# A rapid assessment of potatoes grown within St Ouen's Bay, Jersey to explore the presence of per- and polyfluoroalkyl substances (PFAS)

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*This paper was prepared by the Department for Infrastructure and Environment, within the Government of Jersey.*

## Introduction

The airport fire service in Jersey historically used firefighting foams that contained per- and polyfluoroalkyl substances (PFAS), including for practice exercises which was regarded as usual practice at the time. This was prior to the current understanding of the potential environmental and human health effects associated with these chemicals.

Groundwater and surface water below the airport fire training ground now contains elevated levels of PFAS. This has impacted private water supplies (boreholes and wells). The public water supply has historically been extended to properties in the St Ouen's Bay plume area.

Recent global concerns regarding PFAS has led to more in-depth sampling, monitoring, and understanding of potential clean-up options by the Government and Ports of Jersey.

An independent expert advisory panel has been established to advise the Government on health impacts of PFAS (the PFAS Scientific Advisory Panel). The Panel will produce a series of reports with the fourth report focussing on the environmental management of PFAS.

New potatoes have historically been planted within the PFAS plume area in St Ouen's Bay. Annual planting commences in February with harvesting and sale of the crop occurring approximately 12 weeks later. St Ouen's Bay represents an early area for production and the potatoes can command a relatively high price. The sandy soil, although warm and self-draining, means that the crop requires irrigation.

In October 2023, owners of fields and a surface water body in the plume area raised concerns. These centred on the safety of consuming potatoes grown by farmers (who lease the fields) and that are irrigated using water pumped from their water body. Previous sampling by the Government of Jersey has shown that this water contains elevated levels of PFAS.

The matter was seen as urgent as the planting season was four weeks away. There were potentially commercial implications in delaying, including the ability of the farmers to continue to lease the fields, and potential reputational risks for the island. The Government therefore decided to undertake a rapid review.

A small, targeted survey of water, potatoes and soil was undertaken, along with discussions on how to use and interpret the information.

The results were shared with the owners of the field/water body, and redacted information was shared to all interested parties on 4 January 2024.

### Discussions with the PFAS Scientific Advisory Panel

This work was outside the remit of the Panel, and a rapid turnaround was required which would not permit the rigorous methodology the Panel would use for their commissioned work. Despite this, the PFAS Panel met with the Infrastructure and Environment team to discuss what should be tested for PFAS, and how to interpret test results and calculate the likely PFAS burden of consumption by

humans. Discussions included how to interpret the results of the testing in the context of international comparators and food safety guidelines.

## Sampling methods

Testing of PFAS levels was undertaken in three components: water, soil, and potatoes. Because the review was outside of the main potato growing and harvesting season, no marketable potatoes were available. Seed potatoes were also unavailable as they had not been grown in the fields. 'Volunteer potatoes' that had remained in the ground after harvesting and which had subsequently grown (between May and October) were therefore tested.

In terms of the testing of the potatoes themselves, there is some evidence that certain PFAS chemicals accumulate in the skin of the potato (although this is likely to be more important in thicker skinned potatoes, than thinner skinned Jersey potatoes)[1]. Testing therefore included skins as well as the flesh. Potatoes are not consumed raw, so both raw and cooked (boiled) potatoes were tested.

To ensure that the potatoes and soil were representative of the field, they were sampled following a W shape across the field from seventeen locations. Soil was sampled to a depth of 150mm using an auger, and potatoes were in the top 100mm.

Samples were then sub-divided to obtain the required sample weight. Samples of potatoes were split into two, to analyse one raw and one cooked sample. A single sample of soil was submitted. Times and volumes of water irrigated to the respective fields and the samples are given in Table 1 & 2.

**Table 1 Irrigation records**

| Sample identification | Abstraction source for irrigation | Irrigation details 2019 Note 1 | Irrigation details 2020 Note 1 | Irrigation details 2021 Note 1 |
|---|---|---|---|---|
| 2023-1476/1480 | St Ouen's Bay plume (central area) | 24 March, 0630-1645hrs, One inch cover, total 207 $m^3$ | 9 April, 0620-1615hrs, One inch cover, total 207 $m^3$ | 16 April, 1400-1155hrs, One inch cover, total 207 $m^3$ |
| 2023-1477/1481 | St Ouen's Bay plume (central area) | 25 March, 0600-1215hrs, One inch cover, total 103 $m^3$ | 4 April, 0700-1305hrs, One inch cover, total 103 $m^3$ | 15 April, 0700-1300hrs, One inch cover, total 103 $m^3$ |
| 2023-1475/1479 | St Ouen's Bay plume (margin area) | 29 March, 0800-1800hrs, One inch cover, total 224 $m^3$ | 4 April, 0700-1655hrs, One inch cover, total 224 $m^3$ | n/a |
| 2023-1474/1478 | n/a | n/a | n/a | n/a |

Note 1; Rovatti pump 21 $m^3$ per hour, Irrigation gun.

