016	-
WBN_ADJ_GW56_1_141217	GW56	14/12/2017	0.075	0.0048	0.056	0.019
WBN_ADJ_GW57_1_141217	GW57	14/12/2017	0.035	0.0023	0.015	0.02
WBN_ADJ_GW60_1_151217	GW60	15/12/2017	0.004	-	0.0023	0.0017
WBN_ADJ_GW62_1_181217	GW62	18/12/2017	0.0019	-	-	0.0019
WBN_ADJ_GW69_1_191217	GW69	19/12/2017	0.067	0.0034	0.046	0.021

Statistical Summary

Number of Results	22	14	19	20
Minimum Concentration	0.0014	0.0012	0.001	0.0014
Maximum Concentration	0.078	0.0048	0.056	0.039
Median Concentration	0.03	0.00195	0.02	0.0115
Number of Guideline Exceedances	0	0	13	13

Notes:

1. Values in µg/L (parts per billion).

2. Australian Government Department of Health - Health Based Guidance Values for PFAS accessed 01/06/2017 (https://www.health.gov.au/internet/main/publishing.nsf/Content/2200FE086D480353CA2580C900817CDC/$File/fs-Health-Based-Guidance-Values.pdf).

3. Site specific screening values from *Livestock Uptake Modelling and Screening Criteria Development for PFAS* . EnRisks, November 2017. Screening values calculated using a scenario of 10% of the tolerable daily intake. This is the most conservative scenario developed.

4. Total PFOS, PFHxS are calculated by summing monoethyl, dimethyl and linear isomers. Where an isomer is below the detection limit it is not added to the summation. This is following the method in the reported lab results.

5. Summations are made by adding compounds Total PFOS (7), Total PFHxS (3) together. Where one compound is below detection, it is not included in the summation.

No GL	No Guideline or Screening Value
-	Less than the laboratory level of reporting

Table C-3: Surface Water Sampling Results - Per- and Poly-Fluoroalkyl Substances (PFAS) Detections Only - Non-potable, Stock Water and Fodder Irrigation [1]

			Sum PFHxS+PFOS (1) [4]	PFOA	Total PFHxS (3) [5]	Total PFOS (7) [5]
Limit of Reporting			0.001	0.001	0.001	0.001
Non Potable Water / Contact Recreation Guideline [2]			0.7	5.6	No GL	No GL
SSSV - Beef Consumption (home grown) (Stock Watering and Fodder Irrigation) [3]			No GL	**60**	**0.06**	**0.05**
SSSV - Beef Consumption (home grown) (Stock Watering Only) [3]			No GL	150	0.1	0.1
SSSV - Egg Consumption (home grown) (Stock Watering Only) [3]			No GL	*4*	*0.2*	*0.09*
SSSV - Milk Consumption (home grown) (Stock Watering and Fodder Irrigation) [3]			No GL	14	0.008	0.008
SSSV - Milk Consumption (home grown) (Stock Watering Only) [3]			No GL	30	0.02	0.02
Sample Name	**Location**	**Date Sampled**				
WBN_ADJ_SW4_1_141217	SW4	14/12/2017	0.0025	-	0.0013	0.0012
Statistical Summary						
Number of Results			1	1	1	1
Minimum Concentration			0.0025	NA	0.0013	0.0012
Maximum Concentration			0.0025	NA	0.0013	0.0012
Median Concentration			0.0025	NA	0.0013	0.0012
Number of Guideline Exceedances			0	0	0	0

Notes:

1. Values in µg/L (parts per billion).

2. Australian Government Department of Health - Health Based Guidance Values for PFAS accessed 01/06/2017 (https://www.health.gov.au/internet/main/publishing.nsf/Content/2200FE086D480353CA2580C900817CDC/$File/fs-Health-Based-Guidance-Values.pdf).

3. Site specific screening values from *Livestock Uptake Modelling and Screening Criteria Development for PFAS* . EnRisks, November 2017. Screening values calculated using a scenario of 10% of the tolerable daily intake. This is the most conservative scenario developed.

4. Total PFOS, PFHxS are calculated by summing monoethyl, dimethyl and linear isomers. Where an isomer is below the detection limit it is not added to the summation. This is following the method in the reported lab results.

5. Summations are made by adding compounds Total PFOS (7), Total PFHxS (3) together. Where one compound is below detection, it is not included in the summation.

No GL	No Guideline or Screening Value
-	Less than the laboratory level of reporting