STATES OF JERSEY

PFAS AND WATER QUALITY IN JERSEY 2019: AN INTERIM REPORT FROM OFFICER TECHNICAL GROUP – JULY 2019

Presented to the States on 15th July 2019
by the Minister for the Environment

STATES GREFFE

Government of JERSEY

PFAS and water quality in Jersey 2019

An interim report from Officer Technical Group

July 2019

Gouvèrnément d'JÈRRI

Contents

Note from the Minister for the Environment

I would like to thank the members of both the Officer Technical Group and the Political Board for their work in producing this interim report, and to those organisations and individuals who have helped them.

Its findings and recommendations mark a milestone in understanding the safety of Jersey's water supply, particularly for those islanders who are not connected to the mains supply.

My political board and I will now consider the recommendations in this report.

Deputy John Young
Minister for the Environment
July 2019

Executive summary

In December 2018 a private water supply (borehole), north of the Airport (and outside the historic St Ouen's Bay plume), was tested for PFOS at the request of the householder.

Traces of PFOS and PFOA (both part of the PFAS group of chemicals) were found, and it was agreed to conduct a more detailed testing program of other private water supplies and streams around the north of the Airport, which revealed further traces of PFOS and PFOA.

The Minister for the Environment, Deputy John Young, established a political board and an officer technical group to investigate the issue and to make recommendations as required.

Between March and June 2019, a testing programme was undertaken across the island and from different sources. In addition to PFOS and PFOA, there was screening and analysis for pesticides and other chemicals. This comprehensive sampling from private water supplies (boreholes and wells) will continue and supports the routine water quality monitoring undertaken by GHE[1] and Jersey Water.

Results

PFOS results

Trace levels of PFOS and PFOA were identified in the majority of private water supplies sampled (both north of the Airport and across the island). Levels found north of the Airport were the same as levels found across the island. All levels were comparable with levels found in other countries, indicating that the situation in Jersey in not uncommon.

The PFOS and PFOA results in groundwater show that current levels do not warrant any public health concerns. However, stream levels around the south of the Airport and the Pont Marquet area have higher levels and these require further testing.

A single sample from a rain water tank contained traces of PFOS and PFOA, possibly as the result of them being present in rainwater, or from another source. Further testing is therefore required to determine whether PFAS are in rain or not.

No traces of either PFOS or PFOA were identified in potatoes irrigated with water from the main St Ouen's Bay PFAS plume or in milk from dairy herds. There is nothing to suggest that the trace levels shown in the testing to date has had an effect on animal or plant health.

Worldwide, research into the relationship between PFAS exposure and health effects is limited and has concluded that there is no current evidence that supports a large impact on a person's health as a result of high levels of PFAS exposure.

[1] Principally by Environmental Protection

Other results

Testing for nitrates confirms previous findings[2] that approximately half of households supplied by private water systems have supplies with water exceeding the EU and local drinking water limit of 50mg/l[3].

Several of the private water supplies tested contained traces of pesticides and other chemicals. Some were over the prescribed legal limit of 0.1ug/l (a precautionary level based on the limit of detection).

PFAS and health

Worldwide, there has been considerable research into the relationship between PFAS exposure and health effects. This has been summarised in three major reviews conducted and published recently by the national public health authorities in Australia, Canada and the United States. The reports of these reviews are summarised in the Health Effects Chapter of this report. The consensus is that there is no evidence to date confirming adverse effects on human health caused by exposure to PFAS.

All the expert reports – Australia, Canada and the US – are consistent in the view that there are potential health effects, none established definitively, and that further research is needed to clarify any associations. They are also all of the same conclusion that no specific health screening is appropriate or warranted.

However, it remains good advice for people to avoid exposure to these substances where possible. Complete avoidance of PFAS exposure is impossible as the substances are present at low levels in the environment in all societies in western civilisation.

Conclusions

The immediate risk of inappropriate substances in water relate solely to private supplies (privately owned boreholes and wells) [4] which are inherently risky because there is no standard treatment process and householders may not be following advice to have them tested regularly and treated. Further testing is required to determine the efficacy of the various treatment systems that are available for householders to treat private water supplies.

Public water supplied by Jersey Water is regularly tested[5], managed (by blending sources), treated to an optimal level and indeed regulated for quality[6]. No issues were identified with the public water supply which is of high quality and meets all of the regulatory requirements.

Whilst this immediate work has not highlighted any immediate red flag public health issues, which would require the Government to immediately step in, work will need to continue to ensure that inappropriate substances do not find their way into water resources, and that householders with private water supplies are aware of what they need to do to keep their

---

2 Analysis of samples submitted to the Government Official States Analyst laboratory and ongoing monitoring by GHE.

3 The majority of these (40) across island are raw water quality (pre-treatment), although eight from the airport area were post treatment.

4 A private water supply is one which is not provided by Jersey Water. The responsibility for its maintenance and repair lies with the owner or person who uses it.

5 Some 45,000 separate tests for pesticides per annum alone.

6 The Water (Jersey) Law 1972, as amended

own water supply as safe as possible. The work has shown that Jersey should not take its water quality for granted and should not be complacent over the threats to it, and the knock-on impacts to the islands water supply and public health.

The forthcoming work on a revised Water Law for the Island is a real opportunity to tackle issues in relation to private supplies. When this is coupled with better testing regimes and services, and better information, this inherent risk can be reduced.

The work has highlighted the good partnership working with a variety of stakeholders, particularly the Action for Cleaner Water Group[7]. This group underpins the Government agreed Island's Water Plan (2017-2021) that delivers key Government strategic goals. The plan also addresses pesticides and nitrates which are a focus of this report.

So far, the success of the plan (lowering of nitrate and pesticide levels) have been largely due to voluntary measures brought by the agricultural and dairy sectors. According to the Plan and under the Water Pollution (Jersey) Law 2000, Water Management Orders will shortly be enacted. These require proper funding which, although relatively small (£100,000 per annum), could produce marked benefits. The next iteration of the plan is likely to also to encompass a more combined strategic approach on both water quality and quantity (supply) and this links into the current water supply work being undertaken by Jersey Water.

It will be important to continue to engage with elected representatives and the wider community, especially in relation to public health concerns from private water supply owners, and the recommendations around engagement will help this.

Recommendations

Recommendations - Sampling program and further investigation

Recommendation 1	Shallow boreholes and wells close to Jubilee Hill, north of the airport that are used for drinking water are identified and sampled.
Recommendation 2	An investigation is undertaken to determine the sources of these higher levels of PFOS and PFOA, especially those emanating from the drainage of the airport. This is a view to potential remediation. As a result the formal regulatory position should at this stage be reserved.
Recommendation 3	More detailed testing of rainwater for PFAS is undertaken.
Recommendation 4	Further sampling and investigation of the efficacy of various household treatment systems is undertaken so that Environmental Health can advise the public. This should include the potential impact of waste streams from such systems.
Recommendation 5	A system is developed to enable private households and businesses to test their water for pesticides and PFAS and their derivatives.

7 A working group of Jersey Water, agriculture, dairy, Jersey Farmers Union and RJA&HS representatives and Growth, Housing and Environment officers that works in partnership to address diffuse pollution issues (principally high nitrates and pesticide detections through the Government Water Management Plan). The group is chaired by the Deputy Minister for the Environment.

Recommendations - The Water Management Plan / other studies - remediation

Recommendations 6	Further work is undertaken to lower nitrate and pesticide levels both in surface and groundwater. These areas were identified in the 'Challenges for the water environment of Jersey' and the 'Water Management Plan'[8] which was agreed by the States in Dec. 2016. Certain elements of the implementation of the Plan have progressed. These are mainly through voluntary initiatives of the agricultural and dairy sectors through the Action for Cleaner Water Group. However, the easy wins have been made. The Water Management Orders and new Water Code brought in under the Water Pollution (Jersey) Law 2000 will shortly be enacted and these elements and the Plan now require adequate funding, if nitrates and pesticide pollution is to be properly addressed[9]. Further work remains to be undertaken in terms of updating the Pesticides (Jersey) Law, 1991.
Recommendation 7	In the absence of a specific compliance parameter in the Water (Jersey) Law 1972 for PFAS, the wide variety of limits internationally and the proposals by the EU to adopt new parameters within the forthcoming Drinking Water Directive, the Government of Jersey should clarify its position in respect of acceptable PFAS concentrations in drinking water and consider the introduction of scientifically derived parameter compliance limits for PFAS within the forthcoming planned amendment to the Water (Jersey) Law 1972
Recommendation 8	A hydrogeological study to determine the extent of the PFAS pollution in St Ouen's Bay, the likely direction of travel of the pollution plume and prognosis for the future is undertaken.
Recommendation 9	Based on the output from the hydrogeological study, a study to investigate and implement options for the remediation of the PFAS pollution in St Ouen's Bay is undertaken.
Recommendation 10	That a hydrogeological study to confirm the initial results and determine the extent of the PFAS pollution in the Pont Marquet catchment (including the effect on boreholes and wells), the likely direction of travel of the pollution plume and prognosis for the future is undertaken.
Recommendation 11	Based on the output from the hydrogeological study, an investigation of the options for the remediation of the PFAS pollution in the Pont Marquet catchment is undertaken.
Recommendation 12	To permanently offset the inherent risk to the pollution of groundwater and to safeguard public health, the island-wide distribution of both mains drains and mains water is recommended. Noting that this will have implications for water resources in the Island.

8 Available at: https://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=2147

9 Following this report, the recommendations and resource implications will need to be assessed

Recommendation 13 That any on-island use of shorter-chained PFAS compounds is identified and a precautionary approach for early withdrawal of those products is undertaken.

Recommendations - Health impacts

Recommendation 14 With their own and families health as the main concern, islanders with private water supplies should ensure they are tested regularly, and pursue measures recommended by their water treatment company to ensure their water is as safe as possible. Environmental Health will continue to produce and update information leaflets and webpages about water quality in private supplies. Individuals with any health concerns should consult their general practitioner.

Recommendation 15 Government does not need at this point to intervene in the water supply from a public health standpoint as tests show that levels of PFAS are generally well within expected regulatory levels. This message will need to be communicated to residents at the same time of the publication of this report, and an ongoing engagement be designed on all issues relating to water quality.

Recommendations- Public engagement

Recommendation 16 Improve awareness of the need to register boreholes and ensure that those with private water supplies are aware of the possibility of pollution, and the importance of regular testing and management of their source (leaflets are in the process of being produced which will support this).

Recommendation 17 Ensure that gov.je is a reliable source of information on pollution and testing methods, and direct those seeking information to the gov.je using social media and traditional media where necessary. This will need to be supplemented by activity for those who do not use digital communication channels.

Recommendation 18 Subject to Data Protection and other regulations, create a database of emails of registered borehole users, to be held by Environmental Health, so that users can be contacted quickly and directly in the event of issues being found.

Report

1. Background

In January 2019, a resident of St Peter, approached the Environmental Health team with Growth, Housing and Environment to request that a drinking water sample be taken from their property, as there was concern with property's private water supply. The resident had specifically asked for a PFOS test as they were aware of the historic issues of PFOS use at the airport.

As a result of this test, traces of PFOS and PFOA (PFAS) were found in the sample and enough concern was raised to warrant the further testing of private water supplies in that immediate vicinity and a wider radius of ground and surface water.

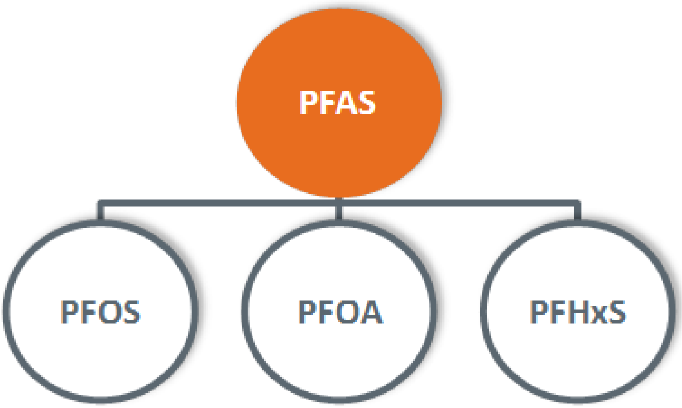
Results from these tests all found traces of PFOS and PFOA. As a result, the creation of a specific officer technical group, reporting to a political briefing board, was agreed by the Environment Minister.

These groups have met on a fortnightly basis since 26 February 2019 (officers) and 8 March (political) to oversee a programme of work to understand what is being witnessed in the water environment, and what implications this may have.

This current work is not related to the historic position in relation to the Fire Training Ground incident to the west of the airport runway and the historic St Ouen's Bay 'Plume Area'. That matter is already known and residents aware. Recommendations will however look to set out a wider island wide approach for the future.

1.1 What is PFOS and PFAS?

PFOS, the substance of particular interest in Jersey because of its presence in some borehole water sources, stands for perfluorooctane sulfonate. It belongs to a group of chemicals known as perfluoroalkyl substances (PFAS). Many of these are emerging anthropogenic compounds that are environmentally persistent and ubiquitous. Other members of the PFAS family include PFOA (perfluorooctanoic acid) and PFHxS (perfluorohexane sulfonate).



Types of PFAS

PFAS do not occur naturally in the environment. They are manufactured chemicals used in products designed to resist heat, oil, stains and water. They have been used extensively around the world to prevent food sticking to cookware, to make sofas and carpets resistant to stains, to make clothes and mattresses more waterproof, and to make some food packaging resistant to grease absorption, as well as in some firefighting foams effective in tackling liquid fuel fires.

Because PFAS help reduce friction, they are also used in a variety of industries including aerospace, automotive, building and construction, and electronics.

PFAS are extremely persistent in the environment because they resist typical environmental degradation processes. They have been found to have contaminated sites where there was historic use of fire-fighting foams containing PFAS. Over time, the chemicals have worked their way through the soil to contaminate surface and ground water, and to have migrated into adjoining areas. As they can bio-accumulate in animals, fish and foods, and may be in water and other drinks, they enter the human food chain.

Because of the potential for harm to health, on a precautionary basis most countries have phased out their use as far as practically possible to reduce human exposure. It is impossible to prevent all PFAS exposure; there are a large number of sources from which people may still get very low exposures. It is considered to be the case, internationally, that everyone generally has low levels of PFAS chemicals in their blood.

