Myra Thompson

From: BRADSHAW Tony <Tony.Bradshaw@ehp.qld.gov.au>
Sent: Thursday, 18 August 2016 1:37 PM
To: Sophie Dwyer
Cc: Virginia Berry; CONNOR Andrew; HOLMES Nigel; VENTURA Simone
Subject: FW: Firefighting Foam: Oakey 31 ppm in borewater?

Hi Sophie,

I was waiting to mention this article at the end of the group meeting but it ended before I had the chance.

The article mentions there being up to 31,000 micrograms of PFOS and PFOA at a well in Oakey.

This is much higher than that reported in the HHRA.

It would be opportune to have a response to this if it is a reality, rather than a misreading of results, that we have not been appraised of.

Cheers Tony

Queensland Government

Tony Bradshaw
Technical Specialist
Technical Support and Community Response
Regulatory Capability and Customer Service
Department of Environment and Heritage Protection

P 07 3330 5704
Level 9, 400 George St, Brisbane QLD 4000
GPO Box 2454, Brisbane QLD 4001

Email tony.bradshaw@ehp.qld.gov.au
Website www.ehp.qld.gov.au

Please consider the environment before printing this email

From: BRADSHAW Tony
Sent: Thursday, 18 August 2016 12:22 PM
To: HOLMES Nigel

Cc: HILL Chris; CONNOR Andrew; GLEESON Kelly; VENTURA Simone; COOK David
Subject: RE: Firefighting Foam: Oakey 31 ppm in borewater?

Hi Nigel,

I've scanned the data in the HHRA and found the highest off site PFOS is 39.2 µg/L, 72.2 µg/L if one adds in PFHxS as per EnHealth 2016 advice.

On site, the highest PFOS is 330 µg/L. There is limited info on other PFAS but where PFHXs is sampled it varies between a fraction and somewhat greater than PFOS.

Can't find a 31,000 µg/L result, even in listing of former results (See HHRA Table 5A). It could be a private bore sample or possible result from a mix up of units?

Cheers Tony

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Sent: Thursday, 18 August 2016 11:30 AM
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Any idea where the 31 ppm cited in the article below comes from?
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http://www.news.com.au/lifestyle/health/health-problems/erin-brockovich-warns-about-potential-cases-of-chemical-contamination-in-australian-water-supply/news-story/090f45234c3a05bdd39847b81643e540

Regards

Nigel Holmes
Principal Advisor Incident Management
Central Queensland

Incident Response Unit | Environmental Services & Regulation
Queensland Department of Environment and Heritage Protection

Pollution Hotline: 1300 130 372
Phone 07 4936 0503 **Mobile** [redacted] **Satellite** 0147 157 660
61 Yeppoon Road, North Rockhampton QLD 4701
PO Box 3130, Red Hill Rockhampton QLD 4701

Myra Thompson

From: Sophie Dwyer
Sent: Wednesday, 24 August 2016 3:37 PM
To: BRADSHAW Tony
Cc: Virginia Berry; CONNOR Andrew; HOLMES Nigel; VENTURA Simone
Subject: RE: Firefighting Foam: Oakey 31 ppm in borewater?

Dear Tony
I agree with your approach to rely on the material in the HHRA. If it is cited again, we can seek information directly from whomever is claiming it so that we can confirm whether it is correct.