[1] https://link.springer.com/article/10.1007/s00244-008-9272-9

**Table 2 Field numbers and sampling undertaken**

| Sample identification | Field type | Sample details |
|---|---|---|
| 2023-1476/1480 | Irrigated field using water from St Ouen's Bay plume (central area) | Two samples of potatoes*, one sample of soil |
| 2023-1477/1481 | Irrigated field using water from St Ouen' Bay plume (central area) | Two samples of potatoes, one sample of soil |
| 2023-1475/1479 | Control. Irrigated field using water from St Ouen' Bay plume (margin area) | Two samples of potatoes, one sample of soil |
| 2023-1474/1478 | Control, Grouville outside the currently identified PFAS plume | Two samples of potatoes, one sample of soil |

* for testing of raw and cooked potatoes

Immediately after sampling, the samples of potatoes and soil were sealed in HPDE PFAS free containers supplied by the UK laboratory and placed into cool boxes with four frozen gel packs. A recording thermometer was included in the cool box to check that the samples remained within the required temperature.

The cool boxes and samples were couriered to Veritas Laboratory Services in Southampton at 1245hrs on 14 December 2023. They arrived the following morning on 15 December 2023.

## Laboratory methodology

PFAS in soil matrix

A known amount of soil sample was fortified with labelled standards of PFAS and extracted with 10ml of methanol followed by 10ml ammoniacal methanol. The obtained extract was concentrated to 10ml, and a second set of labelled standards were added. 10mg of carbon was added to absorb organic material (hydrocarbons), followed by addition of 25ul of acetic acid.

PFAS in potato matrix

A known amount of potato sample was washed in ultra-pure water. Unpeeled potato sample was then soft boiled in fresh amount of ultra-pure water.

A known amount of sample was homogenised and fortified with labelled standards and extracted with 50ml ammoniacal methanol. The obtained extract was concentrated to 10ml, and second set of labelled standards were added. Extract was then filtered through 0.2um filter.

Analysis

The analysis of PFAS samples was performed on Agilent LC/MS QQQ system.

Results for the laboratory were received by Environmental and Consumer Protection on 22 December 2023.

### A methodology for estimating the weekly intake of PFAS resulting from consumption of Jersey potatoes

The following methodology was followed, after discussions with the PFAS Panel:
An adult who only eats potatoes from Jersey as their source of potatoes would receive an estimated weekly intake *I* (µg/kg/week) of the sum of 4 per- and polyfluoroalkyl substances (PFAS) (namely PFOS, PFHxS, PFOA and PFNA), where *I* can be deduced from equation 1 (below). The calculation approach summarized by Equation 1 is the standard procedure for exposure intake calculations for chemicals, including PFAS (https://onlinelibrary.wiley.com/doi/10.1111/j.1539-6924.2008.01017.x).

*Equation 1*

$$I = \frac{C_P Q_P A}{B_W}$$

The terms in Equation 1 can be defined as follows:

$C_P$ = the concentration of the sum of the 4 PFAS measured in cooked Jersey potatoes (in the units of micrograms of PFAS per kilogram (µg/kg) of fresh weight potatoes),

*Qp* = weekly consumption of Jersey potatoes (in units of kilograms of potatoes (on a fresh weight basis) per week and per person),

*A* = gastrointestinal absorption efficiency (a fraction from 0 (no absorption of PFAS by the body) to 1.0 (perfectly efficient absorption of PFAS by the body), and

$B_w$ = average adult body weight (units of kilograms). It is common practice to normalize the intake to body weight.