1.2 The Political Board

- Deputy John Young, Environment Minister
- Deputy Kevin Lewis, Infrastructure Minister
- Deputy Richard Renouf, Health Minister,
- Constable Richard Vibert, St Peter
- Deputy Rowland Huelin, St Peter

Briefed by Mr A. Scate, Group Director Regulation, Growth, Housing and Environment

Terms of Reference for the Political Board

- To receive fortnightly verbal updates from the Group Director of Regulation on the evolving situation
- To provide political input into the ongoing work of the officer group
- To understand any wider political and public implications relating to the issue
- To provide Council of Ministers a political view on the way forward being recommended by officers

1.3 The Technical Group

- Mr A. Scate, Group Director Regulation, Growth, Housing and Environment (chair)
- Dr S. Turnbull, Medical Officer of Health, Government of Jersey
- Mr S. Petrie, Environmental Health Consultant, Regulation/GHE
- Dr T. Du Feu, Director Environmental Protection, Regulation GHE
- Mrs A. De Bourcier, Acting Director Environmental Health/Trading Standards Consumer Protection, Regulation/GHE
- Mr J. Robert, Head of Water Resources, Environmental Protection, Regulation/GHE
- Mr H. Smith, Chief Executive, Jersey Water
- Mr M. Berridge, Chief Engineer and Water Supply Manager, Jersey Water
- Mr A. Mallinson, Head of Communications, GHE

By invite:

- *Mr T. Knight Jones (until end May 2019), States Vet, Natural Environment, GHE*
- *Mr S. Meadows, Assistant Director Rural Economy, Natural Environment, GHE*

Terms of Reference for the Technical Group

- To meet fortnightly to discuss the evolving PFOS issue
- To provide technical advice to Ministers and the Political Board and produce a report on matters arising
- To oversee a testing programme to assess the issue
- To ensure public information is given on the issue and any health impacts
- To understand any public health issues which are relevant
- To understand any issues relating to animals
- To understand any issues relating to wider ecology
- To make recommendations to Ministers on possible actions

2. The testing programme and results

2.1 Sampling methods and coverage

A total of 126 surface (stream), groundwater (boreholes/wells), mains and rainfall tank water sources were sampled and tested for PFAS (PFOS and PFOA[10]). At some locations, the water samples were also tested for pesticides (separate analytical determinations) and chemistry (including nitrates) (Sect. 2.7).

The sampling sites included:

i Properties at the north and east of the Airport

ii Outfall drainage and surface water streams adjacent to the Airport

iii Island-wide groundwater (boreholes/wells) and surface water (streams)

iv Sampling of mains water and rain water harvest tank supplies.

Properties were selected for sampling either from the database of borehole/wells held by GHE[11] or from requests to sample from the public. All samples from properties were taken from the kitchen tap. These are representative of the water being consumed. Properties with water treatment were sampled both pre and post treatment in order to determine the effectiveness of the treatment against PFOS and PFOA.

All groundwater island control sites (groundwater and surface water) and some properties around the airport were further tested for pesticides[12], chemistry[13] and bacterial content.

Water samples taken for PFOS and PFOA were analysed by the UK accredited laboratory, National Laboratory Service, National Monitoring Services Leeds Laboratory, Olympia House, Gelderd Lane, Leeds. The limit of detection ranged between <0.00009 and 0.001µg/l (micrograms per litre) for PFOS and between <0.00009 and <0.002µg/l for PFOA. The method summary is included in Appendix 2.

Samples taken for pesticide screening analysis underwent multi residue screening by the accredited Concept Life Sciences Laboratory, Cambridge. The limit of detection was 0.1µg/l. The test included a screening for 455 active ingredients and breakdown products. The cost of a test of borehole water was £120 per sample[14].

Samples for chemistry and bacteriological analysis were undertaken by the Government of Jersey Official Analysts Laboratory.

---

10 Other derivatives of PFAS exist but no accredited laboratory to undertake a more detailed analysis than PFOS and PFOA could be identified.

11 A database of all registered and licensed water abstractions https://www.gov.je/Environment/ProtectingEnvironment/Water/Pages/ManagingIslandWater.aspx

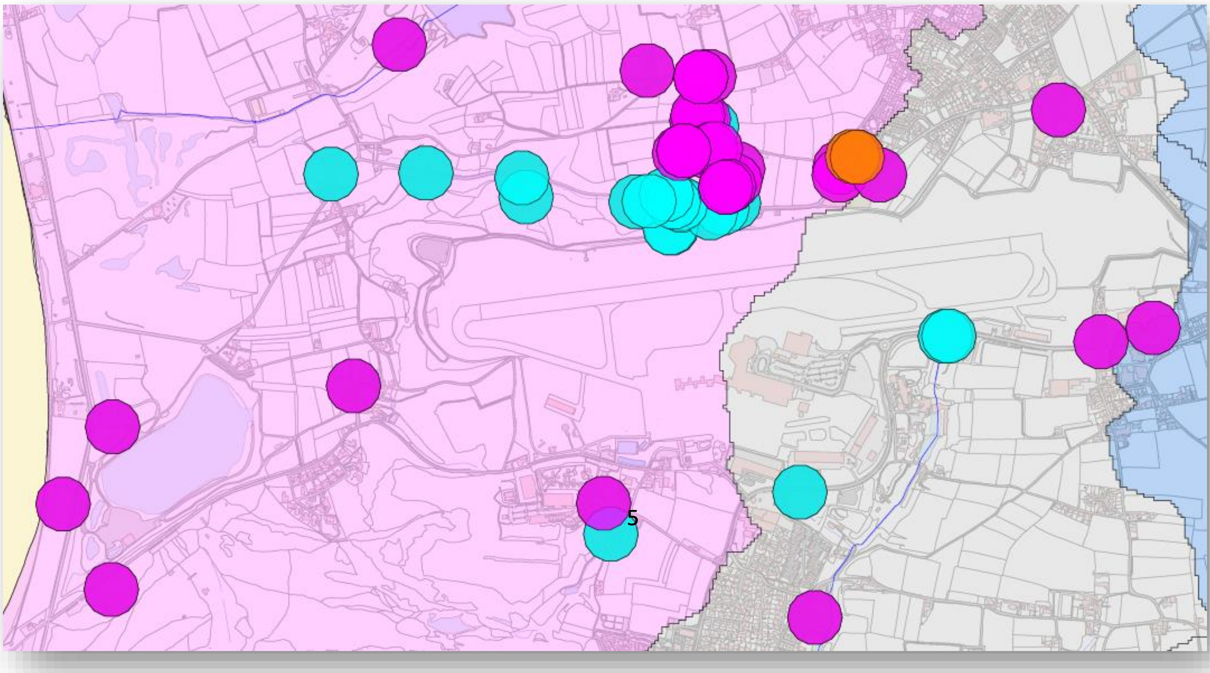
12 Pesticide screening by Central Laboratory Services, UK

13 Water chemistry undertaken by Government of Jersey Official Analyst Laboratory

14 This screening does not include all pesticides used on Jersey, glyphosate for example is excluded. The report addresses this by using other sampling undertaken by GHE.

Table 1 Number of surface and groundwater[15] sites tested for PFOS and PFOA by location

Location	Surface water	Groundwater (boreholes/wells)	Mains water	Rainwater tank
East of Airport		2		
North of Airport	13	24	2	
Drainage from the Airport	8			
Island controls	36	40		1
Total	57	66	2	1



Streams/outfalls (surface water)

Borehole/well (groundwater)

Mains water

15 Excludes samples taken from the St Ouen's Bay historic plume area (currently sampled through Ports of Jersey)

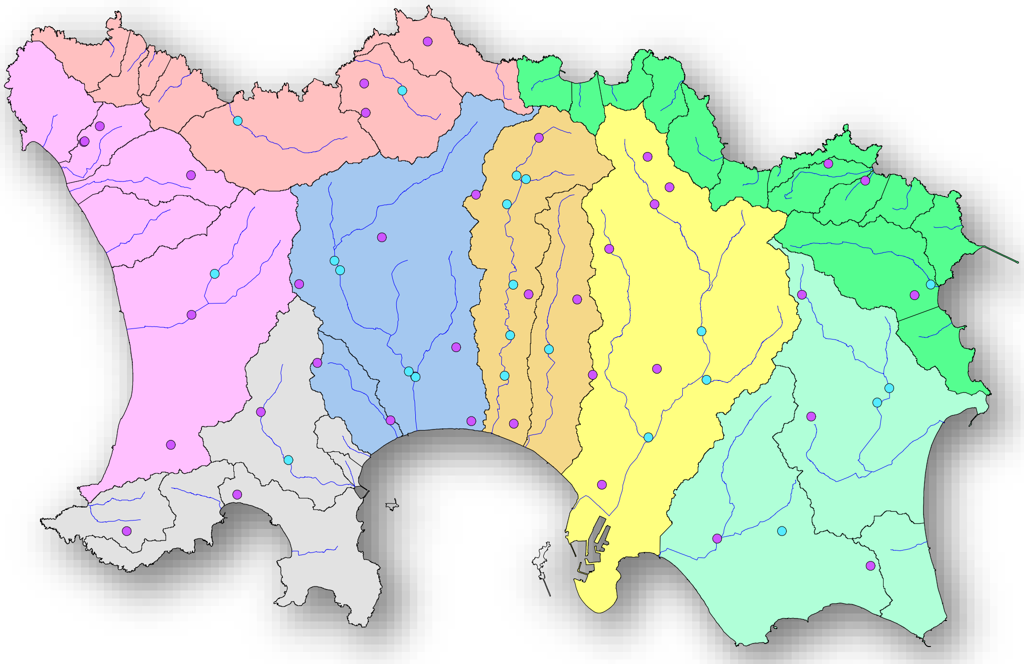


Fig. 1 Sampling locations for PFAS around the Airport, St Peter and Island-wide (the shaded areas indicate separate water catchment management areas[16])

2.2 Results- general overview

The average and maximum concentration of PFOS and PFOA for groundwater and surface water around the airport, the airport drainage and across the island is shown in Table 2.

All recorded levels in groundwater are at trace levels. This is partly a reflection of the low limit of detection by the laboratory (millions of grams per litre). Importantly, the concentration of PFOS[17] and PFOA[18] in groundwater tested in the northern airport area (north of Jubilee Hill) is the same as that recorded across the island.

The average levels in surface water recorded across the island are similar to background values reported in other geographical locations. Vedagiri et al. (2018) evaluated levels of PFOS and PFOA in surface water across North America. They found average levels of PFOS between 0.002-0.046 µg/l and between 0.0004 to 0.287 µg/l for PFOA. Likewise, drinking water levels (representing a combination of surface and groundwater) were around <0.040- 0.043 µg/l for PHOS and <0.020- 0.022 µg/l for PFOA. Atkinson *et al.* (2008) examined five water sources from control non-contaminated sites in the UK. All results from control sites for PFOS were <0.011, whilst the mean level of PFOA was 0.131µg/l. All sites in Jersey, apart for the St Ouen's plume area and the Airport streams and drainage, are currently below these levels. Skutlarek (2006) examined surface water samples from German rivers and found that the sum of seven PFAS compounds was <0.1 µg/l with PFOA being the major compound. This indicates trace background levels.

---

16 A catchment (or drainage basin) is an area where rain water is collected by the natural landscape which then eventually flows into groundwater, a stream or the coast within the catchment.

17 Mann-Whitney U. Non parametric test. P=0.60, Z=0.77

18 Mann-Whitney U test. Non parametric test. P=0.97, Z=0.49

There was no difference in the recorded levels of PFOS[19] and PFOA[20] in groundwater and surface water. However at the north of the airport, the level of PFOS[21] and PFOA[22] was significantly higher in surface water than groundwater. This was a reflection of the high concentration in the Jubilee Hill stream next to the airport that is impacted by higher levels from the airport area via the drainage.

The highest recorded levels recorded existed in the outfall drainage water from the airport where maximum levels of 0.149µg/l of PFOS and 1.7µg/l of PFOA were recorded (at the southern drainage). This is possibly indicative of sources of PFAS from the airport.

The level of PFOS and PFOA are aligned (correlated) for groundwater[23], however are not correlated for surface water[24]. This is strange given that almost all island streams are groundwater fed. However, it may be indicative of differing chemistry at depth (this should not be taken as some good news, as it remains that PFAS are extremely persistent in the environment).

To date, there has been little sampling of boreholes and wells in this southern airport area and more detailed sampling is recommended.

Table 2: The mean and maximum (in brackets) concentration of PFOS and PFOA (µg/l) for surface and groundwater by location

Location	PFOS Groundwater	Surface water	PFOA Groundwater	Surface water
East Airport	0.003 (0.005)		0.001 (0.001)	
North Airport	0.007 (0.059)	0.314 (1.240)	0.007 (0.019)	0.031 (0.045)
Outfall Airport		0.060 (0.149)		0.613 (1.700)
Island Control	0.008 (0.055)	0.006 (0.021)	0.008 (0.036)	0.015 (0.127)
Average	**0.007 (0.059)**	**0.084 (1.240)**	**0.007 (0.036)**	**0.102 (1.700)**

Table 3 shows the levels of PFOS and PFOA recorded across the island compared with the levels in the main St Ouen's Bay plume, the Drinking Water Inspectorate (DWI) in England and Wales definition of wholesomeness of 1.0µg/l and, for a robust understanding, the most stringent non-regulatory lifetime health advisory limits from the US EPA (0.07 µg/l). Interpretation should focus on groundwater supplies, which are commonly used as private water supplies (boreholes and wells).

19 Mann-Whitney U. Non parametric test. P=0.09, Z=-1.67 (no significant difference)
20 Mann-Whitney U. Non parametric test. P=0.11, Z=-1.61 (no significant difference)
21 Two sample Kolmogorov-Smirnov Z test, P=0.00, Z-=2.38
22 Two sample Kolmogorov-Smirnov Z test, P=0.00, Z-=-4.83
23 Pearson's correlation, N=66, r=0.31, P=0.01
24 Pearson's correlation, N=55, r=0.04, P=0.77

Levels of PFOS recorded in island groundwater were on average only 0.08% of those recorded in the main St Ouen's Bay plume area.

PFOS generally has lower actual and suggested drinking water limits than PFOA. The highest level of PFOS found in island groundwater was just under 6% of the DWI definition of wholesomeness of 1.0µg/l. It was also less than the most stringent non-regulatory limit of the US EPA.

Maximum levels of PFOS in island surface water (streams) were again below the DWI definition of wholesomeness, whilst drainage water from the airport exceeded this level. It is recommended that further sampling of surface water takes place in the Jubilee Hill and southern airport area (where the current high levels were recorded) under various weather conditions. As a safeguard, shallow wells in these areas that may serve as drinking water supplies are also recommended to be sampled.