Sophie Dwyer PSM
Executive Director, Health Protection Branch
Prevention Division, Department of Health| Queensland Government
15 Butterfield Street, QLD
t. 07 33289266 m.
e. sophie.dwyer@health.qld.gov.au | www.health.qld.gov.au

From: BRADSHAW Tony [mailto:Tony.Bradshaw@ehp.qld.gov.au]
Sent: Thursday, 18 August 2016 1:37 PM
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GPO Box 2454, Brisbane QLD 4001

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Website www.ehp.qld.gov.au

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Regards

Nigel Holmes
Principal Advisor Incident Management
Central Queensland
Incident Response Unit | Environmental Services & Regulation
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PO Box 3130, Red Hill Rockhampton QLD 4701

Myra Thompson

From: Sophie Dwyer
Sent: Friday, 7 October 2016 12:02 PM
To: SANDERS Paul
Cc: HOGAN Stephenie; WELLER Jim; TEMPLAR Tessa; KEARNAN Wally; Suzanne Huxley
Subject: RE: For DNRM re Oakey
Attachments: NRM ministerial-briefing-note oakey v6.docx

Dear Paul
I have made some minor changes. I inserted a point regarding precedence. I think it is important because the concern is not about using the water for drinking (odefence has supplied drinking water) but other uses/misuses. That could apply anywhere.
Your approach is sound, and also leaves open reconsideration if circumstances dictate.
Regards
Sophie

Queensland Government

Sophie Dwyer PSM
Executive Director
Health Protection Branch, **Department of Health**
p: 07 3328 9266 | **m:** 0412422181
a: 15 Butterfield Street, Herston, Qld 4006
w: Queensland Health | **e:** Sophie.dwyer@health.qld.gov.au

Queensland's health vision | *By 2026 Queenslanders will be among the healthiest people in the world.*

Queensland Health acknowledges the Traditional Owners of the land, and pays respect to Elders past, present and future.

From: SANDERS Paul [mailto:Paul.Sanders@dnrm.qld.gov.au]
Sent: Wednesday, 5 October 2016 6:30 PM
To: Sophie Dwyer
Cc: HOGAN Stephenie; WELLER Jim; TEMPLAR Tessa; KEARNAN Wally; Suzanne Huxley
Subject: FW: For DNRM re Oakey

Hi Sophie,
Just checking if you have any comments before we send this up the line please.
Thanks
Paul

From: SANDERS Paul
Sent: Tuesday, 4 October 2016 12:28 PM
To: CONNOR Andrew <Andrew.Connor@ehp.qld.gov.au>; MILLER Elton <Elton.Miller@daf.qld.gov.au>; Sophie Dwyer (Sophie.Dwyer@health.qld.gov.au) <Sophie.Dwyer@health.qld.gov.au>; Suzanne Huxley <Suzanne.Huxley@health.qld.gov.au>; ROUTLEY Richard <Richard.Routley@daf.qld.gov.au>; Virginia Berry (Virginia.Berry@premiers.qld.gov.au) <Virginia.Berry@premiers.qld.gov.au>; adrian.jeffreys@premiers.qld.gov.au; HILL Chris <Chris.Hill@ehp.qld.gov.au>; Don Bletchley (donald.w.bletchly@tmr.qld.gov.au) <donald.w.bletchly@tmr.qld.gov.au>

Cc: 'Kearnan Wally (wally.kearnan@dnrm.qld.gov.au)' <wally.kearnan@dnrm.qld.gov.au>
Subject: FW: For DNRM re Oakey

Hi all,
Further refinement since our last IDC meeting. Feel free to provide me with any comments/thoughts.
Thanks
Paul

From: WELLER Jim
Sent: Monday, 3 October 2016 11:15 AM
To: sophie.dwyer@health.qld.gov.au
Cc: HOGAN Stephenie <Stephenie.Hogan@dnrm.qld.gov.au>; SANDERS Paul <Paul.Sanders@dnrm.qld.gov.au>; Suzanne Huxley (Suzanne.Huxley@health.qld.gov.au) <Suzanne.Huxley@health.qld.gov.au>
Subject: RE: For DNRM re Oakey

Hello Sophie and Suzanne

Thanks for the advice.

As per discussions with Suzanne last Thursday, DNRM have prepared a Min brief (draft attached) on using the Water Act provisions to limit the purpose for which groundwater could be used in the investigation area. The brief is for noting only and doesn't propose any action on DNRM's part.