## Results

**Table 3: Summary of the analytical data (conducted by Veritas Laboratory Services, Southampton, UK) for four PFAS in Jersey unpeeled raw potatoes.**

Concentrations were provided in µg/kg fresh weight. The method detection limits were 0.001 µg/kg for all four PFAS in the potatoes.

| Sample Identification | Individual PFAS concentrations (µg/kg fresh weight) | | | | Sum PFAS (µg/kg fresh weight) |
|---|---|---|---|---|---|
| | PFOS | PFHxS | PFOA | PFNA | |
| 2023-1476/1480* | 0.1340 | 0.0169 | 0.0177 | 0.0068 | 0.1754 |
| 2023-1477/1481* | 0.1490 | 0.0072 | 0.0035 | 0.0032 | 0.1629 |
| 2023-1475/1479 | 0.0078 | 0.0044 | 0.0037 | 0.0010 | 0.0169 |
| 2023-1474/1478 | 0.0128 | 0.0044 | 0.0018 | 0.0011 | 0.0201 |
| Average (mean) potato concentration<br>Range (low** to high***) | | | | | 0.0938<br>0.0169 - 0.1754 |

*irrigated fields using water from the St Ouen plume (central area)
**sum of all the lowest individual values.
***sum of the highest individual values.

**Table 4: Summary of the analytical data (conducted by Veritas Laboratory Services, Southampton, UK) for four PFAS in Jersey unpeeled cooked potatoes.**

Concentrations were provided in µg/kg fresh weight. The method detection limits were 0.001 µg/kg for all four PFAS in the potatoes.

| Sample Identification | Individual PFAS concentrations (µg/kg fresh weight) | | | | Sum PFAS (µg/kg fresh weight) |
|---|---|---|---|---|---|
| | PFOS | PFHxS | PFOA | PFNA | |
| 2023-1480* | 0.0973 | 0.0049 | 0.0031 | 0.0021 | 0.1074 |
| 2023-1481* | 0.0870 | 0.0094 | 0.0025 | 0.0032 | 0.0996 |
| 2023-1479 | 0.0189 | 0.0052 | 0.0036 | 0.0017 | 0.0294 |
| 2023-1478 | 0.0176 | 0.0048 | 0.0016 | <0.001** | 0.0245 |
| | | | | Average (mean) potato concentration<br>Range (low*** to high****) | 0.0652<br>0.0245 - 0.107 |

*irrigated fields using water from the St Ouen plume (central area).
**below the method detection limit.
***sum of all the lowest individual values.
****sum of the highest individual values.

Comparison of the PFAS concentration between raw and cooked potatoes (Tables 3 and 4) showed that boiling potatoes reduced the total PFAS concentration by an average 30%, with the two irrigated fields from the St Ouen's Bay plume (central area) showing a reduction of almost 40%.

The cooked data is more relevant for human exposure. The mean concentrations of the sum of the four PFAS measured in cooked (boiled) unpeeled Jersey potatoes were deduced from the laboratory results from Veritas Laboratory Services (Table 4).

Concentrations of the four PFAS (PFOS, PFHxS, PFOA and PFNA) were measured in four individual cooked potato samples (Table 4). PFNA was below the method detection of 0.001 µg/kg (denoted as less than 0.001 µg/kg) in one of the four cooked potato samples, but above the method detection limit in the other three cooked potato samples. The three other PFAS (PFOS, PFHxS and PFOA) were always above the method detection limit of 0.001 µg/kg in all four cooked potato samples.

## Further interpretations and assumptions

The following interpretations and assumptions were provided by the PFAS Panel:

- The average (i.e. the arithmetic mean; the sum of concentrations divided by the number of samples which equals four) concentration for the sum of four PFAS in the cooked potatoes was calculated to be 0.0652 µg/kg (with a range of 0.0245 to 0.107 µg/kg).
- A common practice was used of substituting half the detection limit for the missing data for PFNA in the one sample where it was below the method detection limit.
- For the range calculations, the lowest and maximum reported concentrations were used, respectively, for the upper and lower bounds. Substituting the missing data for PFNA with zero for the lower limit of the range and the method detection limit (0.001 µg/kg) for the upper limit of the range.
- The weekly consumption of fresh potatoes in the UK in 2021/2022 was 0.317 kilograms per person. This was taken from https://www.gov.uk/government/statistical-data-sets/family-food-datasets

- In the calculations, it was assumed that an adult eats only cooked unpeeled Jersey potatoes as their weekly fresh potato consumption.
- The gastrointestinal absorption fraction was assumed to be 1.0 unitless, i.e. it was assumed there is 100% (i.e. perfect) absorption of the four PFAS into the body during ingestion. The perfect absorption efficiency was justified based on the high absorption (>90%) observed in animal dosing experiments for PFOS and PFOA and because humans may have even higher absorption efficiencies than lab animals (typically mice, rats, and monkeys).
- In 2021, the mean weights of men and women in the UK based on adjustments to self-reported weight were 85.1 kg and 71.8 kg, respectively (https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2021/part-4-trends). These data for male and females from 2021 were used separately in the above equation to calculate separate exposure intakes for male and females.