Table 3 The mean and maximum (in brackets) concentration of PFOS (µg/l) of the current sampling compared with levels recorded in the main St Ouen's Bay plume area (as at Oct. 2018)

Location	PFOS level of current sampling (µg/l)	PFOS level in St Ouen's Bay plume area (µg/l)[1]	Current sampling as a percentage of levels in the plume area	Current sampling as a percentage of the UK wholesomeness definition (>1.0µg/l)[2]	Current sampling as a percentage of the most stringent US EPA (>0.07µg/l)[3]
Groundwater – airport and all island	0.007 (0.059)	8.784 (40.50)	0.08% (0.15%)	0.7% (5.9%)	10% (84%)
Surface water- island controls	0.006 (0.021)			0.6% (2.1%)	9% (1%)
Surface water- Airport[4]	0.217 (1.240)			21.7% (124%)	310% (1771%)
Average	0.043 (1.24)	8.784 (40.50)	0.05% (3.00%)		

1 Results from sampling of eight sentinel sites

2 Drinking Water Inspectorate in England and Wales determined that water containing more than 1.0ug/l would not be considered wholesome.

3 Non-regulatory lifetime health advisory limits. This recognises that if PFOS is available then this applies to the sum of the concentration of PFOS and PFOA which for the current sampling of groundwater represents 0.06µg/l (average) and 0.06µg/l (max).

4 Not used as a direct drinking water supply

2.3 Results around the airport

Drainage water from the airport have the highest recorded levels of PFOS and PFOA. The ratio of PFOA to PFOS was highest in all of the sampled outfall drainage (north and south- mean PFOA; 0.656µg/l, PFOS 0.075µg/l).

2.4 Efficacy in removing trace levels of PFOS

Two properties were sampled both before and after treatment of the household water by reverse osmosis. Results for these properties were below the detection limit for both PFOS and PFOA.

This indicates that reverse osmosis might have some effect in treating trace levels of PFOS and PFOA. It is recommended that more properties using water treatment are sampled in order to provide more robust data on their efficacy at removing PFOS and PFOA. Alongside this work, it will be also important to consider the impact to groundwater of any waste streams of such treatment systems draining into the aquifer.

Table 4 The mean concentration of PFOS and PFOA (µg/l) for surface and groundwater by location at the Airport

Location	PFOS Groundwater	PFOS Surface water	PFOA Groundwater	PFOA Surface water
North Upper Valley	0.007		0.007	
North Lower Valley		0.314		0.031
North Airport- outfall		0.027		0.392
South Airport- outfall		0.124		0.920
Average	**0.007**	**0.084**	**0.008**	**0.103**

The concentration of PFOS and PFOA in each of the water catchment areas[25] (see Fig. 1 for areas) is shown in Table 5. This shows that trace concentrations of both PFOS and PFOA exist across the island.

The highest levels of PFOA were seen in the St Ouen's catchment. This is probably a reflection of the higher levels around the Airport and supports the recommendation for more sampling in this area. Interestingly, there was no detection of PFOS in all parks sampled (First Tower, Winston Churchill, Coronation and Parade Parks), whilst at some there was also no detection of PFOA.

Table 5: The mean concentration of PFOS and PFOA (µg/l) by water catchment area

Water Catchment	PFOS Groundwater	PFOS Surface water	PFOA Groundwater	PFOA Surface water	PFOS Sample number	PFOA Sample number
Grands Vaux, Vallee de Vaux and St Helier	0.004	0.004	0.005	0.009	7	6
La Haule and St Peter's Valley	0.003	0.004	0.008	0.008	9	5
Longueville, Queen's Valley and Southeast	0.015	0.011	0.011	0.007	5	3
Northeast	0.004	0.003	0.009	0.006	3	2
Northwest	0.004	0.004	0.008	0.003	3	2

25 A catchment (or drainage basin) is an area where rain water is collected by the natural landscape which then eventually flows into groundwater, a stream or the coast within the catchment.

St Aubin's, St Brelade's and Southwest	0.020	0.015	0.008	0.127	7	1
St Ouen's and West	0.006	0.171	0.007	0.166	26	27
Waterworks Valley and Bellozanne Valley	0.005	0.006	0.008	0.015	6	9
Island average/total sample number	**0.007**	**0.087**	**0.008**	**0.089**	**66**	**55**

2.5 Rainwater tank results

A single sample of water from a rainwater tank, that was not subject to cross contamination from surface or groundwater, was tested. Results show that traces of PFOS and PFOA (0.0206µg/l and 0.0072µg/l respectively) were present.

Further sampling of pure rainwater is recommended as the tank water might have been contaminated by roof tiles, tank linings/debris etc. Without this testing, it cannot at this stage be concluded that rainwater contains PFAS.

2.6 Testing of agricultural products

Potatoes irrigated by water known to be contaminated with PFOS within the St Ouen's Bay plume area and milk from a dairy herd were sent to a specialist accredited laboratory in the USA. A sample of milk and potatoes from the UK market was also sent for comparative purposes, as well as potatoes and milk from elsewhere within the island. No PFOS or PFOA was detected in any sample.

The identification of the laboratory, results and method summary are included in Appendix 3. The cost of sampling totalled $1,950 not including carriage.

2.7 Testing for Nitrates and Pesticides

2.7.1 Nitrates

Nitrates in groundwater

GHE routinely monitor the chemistry of groundwater (40 samples)[26] in all of those boreholes / wells that were tested for PFOS[27]. This was combined with chemistry data collected from boreholes around the Airport (14 samples) to produce a snapshot of nitrates in groundwater.

The average concentration of nitrates in groundwater in April-May 2019 was 63mg/l. This is higher than recent published island averages[28]. The reason were the higher levels recorded around the airport (over half of the samples taken in this area were more than 100mg/l and the maximum recorded level was 262mg/l) and higher levels recorded in the west during the GHE routine sampling in April-May (this latest sampling coincided with heavy rainfall).

Overall, the results show that just over half (53%) of samples were below the EU and local drinking water limit of 50mg/l (and a corresponding 47% above the limit). This percentage is in broad agreement with previous analyses[16] and equates to approximately 1500 of island

26 Part of Environmental Protection's monitoring program. Groundwater id monitored every six months.

27 These data also form part of the monitoring requirements of the AFCW Group. Addressing island nitrate pollution is a key objective of the Island's Water Management Plan, 2017-2021.

28 Internal documents prepared for the Action for Cleaner Water Group

boreholes being above the 50mg/l EU and local drinking water limit. Slightly under one quarter (24%) of samples taken were more than 100mg/l of nitrate.

The percentage of samples more than 50mg/l and the overall average level of nitrates in groundwater has reduced since 1990 (Figures 2 and 3).

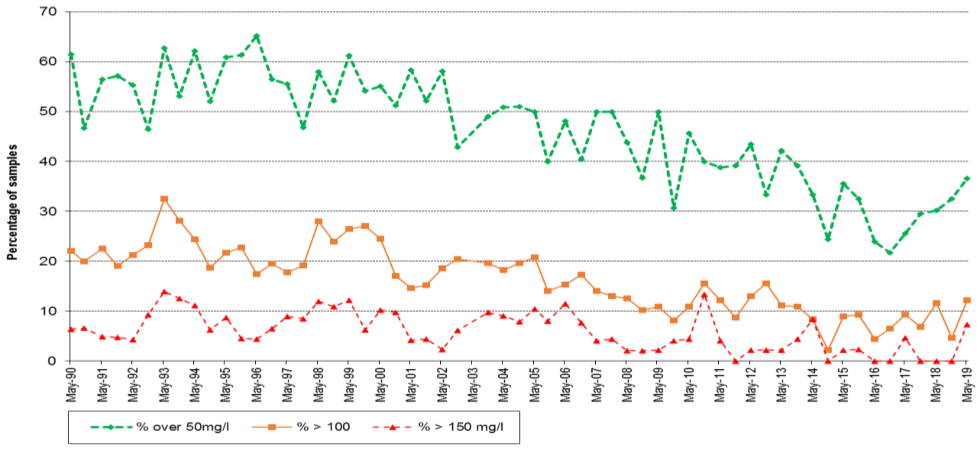


Figure 2: The concentration of nitrates in groundwater (mg/l) using the regular 6-monthly data collected by GHE (1990-2019). Note the upswing in 2019, probably caused by the wetter sampling period.

Nitrates in surface water

Jersey Water undertake weekly testing of nitrates in all the streams that were tested for PFOS and PFOA. Of these, 32 sites with historic data were selected to determine long term trends. The annual average concentration of nitrate in surface water is reducing year on year (Fig. 3). Since 1998, this reduction has averaged 12mg/l every 10 years. Annual high levels occur during the potato planting and harvesting season (principally Jan-May).

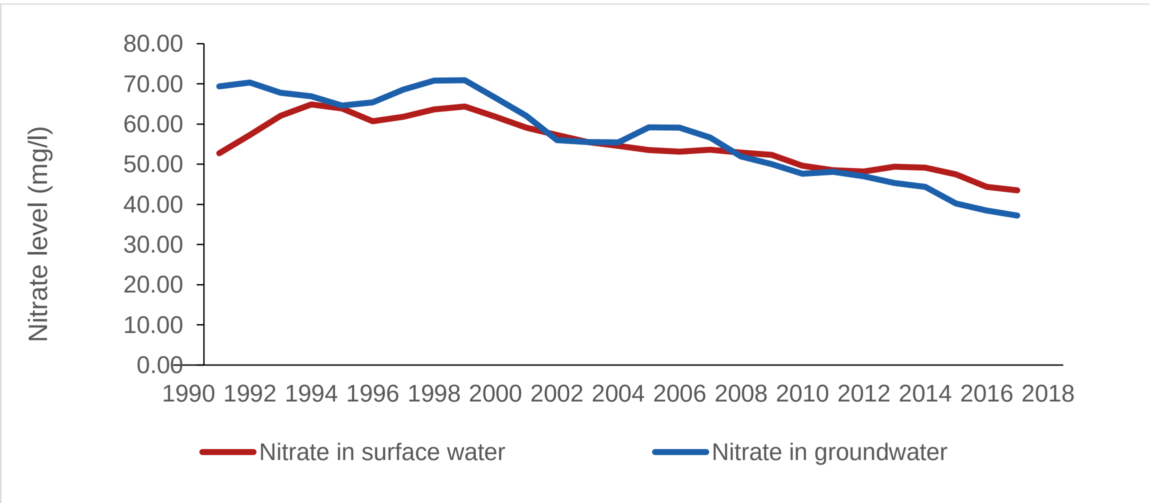


Figure 3: Three year rolling average for nitrate (mg/l) in surface water streams and groundwater

2.7.2 Pesticides

A total of 81 groundwater and surface sites across the island were sampled for pesticide screening analysis by both GHE and Jersey Water.

It is important to note that values given below are for those analytical determinations that were identified above the laboratory limit of detection. They should not therefore be quoted either as exceedances or breaches and these are not health-based limits.

Table 6: Number of surface and groundwater[29] sites tested for separate analytical determinations by location

Location	Surface water	Groundwater (boreholes/wells)
North of airport	0	7
Island controls	36 (Jersey Water sampling)	38 (GHE sampling)
Total	36	45

The separate analytical determinations that were identified above the laboratory limit of detection is shown in Table 7.

Table 7: The separate analytical determinations identified above the laboratory limit of detection in island boreholes during screening of pesticides, May 2019

Sample ID	Determinand	Limit of detection	Value	Units
J112	Oxadixyl	0.1	0.1	µg/l
J20	Oxadixyl	0.1	0.2	µg/l
J123	Metobromuron	0.1	0.2	µg/l
J125	Oxadixyl	0.1	0.4	µg/l
	Metalaxyl	0.1	0.3	µg/l
	Diuron	0.1	0.1	µg/l
J129	Oxadixyl	0.1	0.1	µg/l
	Oxadixyl	0.1	0.1	µg/l
	Atrazine	0.1	0.7	µg/l
J135	Metamitron	0.1	0.1	µg/l
	Oxadixyl	0.1	0.2	µg/l
	Oxadixyl	0.1	0.1	µg/l
	Oxadixyl	0.1	0.2	µg/l
J44	Diuron	0.1	0.2	µg/l
J66	Oxadixyl	0.1	0.7	µg/l
	Monolinuron	0.1	0.2	µg/l
Sample 02	Oxadixyl	0.1	0.1	µg/l

[29] Excludes samples taken from the St Ouen’s Bay historic plume area (currently sampled through Ports of Jersey)

Jersey Water sample surface waters (streams and reservoirs) at the same sites as they sampled for PFOS and PFOA. These form part of their regular monitoring of surface water quality. The detections recorded during the current sampling period (18 February-24 May 2019) are shown in Appendix 4. A fuller breakdown for the year is available on request. It should be noted that the results in Appendix 4 are from raw water and are not present in the treated water supplied to Jersey Water's customers as they are removed by their processes at their treatment works.

Each quarter GHE (Environmental Protection) collect additional surface and groundwater samples, which are sent to the National Laboratory Service (the Environment Agency's Laboratory in the UK). Over 200 parameters are analysed, which includes heavy metals and pesticides. Some of these parameters are listed as Water Framework Directive Priority Hazardous Substances, Priority Substances, Chemical Investigation Programme chemicals and UK Specific Pollutants. These are chemicals that have been identified either Europe wide or by Nation as being hazardous or harmful to the environment and some of these chemicals are banned from use. The current cost of analysis by NLS is £320 per sample, which equates to £2,560 for eight sites plus transport costs.

For surface waters, a total of twelve separate analytical determinations were detected above 0.1µg/l during March 2019 (this compares to five analytical determinations above 0.1µg/l during December 2018 monitoring). In groundwater, No analytical determinations were detected above 0.1µg/l during May 2019 monitoring, whilst two analytical determinations were detected above 0.1µg/l during winter 2018 monitoring (Table 8).

Table 8: The separate analytical determinations identified in surface water and Island boreholes (µg/l) during sampling for Water Framework Directive Priority Hazardous Substances, Priority Substances, Chemical Investigation Programme chemicals and UK Specific Pollutants, Winter 2018 and Spring 2019 sampling.