The brief includes advice provided by Qld Health and we would appreciate any comment you may have before we finalise.

Note Paul is back from leave this week so he will resume his role on the IDC.

Regards

Jim

From: Suzanne Huxley [mailto:Suzanne.Huxley@health.qld.gov.au]
Sent: Thursday, 29 September 2016 3:22 PM
To: WELLER Jim
Subject: FW: For DNRM re Oakey

Hi Jim

We would not expect fish from Oakey Creek to form a primary/major food source for members of the community.

Based on the advice provided in the HHRA incidental recreational activity in Oakey Creek would be expected to be low risk. There are some riders over this advice though:

1. The extent of sampling on which the HHRA was based is limited and the IDC has advised that further biota testing is warranted.
2. We know some people in Oakey have elevated blood levels of PFASs. The advice for these people is to minimise exposure as much as possible. So exposures which we could consider acceptable for the general public may not apply to these people. A diet containing a significant component of fish from PFAS contaminated water may not be advisable for someone who wants to limit their exposure as much as possible.

There are potential risks associated with the consumption of fish from inland waterways, such as elevated mercury levels and cyanobacteria toxins. Preliminary work undertaken by Queensland Health suggests that limiting consumption

of fish from inland waterways to manage these risks would be protective for PFAS as well. We are in the process of finalising advice relating to recreational fishing in inland waters and can provide this when it is completed.

Regards

Suzanne

From: WELLER Jim [mailto:Jim.Weller@dnrm.qld.gov.au]
Sent: Thursday, 22 September 2016 11:50 AM
To: Suzanne Huxley
Cc: Sophie Dwyer
Subject: RE: For DNRM re Oakey

Thanks Suzanne

We have also had discussions about signage on Oakey Creek. My readings of the report plus your advice are that there are low risks in this area from incidental recreational activities, ie, fishing, swimming?

Also are you able to confirm Qld Health believe the risks are being managed adequately and haven't identified any other urgent action necessary at this stage.

Regards

Jim

From: Suzanne Huxley [mailto:Suzanne.Huxley@health.qld.gov.au]
Sent: Thursday, 22 September 2016 11:25 AM
To: WELLER Jim
Cc: Sophie Dwyer
Subject: For DNRM re Oakey

Hi Jim

I have discussed this with Sophie and below are some points you may find useful.

- The most prominent exposure source for people in contaminated sites is the intake of contaminated water, in the case of Oakey contaminated groundwater.
- The Department of Defence has provided alternative drinking water supplies to those people who were previously using groundwater for household purposes. This has been an important step in minimising future exposure.
- In addition, the Human Health Risk Assessment – Army Aviation Centre Oakey report provides useful and targeted recommendations on ways residents living in the areas with contaminated ground water can minimise their exposure. This information has been made available to all community members.
- The risk to human health arises if contaminated bore water is not used in accordance with the advice provided in the Human Health Risk Assessment – Army Aviation Centre Oakey report.
- There was concern expressed by some community members at the Oakey public meeting held on Monday 5 September 2016 that people would may continue to use the bores in a manner inconsistent with this advice and further that use of the bores would continue to contaminate the local environment.

Also Jim, just for you information:

- In response to the request of the Department of Defence (Defence) of 19 July 2016 that the Queensland Government identify the key items relevant departments would prefer to see included in any additional scope of work in relation to the Army Aviation Centre at Oakey (AACO), the Queensland Government Perfluorinated Firefighting Foam Interdepartmental Committee included a request that there needs to be consideration given to the provision of alternate water supplies to people whose use of water is precluded by the contamination. This should apply to all existing uses, as well as realistic future uses, of water protected under *The Environmental Protection Act 1994* and *Environmental Protection Water Policy 2009*.