Using all the data described above as input to Equation 1, the range was estimated of weekly intakes of the sum of four PFAS due to the consumption of unpeeled cooked Jersey potatoes (estimated the range of intakes separately for UK males and females). For UK males, the mean estimated weekly intake of the four PFAS is 0.24 nanograms per kilogram per week (ng/kg/week) with a range of 0.09 to 0.40 ng/kg/week. For UK females, the mean estimated weekly intake of the four PFAS is 0.29 nanograms per kilogram per week (ng/kg/week) with a range of 0.11 to 0.47 ng/kg/week.

**Comparison with levels set by the European Food Safety Authority (ESFA)**

The EFSA set a safety threshold for the four PFAS measured in Jersey potatoes, with limits, and is available here PFAS in food: EFSA assesses risks and sets tolerable intake | EFSA (europa.eu).

The safety threshold is expressed as a group tolerable weekly intake (TWI) of 4.4 nanograms per kilogram of body weight per week and was set as part of a published scientific opinion on the risks to human health arising from the presence of these substances in food. The TWI set by EFSA is the most stringent food safety guideline which has so far been set for PFAS. It was set low specifically to protect infants, toddlers, and other children from PFAS exposure.

Based on the results and methodology, the estimated weekly intake from consumption of Jersey potatoes falls considerably below the EFSA tolerable weekly intake (TWI).

On average, females consuming Jersey potatoes sampled from the are 15 times below the tolerable daily intake (TDI) (with a range of 9 to 41 times below the TDI) and males are 18 times below the TDI (with a range of 11 to 48 times below the TDI). The range of 9 and 11 for females and males respectively equates to those fields irrigated using water from the St Ouen's Bay plume (central area). Noting that those who consume Jersey potatoes may also be exposed to these four PFAS from other exposure sources (e.g. drinking water ingestion and dust ingestion etc.).

The levels were also triangulated against the levels of PFAS in potatoes in the UK Total Diet Survey, available here https://www.food.gov.uk/sites/default/files/media/document/research-report-total-

diet-study.pdf which looked at potatoes available to purchase in the UK in 2012, averaged across multiple sources.

This shows that PFOA, PFNA and PFHxS were considerably below the UK survey for raw potatoes in all four samples (irrigated and control samples). The value of PFOS were however higher in potato samples from fields irrigated from the St Ouen's Bay plume (central area).

PFAS are detectable everywhere, not just near to known hotspots of contamination. There is likely some PFAS in all potatoes (grown in industrialised countries around the world) and it is unlikely that any potatoes across the UK in the general supply chain would have zero PFAS (subject to the detection levels used).

It might also be assumed that the likelihood of consumers eating Jersey potatoes from the same fields over the course of time is low.

## Liability to persons supplying the irrigation water for potatoes and the famers growing the potatoes.

The question of personal liability of persons suppling irrigation water to farmers to use on their fields to water crops has been raised.

The Government of Jersey is unable to advise on this specific matter, as it is more appropriately discussed between parties (the suppliers and users of irrigation water) and their respective lawyers.

It is recognised that blanket clauses limiting personal liability are widely used in many forms of lease agreements between parties.

## Further plans

The PFAS Scientific Advisory Panel will consider in detail the broader impact of PFAS on the environment at a later stage, as part of their suite of reports. This will include considering PFAS in food. Further information about the Panel and their work can be found at PFAS in Jersey (gov.je).

## Conclusion

Having reviewed the results from the samples taken in December 2023 against the methodology outlined above, the estimated tolerable weekly intake (TWI) from the consumption of Jersey potatoes (based on these samples) falls considerably below the European Food Safety Authority (ESFA) TWI for PFAS, which is a stringent food safety guideline.

This was a small-scale review, carried out at pace, in an emerging area of science with some limitations.

Based on the available evidence and guidance at this time, Environmental and Consumer Protection within the Infrastructure and Environment Department conclude that all the potatoes sampled were not deemed unsafe for human consumption.