Surface waters (monitored quarterly)

Analytical determination	Value	Sample point	Date	European Drinking Water Directive[1]
Glyphosate	0.223	2203	04/03/2019	0.1
Glyphosate	0.109	VDLM EA 2	04/03/2019	0.1
Glyphosate	0.273	B7	04/03/2019	0.1
Glyphosate	0.141	P13	04/03/2019	0.1
Glyphosate	0.162	Grouville SSI	04/03/2019	0.1
AMPA	0.219	2203	04/03/2019	0.1
4-Methylphenol (p cresol)	0.162	Grouville SSI	04/03/2019	0.1
Azoxystrobin	0.254	2203	04/03/2019	0.1
Azoxystrobin	0.25	Grouville SSI	04/03/2019	0.1
Pendimethalin	>0.1	2203	04/03/2019	0.1
Triclopyr	0.147	Millbrook SSI	04/03/2019	0.1
4-Chloro-3,5-dimethylphenol :-{PCMX}	0.14	Millbrook SSI	04/03/2019	0.1

AMPA	>0.250	VDLM EA 2	10/12/2018	0.1
Phenol	0.102	B7	10/12/2018	0.1
Phenol	0.168	Grouville SSI	10/12/2018	0.1
4-Methylphenol (p cresol)	0.182	Grouville SSI	10/12/2018	0.1
Azoxystrobin	0.224	Grouville SSI	10/12/2018	0.1
Groundwater (monitored biannually)				
Pesticide	**Value**	**Sample point**	**Date**	
No pesticides detected above 0.1 µg/l in May 2019				
Chlorpyrifos-ethyl	0.123	J107	06/11/2018	0.1
Phenol	0.102	J142	05/11/2018	0.1
no analysis May 18				
Chlorpyrifos-ethyl	0.234	J107	07/11/2017	0.1
Iprodione	0.115	J107	07/11/2017	0.1
Phenol	0.117	J05	06/11/2017	0.1
Phenol	0.116	J84	06/11/2017	0.1
Glyphosate	0.117	J84	06/11/2017	0.1

[1] The European Drinking Water Directive set a standard of 0.1µg/l for each individual pesticide in drinking water. This corresponds to a concentration of 1 part in ten billion. This is not a health based standard; it was set by the European Commission in 1980 to reflect the limit of analytical methodology at the time and as an environmental policy to generally limit pesticides. The Directive also set a standard of 0.5µg/l Total Pesticides (the sum of all the substances detected in a sample).

2.8 Costs of testing

The cost of each water sample for PFOS and PFOA analysis (not including the bottle and carriage) was £56.97. The cost of a test of borehole water for pesticides was £120 per sample.

Total costs to date of the PFAS work and sampling has been £15,000. The majority of this spend has been on testing bottles and laboratory time.

2.9 Testing on-island

The States Analyst provides a service to Islanders for drinking water quality. It provides a general drinking water analysis for chemicals including calcium, magnesium, sodium, potassium, iron, manganese, copper, zinc, lead, arsenic, nitrates, fluoride, chloride, sulphate, pH and Hardness, and a microbiological analysis for e-coli.

There is no current on-island test available for islanders who wish to have their water tested for pesticides or PFAS.

3. Work to reduce nitrates and pesticides in water

In December 2016, the then-States agreed the Island Water Plan[30]. This was an output of work and input both from the then Diffuse Pollution Project Group (a stakeholder group of the agricultural industry, Jersey Water and Government officers, and the precursor to the present Action for Cleaner Water Group) and a Water Challenges document that was produced by Environmental Protection.

This work addresses diffuse pollution sources and specifically identified nitrate, phosphates and pesticides being the current identified key pressures on the island's water environment.

The Action for Cleaner Water Group meets every four months and detailed discussions are had on latest monitoring results (including nitrate trends and pesticide detections) and plans that the industry have, for example prior to planting of potatoes etc.

The group is producing quantifiable results (Sect. 2.7.1.2). These are mainly delivered through voluntary measures brought by the agricultural and dairy sector. Examples include less fertiliser applied to crops due to reduced applications and placement and a risk-based approach to chemical use (only certain pesticides are allowed in specific catchments).

This important work will continue and also move to other sectors, including the use of nitrates and pesticides by landscape gardeners etc. and private households (the public). There are many users of chemicals on the island and it is an important message that, as well as the agriculture sector, all users of nitrates and pesticides on the island have a role to play to ensure our island's water is of good quality.

---

[30] Available at: https://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=2147

4. International standards and guidelines for PFAS and their implications

Perfluorinated substances have been widely used as the building blocks of a range of chemicals from non-stick cookware and dirt resistant fabrics to ingredients in some fire-fighting foams. These were widely used at airports and are very effective for fighting aircraft fires. While such fires are fortunately rare, the foams were also used for practice and washed onto the surface of the ground in practice areas. The foams were sold as degradable but the degradation was incomplete and released the perfluorinated building blocks which are both persistent and water soluble. Consequently, they entered the soil and moved into groundwater and sometimes into surface streams and they have been found in many places around the world in wells used for drinking water. They have also been found in groundwater near industrial installations in which PFAS were manufactured or used. This has been widespread in the USA but one significant case in Europe is in the Veneto region of Italy. As a consequence the position over possible standards for drinking water has been complicated by various political pressures.

While there was some information available to allow the calculation of safe levels more studies have been carried out. Rather than clarifying the derivation of safe levels, these studies have complicated the process and have caused some controversy between different environmental health authorities around the world. In 2006 the UK Committee on Toxicology proposed a tolerable daily intake (TDI) based on a study in monkeys and this was used to derive a guide level for PFOS in drinking water of 3.0µg/L. In 2008 the Drinking Water Inspectorate in England and Wales provided further guidance but determined that water containing greater than 1.0 µg/L of PFOS would not be considered wholesome, with a value of 10.0 µg/L for PFOA. There remained a good deal of uncertainty regarding the health effects of PFOS and PFOA at low levels of exposure. More recently a number of authorities have taken a more precautionary or conservative approach to determining drinking water values. In the case of the USA the value is advisory but Congress is likely to require USEPA to set a standard, which will be more binding and will leave the different states less leeway to set their own standards.

Recently there has been debate over the results epidemiological studies of populations that have had varying degrees of exposure to PFOS and PFOA and it is acknowledged that considerable uncertainty remains. In particular, epidemiological studies often show links between various health endpoints and the presence of a contaminant but demonstrating that the contaminant actually causes the health outcomes requires a great deal more evidence. The most consistent finding is a small increase (5%) in serum cholesterol levels.

The debate over whether animal studies should be used versus the use of the epidemiological data is one that is continuing. Most authorities that have developed standards or guidelines have to date used animal studies but others are not comfortable with this approach. In the end using all of the evidence is probably best to derive an approximate safe level since relatively small differences in a final value is of no real significance for health while this can have significant practical implications. In developing standards, a tolerable daily intake is developed incorporating uncertainty factors to reflect uncertainties in the data. These are usually very conservative and vary from 100 to 1000 if animal studies are used but 0 to 10 if epidemiological studies are used. A proportion of the safe level, usually 20%, is then allocated to drinking water allowing 80% from other sources such as food or the environment and this is often quite conservative.

While several authorities have issued standards or guidance levels, WHO and the European Food Standards Agency have not yet finalised their new assessments because of the uncertainties in the health data. The values range from 0.07 µg/L (USEPA) to 0.6 µg/L (Health Canada) for PFOS and 0.07 µg/L (USEPA) to 0.56 µg/L (Australia) for PFOA. The most recently published was Health Canada with a standard of 0.6 µg/L for PFOS and 0.2 µg/L for PFOA. However, Health Canada consider the effects to be additive and so they have stipulated that the sum of the ratios of the detected concentrations to the corresponding maximum acceptable concentration for PFOS and PFOA should not exceed 1. The European Commission proposed compromise values of 0.1 µg/L for individual PFAS and 0.5 µg/L for total PFAS in the draft revision of the drinking water directive. This seemed to be a sensible compromise but it was later modified to 0.1 µg/L for total PFAS, with no value for individual PFAS, following political interventions from some member states who were particularly concerned about PFAS in their countries. It should be noted that, as indicated above, there are varying assumptions and margins of safety in all of the regulatory values proposed to date and exceeding the standard or guideline does not constitute an immediate likelihood of any health effects, not least because all of these values relate to long-term exposure. One common feature is that all of the recent drinking water values proposed are less than 1.0 µg/L, which is less than a millionth of a gram per litre. The value proposed by the USEPA is the most conservative and the value proposed by Health Canada is the least conservative, although it is still certainly protective.

While it is clear that municipal supplies need to be considered, there is a significant potential for private supplies to be affected by PFAS. These should not be forgotten since they can result in the exposure of a significant number of people. In particular, where private supplies are used for businesses in which members of the wider public will consume the water, or products made with the water, there would be a duty to apply similar standards as for municipal supplies. It is, therefore, important that private boreholes/wells are examined for PFAS to determine whether owners should be advised that there is a need to install treatment or to switch to the public piped-water supply.

Professor John Fawell (see Appendix 5 for his curriculum vitae)

30/06/2019

5. Health effects – summary of expert advice

5.1 international studies

PFAS have become a matter of particular scientific interest internationally because of potential effects on human health, and understandable public concerns about this. Expert reviews /reports published separately in very recent years from Australia, Canada and the United States all report that PFAS are so widely found in the environments of developed nations, including their own, that they can be regarded as 'ubiquitous' (present everywhere). Because of this, most people living in the western world are considered likely to have some accumulation of PFAS in their bodies.

In May 2018 a report was published by an independent expert health panel established by the **Australian** Government[31] to provide advice on the potential health impacts associated with PFAS exposure. The panel included experts in the fields of environmental health, toxicology, epidemiology and public health. It considered the evidence available from international as well as Australian scientific research.

The Australian expert panel found that the evidence on health effects associated with PFAS exposure is limited, and that there was insufficient evidence of causation of any adverse health outcomes. Importantly, the panel concluded there is "no current evidence that suggests an increase in overall cancer risk".

The panel reported that, because much of the evidence available is weak and inconsistent, decisions to minimise exposure to PFAS chemicals should be largely based on their known ability to persist and accumulate in the body.

The expert panel did not support any specific screening or health interventions for highly exposed groups, except for research purposes. A detailed summary of the Australian Government's expert panel Review is provided at Appendix 1.

In December 2018, **Canada** updated its PFOS drinking water quality guideline[32], part of the provisions of the Canadian Environmental Protection Act. The guideline 'technical document'' reviewed and assessed current identified health risks:

"*PFOS is a synthetic compound that does not occur naturally in the environment. It is no longer manufactured, imported, sold, offered for sale or used in Canada, but is still found in the environment because of its extremely persistent nature. PFOS was used for water, oil and/or stain resistance on surface and paper-based applications, such as rugs and carpets, fabric and upholstery. It was also used in specialized chemical applications, such as firefighting foams, hydraulic fluids, and carpet spot removers."*

"As PFOS and other perfluoroalkyl substances (PFAS) are increasingly being detected in the environment, more scientific studies on their health effects are being conducted in Canada and around the world. Health Canada continues to monitor new research and will

---

[31] https://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas-expert-panel.htm

[32] https://www.canada.ca/en/services/health/publications/healthy-living/water-talk-drinking-water-screening-values-perfluoroalkylated- substances.html

work with the provinces and territories to update the guideline, or develop new guidelines or other technical support material, as needed, to reflect significant changes in the weight of evidence."

"Some cancer effects were observed in humans after exposure to PFOS, but no clear links could be made due to various study limitations. Tumours were observed in the liver, thyroid, and mammary gland of rats following long-term exposure to PFOS. Non-cancer effects occurring at the lowest level of exposure to PFOS in animals include effects on the immune system, liver effects, effects on the thyroid and changes in serum lipid levels."

"Canadians can be exposed to PFOS through its presence in food, consumer products, dust, and drinking water. Exposure is mainly from food and consumer products, however, the proportion of exposure from drinking water can increase in individuals living in areas with contaminated drinking water."

In the **United States**, the US Centers for Disease Control and its Agency for Toxic Substances and Disease Registry have published very recent guidance about PFAS, for members of the public and also for clinicians. This is all readily accessible via its website:

https://www.atsdr.cdc.gov/PFAS/

It provides a great deal of background information, overlapping with that provided in the Australian and Canadian expert reviews. It also includes very informative interim 'Guidance for Clinicians Responding to Patient Exposure Concerns'.

It includes a section on Health Studies, animal and human. Its advice to clinicians about potential health effects appears to be largely based on the findings of one large epidemiological study of people exposed over several decades (until 2002) in a number of water districts in West Virginia to drinking water contaminated by high levels of **PFOA** (not PFOS).

That study found probable links between the highest exposure to PFOA, with a number of health conditions:

- High blood cholesterol
- Ulcerative colitis
- Thyroid function
- Testicular cancer
- Kidney cancer
- Pre-eclampsia and elevated blood pressure during pregnancy

Another study found a possible association between PFOA and PFOS exposure with elevation of the levels of uric acid. Insignificant alterations in liver enzymes (a marker of liver function) were also detected in some studies.

Regarding cancer, it notes that the International Agency for Research on Cancer (IARC) has classified PFOA as potentially carcinogenic and the US Environmental Protection Agency has concluded that both PFOA and PFOS are potentially carcinogenic.

It is worth noting that both the Australian and the Canadian expert reviews concluded that there is only very limited evidence (based on these same studies) of a possible link with any particular health effects.

All – Australia, Canada and the US – are consistent in the view that there are potential health effects, none established definitively, and that further research is needed to clarify any associations. They are also all of the same conclusion that no specific health screening is appropriate, or warranted.

5.2. PFOS in animals/ecological issues

Much of our knowledge of the possible negative health effects of PFOS and related compounds on human health come from effects observed in animal studies, principally using rats and monkeys. Therefore, we know that in sufficiently high doses PFOS can be harmful to animals. However, to the author's knowledge, in the animal population at large health concerns resulting from PFOS exposure have not been reported, and, except when deliberately exposed during experimental studies, PFOS is not recognised as a cause of disease in animal populations.

Experimental studies

Deliberate exposure of rats and monkeys to PFOS resulted in liver pathology and changes in liver function, and the development of liver tumours. Changes in thyroid hormones have been observed, although the underlying mechanisms are not understood. Monkeys died at doses of a few mg/kg per day. Rats were less sensitive than monkeys. The evidence for induction of thyroid and mammary tumours was limited. Toxic effects have also been observed in animals exposed before birth when the mother was exposed to high doses of PFOS (EFSA, 2008)[33].

A review of the, PFOS and PFOA Toxicological Overview*,* Prepared by the Toxicology Department*,* CRCE, Public Health England *(*2009) informs us that :

"A range of toxic effects has been seen in animals following chronic exposure including effects on the liver, gastrointestinal tract and thyroid hormone levels.

Neither PFOS or PFOA have any mutagenic properties. They have both been shown to induce tumours in studies in animals at relatively high doses. A threshold can be assumed for the carcinogenic effects."

Studies have not been found on amphibians or reptiles which may be more at risk than other species of wildlife, due to their ecology.

An article reference below, describes the (slow) elimination of PFOS through milk. If none is detected, this would be a marker for low exposure for any cows.

https://www.sciencedirect.com/science/article/pii/S0308814613004810

[33] Opinion of the Scientific Panel on Contaminants in the Food chain on Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts, *The EFSA Journal* (2008) Journal number, 653, 1-131.