Regards

Suzanne

From: Sophie Dwyer
Sent: Wednesday, 21 September 2016 1:21 PM
To: WELLER Jim; Suzanne Huxley
Subject: Re: Oakey Army Av Centre

Jim
I am tied up in a meeting today. Suzanne may be able to advise. Her phone number is 0733289606.
Regards
Sophiw

Sent from my BlackBerry 10 smartphone on the Telstra Mobile network.

From: WELLER Jim
Sent: mercredi 21 septembre 2016 13:06
To: Sophie Dwyer
Subject: Oakey Army Av Centre

Hello Sophie

I am currently standing in for Paul Sanders whilst he is on leave and that includes progressing tasks related to Oakey Groundwater contamination.

DNRM are currently in discussions about placing a restriction on groundwater under the Water Act 2000 and I would like to catch up with you to get Health's view.

I don't have a contact number. Are you able to give me a call when convenient please?

Thanks

Jim

Jim Weller

Manager, Water Services, South Region
Department of Natural Resources and Mines
Ph 07 45291397
Mobile
Email jim.weller@dnrm.qld.gov.au

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CTS:
eDOCS:

Department of Natural Resources and Mines
MINISTER'S BRIEFING NOTE – Dr Anthony Lynham MP

SUBJECT: Fire fighting foam groundwater contamination – Interdepartmental committee review of Human Health Risk Assessment, Army Aviation Centre Oakey

TIMING: Routine

Policy Advisor……..…..OK
Chief of Staff ……..……OK

Approved / Not approved / Noted

Minister ……
Dated……/…../……

RECOMMENDATION:
It is recommended that you:

a. **Note** the attached Human Health Risk Assessment report (attachment A) prepared for the Commonwealth Department of Defence, which:
   - Concludes that there is potentially an elevated risk to human health resulting from consumption of contaminated groundwater within the Oakey groundwater contamination investigation area (the investigation area – shown in attachment B); and
   - Recommends that, as a precautionary measure, surface and groundwater within the investigation area not be used for human consumption.

b. **Note** that the Department is working with the Queensland Government Perfluorinated Firefighting Foam Interdepartmental Committee (IDC) on Oakey groundwater contamination to review the recommendations of the report and coordinate an appropriate whole-of-government response.

c. **Note** that ~~neither~~ the Department of Health (Queensland Health) ~~or Toowoomba Regional Council have~~has not considered it necessary ~~to take~~for action to be taken by Toowoomba Regional Council under their powers delegated to them in the *Public Health Act 2005*~~s~~, on the basis that the measures currently put in place by the Commonwealth Department of Defence are adequately managing the general risks to human health and no specific situations have emerged of residents inappropriately using the water.

d. **Note** that the Minister has an option to make a public notice or regulation under sections 22 or 23 of the *Water Act 2000* requiring water users to not take water for human consumption.

KEY ISSUES:

1. The Commonwealth Department of Defence is continuing to investigate the risks to human health associated with groundwater contamination in Oakey resulting from their historical use of fire fighting chemicals.
2. The attached report prepared for the Department of Defence dated 1 September 2016 indicates a potential elevated risk to human health as a result of direct consumption (~~for~~ drinking or cooking) of groundwater within the investigation area.
3. The report also indicates a potentially elevated risk associated with consumption of eggs from chickens watered using groundwater within the investigation area, as well as potentially elevated risk associated with indirect consumption of water (incidental to non-consumptive indoor and outdoor water use e.g. bathing, swimming) within Zone 2 of the investigation area.
4. The report indicates a low and acceptable level of risk associated with all other potential exposure pathways investigated, such as consumption of produce grown within the investigation area (fruit, vegetables, beef, sheep, fish) as well as from incidental contact or ingestion resulting from a range of indoor and outdoor, non-consumptive water uses outside Zone 2 of the investigation area.
5. The report recommends that, as a precautionary measure, surface and groundwater should not be used for human consumption within the investigation area. It also recommends that water with detectable concentrations of the key contaminent (poly-fluorinated alkyl substance or PFAS) not be used for watering chickens within the investigation area or for non-consumptive domestic or recreational use within Zone 2 of the investigation area.
6. The Department of Defence has made alternate arrangements for residents so they don't have to drink contaminated water.
7. The Department understands that the Department of Defence advice since 2014 to people in the affected area has been not to drink groundwater in the investigation area and that affected residents are generally well aware of the potential risks associated with the consumption of