Another article is referenced below, which relates to exposure of animals following the Buncefield incident in 2005.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/338261/PFOS_and_PFOA_Toxicological_Overview_phe_v1.pdf

This has some experimental data. It suggest that the elimination route is again slow but via urine and faeces. It describes hepatotoxicity in rats but at a much higher dose than is likely in Jersey.

It is veterinary opinion that the levels found in Jersey would not have affected cattle. Higher doses might lead to abortions and foetal abnormalities if the rat/primate models applied to cattle, and it is possible that higher levels might be present in liver of cattle exposed to low levels in the absence of any in the milk. To the best of our knowledge no work has been undertaken on this here.

5.3 Human exposure to PFOS via contamination of products of animal origin

Although there appears to be little evidence of environmental exposure to PFOS resulting in disease in animals, there is the potential for human exposure from food products derived from animals becoming contaminated with PFOS via production animal exposure.

Contamination of fish and fishery products is recognised and bio accumulation is known to occur in fish, but this is not relevant for this particular issue in Jersey. In studies elsewhere, there has been limited detection of PFOS across other products of animal origin, including dairy and beef. Furthermore, other than fish, food consumption is not typically seen as major route of PFOS exposure, although uncertainty over exposure routes exists (EFSA, 2008)[1], however, without specific expert investigation it is difficult to draw firm conclusions.

6. The public water supply

6.1 Overview

This section provides information on the influence of perfluorinated chemicals including Perfluorooctane sulphonate (PFOS) and Perfluorooctanoic acid (PFOA) (collectively PFAS) on the public drinking water supplied by Jersey Water, following the recent investigations into the presence of PFAS in St Peter and other parts of the Island.

The drinking water supply in Jersey has been tested for PFAS since 1999. Based on the results of the testing for PFAS the drinking water supply in Jersey has been fully compliant with the water quality requirements of the Water (Jersey) Law 1972 and meets the definition of wholesomeness against which water quality is assessed. Results of drinking water testing show either no detections for PFAS or detections well within the limits set by the UK's Drinking Water Inspectorate's (DWI) guidance.

Additionally, when considered against wide ranging international standards for PFAS and the new standards proposed by the EU Drinking Water Quality Directive, the treated water supply in Jersey meets all quality standards for PFAS.

There is no parameter limit for PFAS in the Water (Jersey) Law 1972 or in UK primary legislation. Accordingly, Jersey Water adopts guidance provided by the UK DWI on PFAS. Internationally there is wide variation on individual parameter limits for PFAS and the EU are in the process of introducing new limits within the revised Drinking Water Directive.

It should be highlighted that the high quality of water supplied by Jersey Water is achieved despite the pollution of St Ouen's sand aquifer with PFAS and the recent discovery of PFAS pollution in the Pont Marquet catchment. Both pollution zones present a significant raw water quality challenge in their respective catchments and directly affect the quality of water in Val De la Mare reservoir.

On an Island facing significant potential future water shortages, priority must be given to resolving these pollution issues such that water resources are not denuded by virtue of being unusable due to quality considerations. Jersey Water have included three recommendations for action that we believe are necessary for the Government of Jersey to enact in order that the PFAS issue may be effectively and sustainably brought under proper control.

Drinking Water Quality regulations - Water (Jersey) Law 1972

Water quality in Jersey is regulated under the Water (Jersey) Law 1972 ("the Law"). The Law prescribes that the water supplied by Jersey Water shall be "Wholesome".

Wholesome is defined in the Schedule to the Law as water that meets (inter-alia) the following criteria[34]:

[34] Paragraph 2 of the Schedule of the Water (Jersey) Law 1972

a) the water does not contain any micro-organism (other than a parameter) or parasite, or any substance (other than a parameter), at a concentration or value which would constitute a potential danger to human health;

b) the water does not contain any substance (whether or not a parameter) at a concentration or value which, in conjunction with any other substance it contains (whether or not a parameter), would constitute a potential danger to human health;

c) the water does not contain concentrations or values of the parameters listed in Tables A and B in the Annex in excess of, or as the case may be, less than the prescribed concentrations or values; and

d) the water satisfies the formula [nitrate]/50 + [nitrite]/3 < 1, where the square brackets signify the concentrations in mg/l for nitrate (NO^3) and nitrite (NO^2) respectively.

The Schedule does not include a specific parameter for perfluorinated chemicals including Perfluorooctane sulphonate (PFOS) and Perfluorooctanoic acid (PFOA). Accordingly, paragraph B above applies and treated water must not contain perfluorinated chemicals at a concentration or value which, in conjunction with any other substance it contains (whether or not a parameter), would constitute a potential danger to human health.

In the absence of regulatory guidance in Jersey, Jersey Water's policy is to reference guidance and regulations issued by the UK Drinking Water Inspectorate. These are summarised below.

Drinking Water Inspectorate Guidelines

The extant DWI Guidance on perfluorinated chemicals in treated water is set out in the October 2009 guidance note issued by the DWI[35].

The document provides guidance on the levels of PFOS and PFOA that water companies should act upon in order to fulfil their statutory obligations to ensure the safety of drinking water, the guidance is based on a multi-tiered approach to the protection of water safety.

The guidance tiers and values are summarised in the table below:

Item	**Regulatory requirement**	**Guidance value (concentration)**		**Minimum action to be taken by water provider**
		Perfluorooctane sulphonate (PFOS)	**Perfluorooctanoic acid (PFOA)**	
Tier 1	Regulation 27 (Risk assessment)	potential hazard	potential hazard	– ensure considered as part of statutory risk assessment
Tier 2	Regulation 10 (Sampling:	> 0.3µg/l	> 0.3µg/l	– consult with local health professionals

[35] Guidance on the Water Supply (Water Quality) Regulations 20001 specific to PFOS (perfluorooctane sulphonate) and PFOA (perfluorooctanoic acid) concentrations in drinking water (http://www.dwi.gov.uk/stakeholders/information-letters/2009/10_2009annex.pdf)

Item	Regulatory requirement	Guidance value (concentration)		Minimum action to be taken by water provider
		Perfluorooctane sulphonate (PFOS)	Perfluorooctanoic acid (PFOA)	
	further provisions)			– monitor levels in drinking water.
Tier 3	Regulation 4(2) (Wholesomeness)	> 1.0µg/l	> 5.0µg/l	As tier 2 plus: – put in place measures to reduce concentrations to below this level as soon as is practicable.
Tier 4*	Water Industry (Suppliers' Information Direction) 2009 (Notification of events)	> 9.0µg/l	> 45.0µg/l	As tier 3 plus: – ensure consultation with local health professionals takes place as soon as possible; – take action to reduce exposure from drinking water within 7 days.
*Note - notification to the Inspectorate under the Information Direction may also be triggered at lower levels due to Tier 1, 2 or 3 activities				

6.2 International standards

Drinking water quality standards for perfluorinated chemicals in treated water vary from country to country. A selection of limits from various jurisdictions is shown below. Note that the EU Drinking Water Directive includes the proposal that parameter limits for PFAS be set at a total limit of 0.1µg/l for the combined concentrations of eight PFAS related substances.

Jurisdiction	PFOS concentration	PFOA concentration
Health Canada	0.6µg/l Sum of ratio of PFOS/PFOA not to exceed 1 µg/l	0.2µg/l Sum of ratio of PFOS/PFOA not to exceed 1 µg/l
US EPA	0.07µg/l (non-regulatory lifetime health advisory)	0.07 µg/l (non-regulatory lifetime health advisory) but notes that if PFOS also occurs then the limit is applied to the sum of the concentrations of PFOS and PFOA
Australia Dept. of Health	0.07µg/l (health-based drinking water quality value)	0.56µg/l
EU	No established limit in drinking water. Proposed Drinking Water	No established limit in drinking water. Proposed Drinking Water Directive

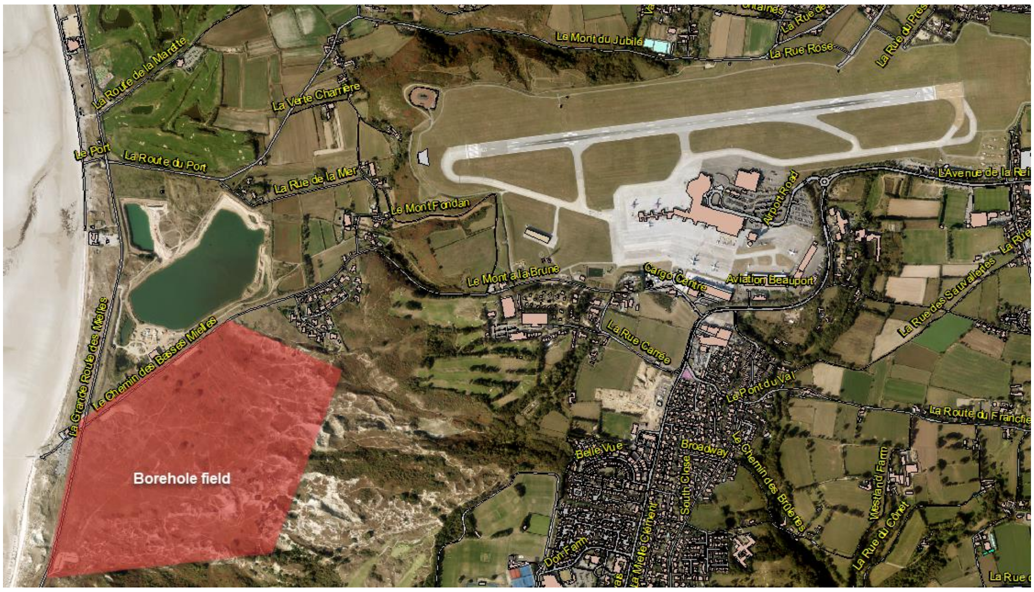
	Directive combined limit for all PFAS substances of 0.1µg/l.	combined limit for all PFAS substances of 0.1µg/l.
WHO	No established limit in drinking water	No established limit in drinking water
Swedish Food agency	0.09µg/l combined limit for PFAS substances	
German Ministry of Health	Health Based 0.3µg/l Regulatory limit of 0.1µg/l for combined PFOA/PFOS	

6.3 Detections in raw water resources

Jersey Water adopts a precautionary risk-based approach to raw water quality monitoring, focussing on the risks inherent within the water catchments. This approach is adaptive and dynamic in which the water quality monitoring regime is updated and evolves as risks change or develop over time. In terms of monitoring for PFAS, the principle risks have historically related to the use of firefighting foam on the fire training ground at the airport. Recent testing undertaken by the Government of Jersey has identified that the catchment at Pont Marquet is also affected by PFAS. Wider testing of other catchments has indicated that whilst PFAS are present, they are not currently at levels of concern from a mains drinking water quality perspective. Further details of the raw water monitoring is provided below.

6.3.1 Raw water testing – St Ouen's Bay boreholes

The aerial picture below shows the location of the borehole field relative to the fire training ground and airport. The borehole field consists of five boreholes (A1 – A5) through which water is extracted from the sand aquifer located in the area and pumped to Val De La Mare reservoir. The boreholes yield approximately 0.38Ml/day and are in service on average 365 days per year.



Water quality has been monitored for PFAS since 1999. In summary, of the 5 boreholes, A1 has shown consistently high levels of PFAS and has been out of service since 2015.

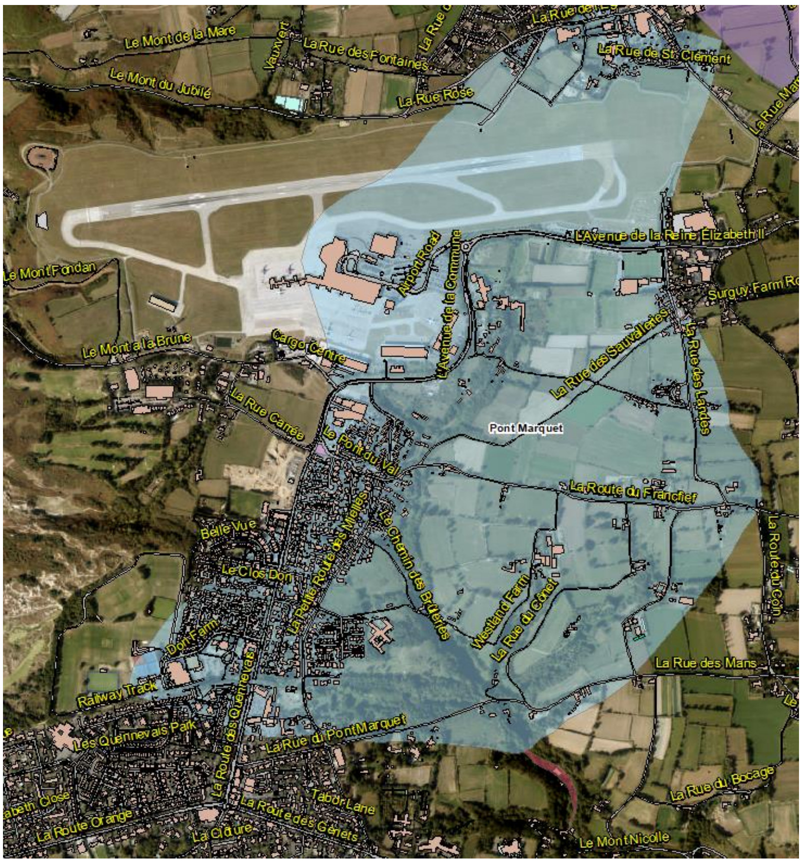
Lower concentrations of PFAS have been detected in boreholes A2 and A5 and boreholes A3 and A4 have only had occasional detections, being mainly free from detections.

Boreholes A2 – A5 remain in use on a daily basis. The concentrations within the combined output from the 4 boreholes diluting down to levels that reduce the risk to treated water quality compliance when taking into account the dilution factors presented by transfer to Val De La Mare Reservoir, blending with other sources at the treatment works and partial removal at the treatment works.

From the monitoring data, it is clear that the concentrations of PFAS varies over time, suggesting that the pollution is moving or is influenced by other factors (e.g. the water table). The water resource yield from the boreholes represents approximately 0.38Ml/day (equivalent to approximately 1.9% of daily demand) of otherwise high-quality water and boreholes therefore represent an important water resource for the island. The presence of PFAS constrains the use of or extension of the borehole field and will also most likely affect the quality of the other linked bodies of water in the area (Simon sand quarry and St Ouen's pond). Changes in concentration or direction of travel of the plume could result in the whole borehole field being put out of use by pollution, threatening the island's already fragile water resources. Further study is required in order to understand the long term effects of the PFAS pollution in the area.

6.3.2 Raw water testing – Pont Marquet catchment

The aerial picture below shows the approximate boundary of the Pont Marquet Water Catchment area. The area shaded blue represents the land from which water drains into the Pont Marquet pumping station, located adjacent to the railway walk, off Mont Nicolle. The catchment yields approximately 0.9Ml/day (equivalent to approximately 4.5% of daily demand) and is in service on average 300 days per year.



Water from Pont Marquet is transferred to Val De La Mare reservoir via the same raw water main that picks up the water from the 5 boreholes above. PFOS concentrations in water from this transfer main have historically been associated with the pollution of the aquifer in St Ouen's Bay and the borehole abstractions. The recent discovery of PFAS in boreholes in land outside of the influence of the fire training ground has prompted a wider assessment of PFAS pollution around the airfield and its impact on water quality in neighbouring catchments.

The table below shows the results of two sets of samples taken at Pont Marquet pump station, confirming that the catchment is affected by pollution from PFAS.

Name	Date Sampled	PFOS (µg/l)	PFOA (µg/l)
Pont Marquet	11/04/2019	0.127	0.0145
Pont Marquet	04/03/2019	0.406	0.0290

As the two detections vary a great deal in concentration over a short space of time, further work is required to get a clearer understanding of the pollution in this catchment.

It should be noted that private wells and boreholes within parts of the Pont Marquet catchment (downstream from the airport) may also be affected.

6.3.3 Raw water testing - Val De La Mare Reservoir

Water collected in the boreholes and Pont Marquet catchment referred to above are transferred to Val De La Mare Reservoir for storage before onward transfer to a treatment works. On average, 1.28Ml is transferred to Val De La Mare each day which represents approximately 0.135% of the total volume of the reservoir. The reservoir therefore provides significant buffering and dilution to water transferred into it; diluting down any PFAS. Val De La Mare has been tested for PFAS since 2009. The results are shown in the table below.

Date	Parameter (µg/l) (nd = No detection)			
	PFBS	PFHS	PFOA	PFOS
07/05/19			0.01840	0.0784
11/04/19			0.00803	0.0509
04/03/19			0.01600	0.1000
03/05/17	nd	nd	nd	nd
12/04/16	nd	0.020	nd	0.0230
01/06/15	nd	nd		0.0240
20/10/11	nd	0.034		0.0680
14/01/10		nd		nd
23/06/09	nd	nd		0.0480

Whilst concentrations have varied over time, the results are consistently within the UK DWI wholesomeness guidelines of 1.0µg/l for PFOS and 5.0µg/l for PFOA. This is before taking account of further blending and dilution of water within the final transfer for treatment and the partial removal during the treatment process.

Based upon the wider sampling undertaken recently, it is understood that the principle source of PFAS within Val De La Mare Reservoir are the boreholes in St Ouen's Bay and Pont Marquet catchments discussed above.

6.3.4 Raw water testing – other catchments

Recent island-wide testing undertaken by the Government of Jersey has identified that PFAS are ubiquitous in Jersey's environment. The presence of PFOS and PFOA was identified in low concentrations in all samples taken from streams across the Island.

Jersey Water manages water quality in several ways including the use of dilution and blending to reduce concentrations of substances in untreated water. Accordingly, water from Val de La Mare will be diluted with water from other catchments as it is taken into treatment ensuring that the risks presented by higher concentrations in western resources are addressed.

Name	**Date Sampled**	**PFOS (µg/l)**	**PFOA (µg/l)**
Bellozanne	12/04/2019	0.00730	0.00440
Dannemarche	12/04/2019	0.00846	0.00456
Fernlands	12/04/2019	0.00246	0.00148
Grand Vaux Pump	11/04/2019	0.00644	0.00334
Grands Vaux stream	12/04/2019	0.00595	0.00267
Greve de Lecq stream	11/04/2019	0.00303	0.00340
Handois stream	12/04/2019	0.00972	0.01000
Handois reservoir outlet	11/04/2019	0.02430	0.00671
Handois west	12/04/2019	0.00867	0.00492
La Hague	12/04/2019	0.00403	0.00376
La Hague dip	11/04/2019	0.00683	0.00343
Le Mourier	12/04/2019	0.00318	0.00506
Little Tesson	12/04/2019	0.00258	0.00269
Millbrook reservoir	11/04/2019	0.01480	0.00494
Millbrook stream	12/04/2019	0.00912	0.00424
Queens valley pump	11/04/2019	0.00572	0.00330
Queens valley side stream	12/04/2019	0.00392	0.00396
Queens valley stream	12/04/2019	0.01350	0.02130
Rue a la Dame	12/04/2019	0.00386	0.00248
St. Catherine	12/04/2019	0.00572	0.00246
Tesson	12/04/2019	0.00793	0.00383
Vallee des Vaux	12/04/2019	0.00743	0.00539
VDLM Stream pt 1	11/04/2019	0.04580	0.00771
VDLM Stream pt 2	11/04/2019	0.00371	0.00748
VDLM Stream pt 3	11/04/2019	0.04300	0.00729
VDLM Stream pt 4	11/04/2019	0.00221	0.00282
VDLM Stream pt 5	11/04/2019	0.00288	0.02050
VDLM West Stream Pt A	11/04/2019	0.00396	0.00828

6.4 Detections in drinking water

The drinking water supply in Jersey has been tested for PFAS since 1999. Based on the results of the testing for PFAS, the drinking water supply in Jersey has been fully compliant with the water quality requirements of the Water (Jersey) Law 1972 and meets the definition of wholesomeness, against which drinking water quality is assessed. Results of drinking water testing show either no detections for PFAS or detections well within the UK DWI guidance.

Additionally, when considered against the international standards listed in section 0 above and the new standards proposed by the EU Drinking Water Quality Directive the treated water supply in Jersey meets all quality standards.

Date	Handois Treated Water (µg/l)				Augres Treated Water (µg/l)			
	PFBS	PFHS	PFOA	PFOS	PFBS	PFHS	PFOA	PFOS
07/05/19				0.047				0.0243
11/04/19			0.00609	0.022			0.00525	0.0200
19/02/19			0.01200	0.048			0.01000	0.0450
03/05/17	nd	nd	nd	nd				
12/04/16	nd	nd	nd	nd	nd	nd	nd	nd
01/06/15	nd	0.021	nd	nd	nd	nd	nd	nd
28/08/14	0.044	0.014		nd	0.026	nd		nd
16/01/02		nd		nd				
13/10/99				nd				

Drinking water has historically been tested for PFAS for risk assessment purposes to assess the threat presented by PFAS to drinking water quality when measured against the UK DWI wholesomeness standard of 1µg/l. The concentrations seen in water taken for treatment and in drinking water in Jersey are at concentrations that, in the UK under DWI regulations, would not require water to be tested for PFAS. Nevertheless, as a result of the wide variation in international regulatory standards for PFAS and the proposed changes in EU regulation, Jersey Water has proactively and voluntarily amended its drinking water monitoring programme and included PFAS at audit monitoring frequency with effect from 25th April 2019. Results of the testing will be included within Jersey Water's annual water quality reports.

Table 9 St Ouen's borehole field – testing results

Date		30/11/11	10/01/12	28/08/14	01/06/15	12/04/16	03/05/17	19/02/19	04/03/19	01/05/19	07/05/19
A1	PFBS	0.038	0.035	0.036	0.031	nd	0.014				
	PFHS	0.51	0.58	0.02	0.42	0.41	0.2				
	PFOA				0.059	0.059	0.034	0.089			
	PFOS	0.96	0.99	0.87	0.85	0.59	0.46	1.6			
A2	PFBS	0.017	nd	nd	nd	nd	nd				
	PFHS	0.18	0.21	0.11	0.12	0.14	0.11				
	PFOA				nd	nd	nd	0.032			
	PFOS	0.24	0.25	0.21	0.23	0.23	0.21	0.425			
A3	PFBS	nd	nd	nd	nd	nd	nd				
	PFHS	nd	nd	nd	0.013	nd	nd				
	PFOA				nd	nd	nd	<0.01			
	PFOS	nd	nd	nd	nd	nd	nd	<0.01			
A4	PFBS	nd	nd	nd	nd	X	nd				
	PFHS	nd	nd	nd	0.1	X	nd				
	PFOA				0.057	X	nd	<0.01			
	PFOS	nd	nd	nd	0.21	X	nd	<0.01			
A5	PFBS	nd	nd	0.03	nd	nd	X				
	PFHS	0.14	0.14	0.06	0.08	0.069	X				
	PFOA				0.046	nd	X	0.025			
	PFOS	0.08	0.07	0.022	nd	nd	X	0.205			

19/02/03	29/04/03	23/09/03	22/06/05	10/10/06	22/05/08	01/10/08	12/03/09	23/06/09	14/01/10	20/10/11	Date	
					nd	nd	nd		nd	0.036	PFBS	A1
0.36	1.10	0.34	1.00	0.61	0.67	0.69	0.70	1.5	0.53	0.54	PFHS	
											PFOA	
0.94	0.98	1.10	1.90	0.98	1.10	1.50	1.70	0.47	1.2	0.88	PFOS	
					nd	nd	nd		nd	0.021	PFBS	A2
nd	nd	0.22	0.33	0.17	0.20	0.20	0.23	0.17	0.2	0.19	PFHS	
											PFOA	
nd	nd	nd	0.69	0.30	0.26	0.24	0.21	0.18	0.24	0.24	PFOS	
					nd	nd	nd		nd	nd	PFBS	A3
nd	nd	nd	nd	0.01	nd	nd	nd	nd	nd	nd	PFHS	
											PFOA	
nd	nd	nd	nd	0.13	nd	nd	nd	nd	nd	nd	PFOS	
					nd	nd	nd		nd	nd	PFBS	A4
nd	nd	nd	nd	0.02	nd	nd	nd	nd	nd	0.01	PFHS	
											PFOA	
nd	nd	nd	nd	0.12	nd	nd	nd	nd	nd	nd	PFOS	
					nd	nd	nd		nd	nd	PFBS	A5
nd	nd	0.26	nd	0.12	0.25	0.20	0.12	0.09	0.13	0.14	PFHS	
											PFOA	
nd	nd	nd	nd	0.14	nd	0.11	nd	nd	0.078	0.045	PFOS	

Site	Date	09/06/99[36]	11/06/99	28/07/99	13/10/99	07/12/99	22/06/01	05/09/01	16/10/01	16/01/02	22/05/02
A1	PFBS										
	PFHS	1.40		2.56		0.90	nd	0.99	0.65	0.41	0.16
	PFOA										
	PFOS	0.66		0.85		0.68	0.83	0.92	0.98	1.00	0.61
A2	PFBS										
	PFHS		0.29	0.24		0.20	nd	nd	nd	nd	0.16
	PFOA										
	PFOS		0.65	nd		nd	nd	nd	nd	nd	nd
A3	PFBS										
	PFHS		nd	nd			nd	nd	nd	nd	nd
	PFOA										
	PFOS		0.28	nd			nd	nd	nd	nd	nd
A4	PFBS										
	PFHS		nd	nd			nd	nd	nd	nd	nd
	PFOA										
	PFOS		nd	nd			nd	nd	nd	0.50	nd
A5	PFBS										
	PFHS		0.18	0.29			nd	nd	nd	nd	nd
	PFOA										
	PFOS		nd	nd			nd	nd	nd	nd	nd

[36] The St Ouen's Borehole

7. Public Engagement

7.1 Strategy

Public engagement by the PFOS officer technical group has been conducted with the objectives of:

- minimising the amount of public and individual concern about PFOS by:
    - communicating directly with those affected directly and as a priority
    - providing clear information based on scientific evidence, and making additional information from trusted sources available where possible
- ensuring that reporting during the research phase:
    I. did not lead to sensationalism and controversy;
    II. enabled officers to continue their work without distraction;
    III. minimised the likelihood of prejudicing any legal action, should any come as a result of the research
    IV. minimised the risk of changing messages or information leading to confusion and concern
- ensuring that the relevant gov.je page (Gov.je > Environment and greener living > Saving water, water pollution and water monitoring > Private water supplies: pollution and testing) was the single source of truth for information which could be relied upon to contain the information. All inquiries were then directed to the page, and it was updated to reflect questions and concerns.

7.2 Timeline

On 23 January 2019 the Group Director, Regulation, advised the department's Head of Communications that a positive result for PFOS from the water sample of a private borehole in St Peter and the potential for the information to be disseminated more widely.

Registered borehole users were contacted by letter to ask for permission to sample their water.

Friday 15 March: Residents in the area (both those whose boreholes had been tested, and neighbours whose properties included boreholes) were invited to a public event. Responses were requested by Eventbrite in order to measure response and determine whether additional capacity would be required.

The event was held on 20 March and included a presentations and a Q&A session. A database of contact emails was taken at the event, on the assumption that it would be the most effective and direct way of contacting those affected. Alternative methods of contact were considered for those without emails.

A video of the presentations was added to the gov.je page, and the key questions and themes from the Q&A session were used as the foundation of the FAQs, which were also uploaded to the page.

All attendees were subsequently sent a link to the page and invited to receive updates via email. They were also invited to forward the email to anyone else who might like to receive updates.

Since then, a number of emails have been sent to the group, which is open to anyone and enables direct two-way communication between Government and those who are directly affected.

7.3 Conclusions / assumptions

Assumptions that could be drawn from the questions asked at the public meeting, and media reporting are:

- There is a very understandable concern about the impact of PFOS on residents and families with private water supplies
- That concern is not generally matched by the understanding that the risk, while present, is extremely small
- There is limited public understanding of the difference between borehole water, treated water, or of the differing levels of risk associated with them.
- There is evidence of an assumption of Government responsibility for borehole water quality
- There is evidence of an expectation of Government action to resolve the issue

8. References / bibliography

Vedagiri, U.K; Anderson, R.H; Loso, H. M; Schwach, C.M (2018). Ambient levels of PFOS and PFOA in multiple environmental media. The Journal of Environmental Cleanup costs, technologies and techniques.

The Jersey Water Law
https://www.jerseylaw.je/laws/revised/Pages/27.700.aspx

Water management plan for Jersey 2017 to 2021
https://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=2147

Private water supplies: registration and licences
https://www.gov.je/Environment/ProtectingEnvironment/Water/Pages/ManagingIslandWater.aspx

European Drinking Water Directive
http://ec.europa.eu/environment/water/water-drink/legislation_en.html

Australian Government Department of Health Expert Health Panel for PFAS Report
https://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas-expert-panel.htm

Canadian Government Publication PFAS
https://www.canada.ca/en/services/health/publications/healthy-living/water-talk-drinking-water-screening-values-perfluoroalkylated-substances.html

Transfer of perfluorooctane sulfonic acid (PFOS) from contaminated feed to dairy milk*https://www.sciencedirect.com/science/article/pii/S0308814613004810*

Opinion of the Scientific Panel on Contaminants in the Food chain on Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts, *The EFSA Journal* (2008) Journal number,
653, 1-131.

Public Health England PFOS and PFOA toxicological Overview.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/338261/PFOS_and_PFOA_Toxicological_Overview_phe_v1.pdf

Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts. Scientific Opinion of the Panel on Contaminants in the Food chain
www.**efsa**.europa.eu/sites/default/files/scientific_output/files/main_documents/653.pdf

Guidance on the Water Supply (Water Quality) Regulations 20001 specific to PFOS (perfluorooctane sulphonate) and PFOA (perfluorooctanoic acid) concentrations in drinking water (http://www.dwi.gov.uk/stakeholders/information-letters/2009/10_2009annex.pdf)

Appendices

Appendix 1 - The Australian Expert Panel Review – Detailed Summary

The Panel reviewed 20 recently published key Australian and international reports and academic reviews that had examined scientific studies on potential human health effects of PFAS exposure. The Panel also undertook a public consultation to inform them of the communities' concerns regarding PFAS, and their suggestions for future research.

Assessment of evidence

The Panel found that although the scientific evidence on the relationship between PFAS exposure and health effects is limited, current reports, reviews and scientific research provide fairly consistent reports with several health effects. These health effects were

- increased levels of cholesterol in the blood;
- increased levels of uric acid in the blood;
- reduced kidney function;
- alterations in some indicators of immune response;
- altered levels of thyroid hormones and sex hormones;
- later age for starting menstruation (periods) in girls, and earlier menopause; and
- lower birth weight in babies.

However, for the health effects above, the differences reported in the scientific studies between people who have the highest exposure to PFAS and those who have had low exposure, are generally small. The level of health effect reported in people with the highest exposure is generally still within the normal ranges for the whole population.

The Panel concluded there is mostly **limited or no evidence** for any link with human disease from these observed differences. Importantly, there is no current evidence that supports a large impact on a person's health as a result of high levels of PFAS exposure. However, the Panel noted that even though the evidence for PFAS exposure and links to health effects is **very weak and inconsistent**, important health effects for individuals exposed to PFAS cannot be ruled out based on the current evidence.

The Panel concluded that many of the biochemical (for example, higher cholesterol and uric acid levels in the blood) and disease links reported in the studies may be able to be explained by **reverse causation or confounding**. Reverse causation is when there is a link between the exposure to PFAS and a health effect, but it is not clear whether the exposure has caused the health effect or whether the health effect causes increased exposure. Confounding is where a third factor (for example, age, smoking, or socio-economic status), could influence the findings of the study.

For cancer, the Panel concluded there is **no current evidence that suggests an increase in overall cancer risk**. The Panel did however note that the most concerning signal reported in the scientific studies for life-threatening human disease is a possible link with an increased risk of two uncommon cancers: testicular and kidney cancer. However, these associations were only found in one cohort, and the Panel believes they were possibly due to chance, as they have yet to be found in other studies. Additionally, the Panel noted that the limited amount of evidence which is available on cancer relates to the PFOA chemical, not PFOS (which is more common in Australia).

The Panel noted there are **many issues and limitations** with the studies that make up the evidence base. Hundreds of scientific studies on PFAS and health effects are based on just seven cohorts of people, and that there is a high risk that bias or confounding is affecting the results reported. Bias can occur in any part of a study, from the type of people selected, through to how the researcher chooses to analyse the results. Additionally, there are very large numbers of comparisons being done in many studies. This brings an increased risk that findings may be interpreted as real whereas the finding may have in fact been due to chance. Another complicating factor is that there are lots of different PFAS chemicals, and other environmental or occupational differences, with possible interacting toxic effects, making it difficult to find exactly which chemical is involved or responsible for the study findings. Many of the studies had too few participants to detect important associations.

After considering all the evidence, the Panel's advice to the Minister on this public health issue is that the evidence **does not support** any specific health or disease screening or other health interventions for highly exposed groups in Australia, except for research purposes. Decisions and advice by public health officials about regulating or avoiding specific PFAS chemicals should be mainly based on scientific evidence about the persistence and build-up of these chemicals.

Appendix 2 - Method summary for the extraction and determination of PFOS and PFOA in water

National Laboratory Service

Determinand	Perfluorooctanoic acid Perfluorooctane sulphonic acid	PFOA PFOS

Matrix: Freshwater and Saline waters

Instrumentation: UHPLC - Triple Quadrupole Mass Spectrometry

Principle: Freshwater samples are analysed by liquid chromatography-mass spectrometry (LC-MS/MS) using Direct Aqueous Injection.

Saline samples are extracted using solid phase extraction (SPE) prior to analysis by liquid chromatography-mass spectrometry (LC-MS/MS).

An aliquot of sample is injected into a Liquid Chromatogram interfaced to a Triple Quadrupole Mass Spectrometer. This operates in Negative, Atmospheric Pressure Electrospray (ESI) mode. Data is acquired in Multiple Reaction Monitoring (MRM) mode.

Range of Application: Freshwater: up to 0.03µg/l
Saline water**:** up to 0.004µg/l for PFOS and 0.008µg/l for PFOA.
The range may be extended by dilution of the sample.

MRV: Available upon request

Container: 125ml HDPE bottle

Storage/Preservation: Cold Storage at 5°C ± 3°C

Interferences: Any compound with the same MRM transition and retention time as the ion of interest and any co-eluting compounds which result in signal suppression or enhancement will interfere.

Within Laboratory Quality Control & Performance Criteria:

Precision:- Better than 25% RSD
Bias:- Better than 20% Bias

External Quality Control: UKWIR AQS

Appendix 3 - Method summary for milk and potato testing

PFAS in milk samples

The Vista Analytical Laboratory method utilizes isotope dilution and internal standard techniques using solid phase extraction (SPE) with liquid chromatography/mass spectrometry (LC/MS/MS).

A Method Blank, Laboratory Control Sample (LCS) and LCS Duplicate (LCSD) are prepared with every preparation batch of 20 samples or less per matrix type.

An aliquot of milk is spiked with a solution of carbon-labelled Internal Standards. The samples are sonicated with Acetic Acid/Acetonitrile. The samples are centrifuged and the supernatant is decanted and diluted with PFAS-free reagent water before being passed through a conditioned solid phase extraction cartridge.

The cartridge is washed with reagent water and methanol: water before drying under vacuum for ~10 minutes. The cartridge is eluted with methanol and basic methanol and concentrated to near-dryness with nitrogen.

The eluant is passed through an ENVI-Carb™ cartridge and concentrated to near-dryness. Recovery standard is added.

Reversed-phase liquid chromatography is used to separate compounds of interest. The LC/MS/MS instrument is operated in negative ion ionization using multiple reaction monitoring (MRM) for quantitative analysis. Peak area is used for quantitation. An initial 9-point calibration curve is analysed to demonstrate the linearity of the analytical system over the calibration range and verified with a continuing calibration verification standard per analytical sequence (10 samples).

Unique precursor-product ions are monitored for each compound at specific retention times. The reporting limits correspond to the low point of the current calibration curve; they can be adjusted based on project requirements.

PFAS in solid samples

The Vista Analytical Laboratory method, based on EPA Method 537, is used for the determination of the PFAS in solid matrix, by isotope dilution and internal standard techniques using solid phase extraction (SPE) with liquid chromatography/mass spectrometry (LC/MS/MS).

A Method Blank, Laboratory Control Sample (LCS) are prepared with every preparation batch of 20 samples or less per matrix type. All samples should be stored at less than 6°C. Solid and Tissue samples: Samples (1g) are first spiked with Internal Standard, then sonicated with sodium hydroxide for 30 minutes, and incubated for 12-18 hours at ambient temperature. Hydrochloric acid is added to acidify, and the samples are vortexed. The samples are shaken in Acetonitrile:Methanol, then centrifuged. Ten mL is decanted, and the extraction process is repeated. The combined extracts are passed through a conditioned solid phase extraction cartridge.

The cartridge is washed with reagent water and methanol:water before drying under vacuum for ~10 minutes.

The cartridge is eluted with basic methanol and concentrated to near-dryness with nitrogen. When appropriate, the cartridge is passed through an ENVI-Carb™ cartridge and concentrated to near dryness. Recovery standard is added.

Reversed-phase liquid chromatography is used to separate compounds of interest. The LC/MS/MS instrument is operated in negative ion ionization using multiple reaction monitoring (MRM) for quantitative analysis. Peak area is used for quantitation. An initial 5 or 6-point calibration curve is analysed to demonstrate the linearity of the analytical system over the calibration range and verified with a continuing calibration verification standard per analytical sequence (10 samples). Unique precursor-product ions are monitored for each compound at specific retention times. The reporting limits correspond to the low point of the current calibration curve; they can be adjusted based on project requirements.

Appendix 4 - The number of pesticide detections above the laboratory limit of detection recorded in island surface water (streams and reservoirs) during the sampling period
(18/02/2019 - 24/05/2019).

18/02/2019	VDLM West Pt A	Ethoprophos	0.312	
18/02/2019	VDLM West Pt A	Oxadixyl	0.209	
18/02/2019	Bellozanne Side Stream	Diuron	0.160	
19/02/2019	Le Mourier Combined	Oxadixyl	0.205	
25/02/2019	VDLM West Pt A	Oxadixyl	0.235	
25/02/2019	Le Mourier Combined	Oxadixyl	0.221	
25/02/2019	VDLM West Pt A	Ethoprophos	0.178	
25/02/2019	Tesson	Oxadixyl	0.101	
25/02/2019	VDLM Pump/Top Strainer	Metobromuron	0.100	* unaccredited
25/02/2019	La Hague Dip	Metobromuron	0.100	* unaccredited
04/03/2019	Queens Valley Stream	Glyphosate	1.047	
04/03/2019	VDLM West Pt A	Ethoprophos	0.945	
04/03/2019	Queens Valley Stream	AMPA	0.267	
04/03/2019	Tesson	Ethoprophos	0.249	
04/03/2019	VDLM West Pt A	Oxadixyl	0.238	
04/03/2019	VDLM Pump/Top Strainer	Metobromuron	0.100	* unaccredited
04/03/2019	La Hague Dip	Metobromuron	0.100	* unaccredited
05/03/2019	Le Mourier Combined	Ethoprophos	5.920	
05/03/2019	Rue a la Dame	Tebuconazole	2.918	
05/03/2019	Grands Vaux Stream	Boscalid	2.270	
05/03/2019	Rue a la Dame	Glyphosate	1.087	
05/03/2019	Greve de Lecq Stream	Ethoprophos	0.731	
05/03/2019	Greve de Lecq Stream	Azoxystrobin	0.637	
05/03/2019	Vallee des Vaux Stream	Metribuzin	0.624	
05/03/2019	Greve de Lecq Stream	Pendimethalin	0.526	
05/03/2019	Bellozanne	Azoxystrobin	0.267	
05/03/2019	Grands Vaux Stream	Epoxiconazole	0.246	
05/03/2019	Greve de Lecq Stream	AMPA	0.224	
05/03/2019	Le Mourier Combined	Pendimethalin	0.195	
05/03/2019	Le Mourier Combined	AMPA	0.188	
05/03/2019	Pont Marquet Stream	Glyphosate	0.177	
05/03/2019	Greve de Lecq Stream	Glyphosate	0.174	
05/03/2019	Vallee des Vaux Stream	Azoxystrobin	0.157	
05/03/2019	Bellozanne Side Stream	Glyphosate	0.154	
05/03/2019	Grands Vaux Stream	Tebuconazole	0.144	
05/03/2019	Grands Vaux Stream	Ethoprophos	0.139	

05/03/2019	Le Mourier Combined	Glyphosate	0.138	
05/03/2019	Le Mourier Combined	Glyphosate	0.138	
05/03/2019	Bellozanne Side Stream	Pendimethalin	0.123	
05/03/2019	Pont Marquet Stream	Ethoprophos	0.122	
05/03/2019	Rue a la Dame	AMPA	0.109	
05/03/2019	Grands Vaux Stream	Metribuzin	0.104	
11/03/2019	Grands Vaux Stream	Ethoprophos	0.219	
11/03/2019	Queens Valley Stream	Glyphosate	0.177	
11/03/2019	Rue a la Dame	Tebuconazole	0.143	
11/03/2019	Bellozanne	Ethoprophos	0.138	
11/03/2019	Handois Blended Raw Water	Metobromuron	0.100	* unaccredited
11/03/2019	Augres Blended Raw Water	Metobromuron	0.100	* unaccredited
12/03/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
13/03/2019	VDLM West Pt A	Metobromuron	1.700	* unaccredited
13/03/2019	VDLM East Inlet to Res	Metobromuron	0.200	* unaccredited
13/03/2019	VDLM West Pt A	Ethoprophos	0.200	* unaccredited
13/03/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
13/03/2019	Augres Blended Raw Water	Metobromuron	0.100	* unaccredited
15/03/2019	VDLM West Pt A	Ethoprophos	0.222	
15/03/2019	VDLM West Pt A	Oxadixyl	0.217	
15/03/2019	Le Mourier Combined	Oxadixyl	0.199	
18/03/2019	Augres Blended Raw Water	Metobromuron	0.100	* unaccredited
18/03/2019	Handois blended Raw Water	Metobromuron	0.100	* unaccredited
19/03/2019	VDLM West Pt A	Oxadixyl	0.214	
19/03/2019	Le Mourier Combined	Oxadixyl	0.195	
20/03/2019	VDLM West Pt A	Ethoprophos	0.222	
20/03/2019	Queens Valley Stream	Glyphosate	0.218	
20/03/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
20/03/2019	Tesson	Ethoprophos	0.191	
20/03/2019	Bellozanne Side Stream	Glyphosate	0.113	
25/03/2019	Le Mourier Combined	Oxadixyl	0.212	
25/03/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
25/03/2019	Pont Marquet Stream	AMPA	0.125	
25/03/2019	Tesson	Oxadixyl	0.103	
25/03/2019	La Hague Dip	AMPA	0.101	
25/03/2019	Handois Blended Raw Water	Metobromuron	0.100	* unaccredited
26/03/2019	Queens Valley Stream	Glyphosate	0.217	

26/03/2019	Queens Valley Side Stream	AMPA	0.194	
26/03/2019	Queens Valley Stream	AMPA	0.135	
01/04/2019	VDLM West Pt A	Oxadixyl	0.245	
01/04/2019	Le Mourier Combined	Oxadixyl	0.206	
01/04/2019	Tesson	Oxadixyl	0.107	
01/04/2019	Handois Blended Raw Water	Metobromuron	0.100	* unaccredited
02/04/2019	Queens Valley Stream	Glyphosate	0.344	
02/04/2019	Queens Valley Stream	AMPA	0.210	
02/04/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
02/04/2019	Queens Valley Side Stream	Glyphosate	0.160	
02/04/2019	Handois East Pt A	Ethoprophos	0.104	
08/04/2019	Queens Valley Stream	Glyphosate	0.759	
08/04/2019	Bellozanne Stream	Glyphosate	0.654	
08/04/2019	Fernlands Stream	Glyphosate	0.314	
08/04/2019	Rue a la Dame	Glyphosate	0.293	
08/04/2019	Queens Valley Stream	AMPA	0.279	
08/04/2019	Bellozanne Stream	AMPA	0.231	
08/04/2019	Handois East Pt A	Ethoprophos	0.106	
09/04/2019	Little Tesson	Glyphosate	0.657	
09/04/2019	VDLM West Pt A	Oxadixyl	0.243	
09/04/2019	Le Mourier Combined	Oxadixyl	0.205	
09/04/2019	Little Tesson	AMPA	0.160	
09/04/2019	Pont Marquet Stream	AMPA	0.142	
09/04/2019	Greve de L'Ecq Stream	Glyphosate	0.123	
09/04/2019	Pont Marquet Stream	Glyphosate	0.101	
09/04/2019	La Hague Stream	AMPA	0.101	
10/04/2019	La Hague Dip	Glyphosate	0.185	
10/04/2019	VDLM Pump/Top Strainer	Metobromuron	0.100	* unaccredited
15/04/2019	VDLM West Pt A	Oxadixyl	0.254	
15/04/2019	Le Mourier Combined	Oxadixyl	0.196	
15/04/2019	Pont Marquet Stream	AMPA	0.169	
15/04/2019	Tesson	Oxadixyl	0.110	
15/04/2019	VDLM West Pt A	Metobromuron	0.100	* unaccredited
17/04/2019	Handois West Stream	Glyphosate	0.387	
17/04/2019	Queens Valley Stream	Glyphosate	0.314	
17/04/2019	Queens Valley Stream	AMPA	0.248	
17/04/2019	Queens Valley Side Stream	Glyphosate	0.221	
17/04/2019	Vallee des Vaux Stream	Glyphosate	0.165	
17/04/2019	Rue a la Dame	Glyphosate	0.127	
17/04/2019	Fernlands Stream	Glyphosate	0.123	

17/04/2019	Queens Valley Side Stream	AMPA	0.106	
23/04/2019	VDLM West Pt A	Oxadixyl	0.325	
23/04/2019	Dannemarche	Glyphosate	0.237	
23/04/2019	Le Mourier Combined	Oxadixyl	0.210	
23/04/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
23/04/2019	Pont Marquet Stream	AMPA	0.196	
23/04/2019	Little Tesson	Oxadixyl	0.105	
23/04/2019	Greve de Lecq Stream	Oxadixyl	0.101	
24/04/2019	Vallee des Vaux Stream	Glyphosate	1.478	
24/04/2019	Queens Valley Stream	Glyphosate	0.582	
24/04/2019	Queens Valley Stream	AMPA	0.365	
24/04/2019	Rue a la Dame	Glyphosate	0.551	
24/04/2019	Fernlands Stream	Glyphosate	0.506	
24/04/2019	Queens Valley Side Stream	Glyphosate	0.173	
24/04/2019	Vallee des Vaux Stream	AMPA	0.166	
24/04/2019	Bellozanne Side Stream	Glyphosate	0.148	
24/04/2019	Fernlands Stream	AMPA	0.104	
29/04/2019	Le Mourier Combined	Oxadixyl	0.207	
29/04/2019	Pont Marquet Stream	AMPA	0.165	
02/05/2019	VDLM Pump/Top Strainer	Metobromuron	0.200	* unaccredited
03/05/2019	Queens Valley Stream	AMPA	0.358	
03/05/2019	Queens Valley Stream	Glyphosate	0.247	
07/05/2019	Queens Valley Stream	Metribuzin	0.130	
08/05/2019	Dannemarche	Azoxystrobin	0.133	
08/05/2019	Millbrook Stream	Azoxystrobin	0.233	
08/05/2019	Grands Vaux Stream	Boscalid	0.104	
10/05/2019	Tesson	Ethoprophos	1.080	
10/05/2019	VDLM East Inlet to Res	AMPA	0.126	
10/05/2019	La Hague Dip	Glyphosate	0.414	
10/05/2019	La Hague Dip	AMPA	0.158	
10/05/2019	La Hague Dip	Ethoprophos	0.181	
10/05/2019	La Hague Dip	Metobromuron	0.300	* unaccredited
10/05/2019	VDLM West Pt A	Oxadixyl	0.229	
10/05/2019	Le Mourier Combined	Oxadixyl	0.189	
14/05/2019	Tesson	Oxadixyl	0.111	
14/05/2019	Greve de Lecq Stream	Glyphosate	0.103	
14/05/2019	Greve de Lecq Stream	Oxadixyl	0.101	
14/05/2019	VDLM West Pt A	Oxadixyl	0.247	
14/05/2019	Le Mourier Combined	Oxadixyl	0.210	
14/05/2019	La Hague Dip	Oxadixyl	0.129	
14/05/2019	VDLM Pump/Top Strainer	Metobromuron	0.100	* unaccredited

14/05/2019	Handois Res Out	Metobromuron	0.100	* unaccredited
14/05/2019	Millbrook Res Out	Metobromuron	0.200	* unaccredited
14/05/2019	VDLM East Inlet to Res	AMPA	0.126	
14/05/2019	Pont Marquet	AMPA	0.164	
14/05/2019	La Hague Stream	AMPA	0.108	
14/05/2019	La Hague Stream	Glyphosate	0.128	
15/05/2019	Handois Blended Raw Water	Metobromuron	0.200	* unaccredited
15/05/2019	Queens Valley Stream	AMPA	0.416	
15/05/2019	Queens Valley Stream	Glyphosate	0.285	
20/05/2019	Rue a la Dame	Tebuconazole	0.116	
20/05/2019	Handois East Pt A	Glyphosate	0.197	
20/05/2019	Bellozanne Stream	AMPA	0.115	
20/05/2019	Bellozanne Stream	Glyphosate	0.193	
20/05/2019	Vallee des Vaux Stream	AMPA	0.108	
20/05/2019	Rue a la Dame	Glyphosate	0.128	
20/05/2019	Queens Valley Stream	AMPA	0.661	
20/05/2019	Queens Valley Stream	Glyphosate	4.257	
21/05/2019	Greve de Lecq Stream	Oxadixyl	0.102	
21/05/2019	Le Mourier Combined	Oxadixyl	0.204	
21/05/2019	VDLM East Inlet to Res	AMPA	0.141	
21/05/2019	Pont Marquet	AMPA	0.225	
21/05/2019	Little Tesson	AMPA	0.199	
21/05/2019	Little Tesson	Glyphosate	0.140	
21/05/2019	VDLM West Pt A	Oxadixyl	0.278	
22/05/2019	Handois Res Out	Metobromuron	0.100	* unaccredited
22/05/2019	Handois Blended Raw Water	Metobromuron	0.100	* unaccredited
22/05/2019	La Hague Dip	Oxadixyl	0.107	

Note: The European Drinking Water Directive set a standard of 0.1µg/l for each individual pesticide in drinking water. This corresponds to a concentration of 1 part in ten billion. This is not a health based standard; it was set by the European Commission in 1980 to reflect the limit of analytical methodology at the time and as an environmental policy to generally limit pesticides. The Directive also set a standard of 0.5µg/l Total Pesticides (the sum of all the substances detected in a sample).

Appendix 5 - Curriculum Vitae - Professor John Fawell

NAME:	**Professor JOHN FAWELL**
PROFESSION:	**Consultant on drinking water and environment.**
PROFESSIONAL BACKGROUND:	Biologist/Toxicologist
PRIMARY SPECIALISATION:	Assessment and management of risks from drinking water contaminants and from re-use of wastewater. Development of drinking water standards and regulations.
YEAR OF BIRTH;	1945
NATIONALITY:	British
HONOURS:	MBE Received the International Society of Regulatory Toxicology and Pharmacology 2013 International Achievement Award
QUALIFICATIONS:	BSc Applied Biology (Class II. Div 1) University of Bath 1969 MI Biol C Biol 1972 (now C Biol MRSB) Diploma in Toxicology, Royal College of Pathologists 1986
PROFESSIONAL AFFILIATIONS:	Royal Society of Biology British Toxicology Society American Water Works Association Scientific Fellow, of the Zoological Society of London International Water Association Appointed visiting professor at Cranfield University May 2011.
WORKING LANGUAGE:	English

Experience

Prof Fawell has worked on the implications of contaminants in the environment for human health and aquatic life since 1979 and is actively involved at both a national and international level. Key areas included:

- He has been closely involved in the WHO Guidelines for Drinking Water Quality since 1988 and is a member of expert group on the Guidelines. He was a very active participant in the preparation of background documents and revisions of Guideline Values for the fourth edition of the Guidelines published in July 2011 and is part of the team preparing the fifth edition. He was part of the WHO expert group establishing guidelines for the supply of safe drinking water by desalination and a member of the expert group considering the significance of beneficial minerals in drinking water. He was one of the three co-ordinators and one of the authors of the WHO publication “Chemical safety of drinking-water: assessing priorities for risk management”. He was a member of the WHO expert group on pharmaceuticals in drinking water. He was one of the three lead authors for the WHO document “Developing drinking-water quality regulations and standards” published in 2018 and is a member of the expert group on microplastics in drinking-water.
- One of the lead members of a team commissioned in 2007 to prepare the proposals for revising Annex 1 of the European Drinking Water Directive taking into account the introduction of water safety plans. He was closely involved in the development of a new annex II for the Directive and was one of the small team from WHO European Office that prepared recommendations in 2018 that form the basis of the Commission’s proposals for a new drinking water directive.
- Has worked closely with WHO regional offices, including liaison between the European Commission and the European Regional Office on water and between WHO HQ and the Commission on re-use of wastewater.
- Member of several IPCS expert groups and author of working documents on chemical contamination for the WHO working group on bathing water quality. He has served on JECFA for the risk assessment of substances in which drinking water is a key source of exposure and is a member of the panel of experts.
- Has led programmes of research on the toxicology and health implications of a wide range of drinking water contaminants for government and water suppliers since 1982. Has acted as external supervisor and external examiner for a number of PhD students.
- Previously chief scientist at the National Centre for Environmental Toxicology at WRc.
- He has provided independent advice and reviews on chemicals, which are used in drinking water or which may reach the environment, for a range of government departments and industries.
- Prof Fawell provides advice on water contaminants and their management for a number of public drinking water suppliers, including acting as an independent reviewer of water quality of both raw and treated water.
- Has been a member of committees advising government and regulatory bodies such as the Sub-Committee on Pesticides, technical advisor to the Joint Agency Groundwater Directive Advisory Group, The Toxic Algae Task Group and the Steering Group for the Revision of the UK National Environmental Health Action Plan. He was invited to give evidence to the Royal Commission on Environmental Pollution at the beginning of their study on environmental regulations. He has worked closely with the

International Life Sciences Institute (ILSI) in the USA and Europe and was previously chairman of the ILSI Europe Task Force on Environment and Health.

- Provided independent advice on regulatory and environmental issues to the drinking water inspectorate in the UK for over 20 years and a variety of industries and government departments, including governments outside the UK. He has provided an independent opinion on the work of the Irish drinking water regulator and the value for money that it provides. He acted as expert advisor to a Commission of Inquiry on Lead in Drinking Water for the Hong Kong Government.

Prof Fawell has been involved in research on a number of priority contaminants in the environment and drinking water including endocrine disrupters, disinfection by-products and pharmaceuticals. He has extensive research experience on disinfection by-products and has advised WHO and governments, including the European Commission and water suppliers on the significance of disinfection by-products and the importance of various approaches to control. In this respect he has close ties with The Department of Epidemiology at Imperial College and the Small Area Health Statistics Unit in particular.

He has a particular interest in and is actively working in the field of risk assessment of chemicals and microorganisms in the environment. This includes the development of guidelines and standards for drinking water, strategies to manage risks and perceived risks in the managed water cycle by early intervention through developments in wastewater and drinking water treatment. He was part of the team, with WCA Environment and Cranfield University, which carried out an assessment of the significance of pharmaceutical residues for drinking water for DWI and was part of a WHO/USEPA joint initiative on pharmaceutical residues.

He worked with CREH Analytical to develop a framework for managing microbial and chemical risks in drinking water (Water safety Plans) and with CREH Analytical and Owen Hydes to develop a framework for developing criteria for the safe reuse of wastewater. He was leader of the small team that developed advice for the Scottish Government on the introduction of Water Safety Plans in Scotland. He has also worked with the Spanish consultancy Eptisa in Romania to assist the Ministry of Health in meeting the requirements of the EU drinking water and bathing water directives, including introducing water safety plans in Romania. He and Owen Hydes have assisted water companies in developing and implementing their strategy for the introduction of drinking water safety plans and he was a consultant to IWA for their outreach programme to water suppliers on drinking water safety plans, including activities in Brazil, India and the Far East.

Prof Fawell has an international reputation and is involved in a number of international fora in addition to WHO, and has close contacts with regulators, industry and researchers in many parts of the world including North America and Japan. In 1998 he carried out a WHO mission to Kuwait to advise on environmental and environmental health issues. He was chairman of the Expert Committee on Health Aspects of Water Supply for KIWA in the Netherlands. He has acted as a consultant on drinking water standards and drinking water related materials to the Canadian Government and has close links with the USEPA Office of Water. He has assisted the USEPA and Health Canada on research requirements for the assessment of disinfection by-products in drinking water.

Prof Fawell is interested in the public perception of risk and the communication of risks to the public. He has acted as a PhD examiner on this subject and has made numerous radio and television appearances to discuss risks of a wide range of environmental contaminants and issues surrounding environmental contamination.

Prof Fawell is an author of over 100 publications in the open literature and is author of many project and other reports found in the grey literature.

Following a period of 20 years with WRc, he joined Warren Associates (Pipelines) Ltd as a Director of the Environmental Division in January 2000 and transferred to an equivalent position in the Infrastructure and Environment Management Division of FaberMaunsell when Warren Associates (Pipelines) Ltd was acquired by AECOM. He has worked independently since 2003.

He was non-executive chairman of the board of WCA Environment, stepping down to non-executive board member in 2011 and retiring from the board in January 2013. He was appointed visiting professor in the Water Science Institute at Cranfield University in the UK in May 2011.