Author:	Recommended – ED:	Endorsed – DDG:	Endorsed - DG
Name: Title/Business Group: Telephone: Date:	Name: Title/Business Group: Telephone: Date:	Name: Title/Business Group: Telephone: Date:	At direction of Minister's Office, DG, or DDG. Delete this column if DG endorsement not required.

contaminated groundwater.

8. However, concerns have been raised by some community members at an Oakey public meeting held on Monday 5 September 2016 that some water users may be unwilling to change their water use practices.
9. The Department of Defence consultation on the issue has included a number of community presentations, provision of information via a website and making fact sheets available for distribution. There is also a community hotline being operated by the Department of Defence.
10. Ultimately, matters relating to public health for recreational and drinking water supplies are most appropriately considered under the *Public Health Act 2005* (Public Health Act), however the *Water Act 2000* section 22 allows the Minister for Natural Resources and Mines to prohibit the taking or interfering with water, including groundwater, if satisfied 'urgent' action should be taken because 'there is a thing in harmful quantities in water'.
11. It could be argued that there is a thing (the contaminants) in harmful quantities in the groundwater based on the Human Health Risk Assessment from the Department of Defence. In terms of the 'urgency' for action, the Department has sought the advice of Queensland Health about whether there is an urgent need for regulatory intervention under the Water Act.
12. ~~The~~ Queensland Health has advised that under the Public Health Act the contaminated groundwater at Oakey would be a 'local government public health risk'. Therefore, where water users are unwilling to change their water use practices, Toowoomba Regional Council has the authority to issue a public health order, under the Public Health Act, to require the person to cease the use of contaminated groundwater to prevent exposure to humans and animals/produce for human consumption.
13. The Queensland Health also advises that the Public Health Act contains provisions to enable Toowoomba Regional Council to request Queensland Health regulate specified public health risks on their behalf where Queensland Health agrees to do so.
14. In the absence of regulatory action having been taken under the ~~under the~~ Public Health Act, and with the actions being taken by the Department of Defence managing the elevated risks identified in the Human Health Risk Assessment report, there would appear to be no immediate urgency that would necessitate intervention from a water resource management perspective under the Water Act.
15. The Department will continue to engage proactively in IDC discussions on this matter and will advise the Minister of any change in circumstance that would warrant an alternative approach.
16. ~~Note that t~~There is potential for other incidents of groundwater contamination resulting from historical use of firefighting chemicals at airports and firefighting training facilities across Queensland and these are being investigated by the Department of Environment and Heritage Protection.
16.17. Action taken in regard to the use of bores at Oakey may be seen to set a precedent for use of bores in other locations where there is PFAS contamination of groundwater.

BACKGROUND:

17.18. CTS17750/16, CTS15454/16 and CTS13302/16 provide further background information on this issue.

18.19. Section 22 provides ~~for such~~ a prohibition to be made by public notice, for a period of not more than 21 days, and is ~~intended~~ to be used as an urgent interim measure until such time as a regulation can be made under section 23. A prohibition made by regulation under section 23 may be in force for a period of no more than one year.

19.20. The issue of contaminated groundwater continues to receive attention from the media, including an ABC article of 28 September 2016.

20.21. Queensland Health and the IDC were consulted in preparing this brief and support the approach.

ATTACHMENTS:

21.22. Attachment A – Stage 2C Environmental Investigation – Human Health Risk Assessment, Army Aviation Centre Oakey, Executive Summary.

22.23. Attachment B – Oakey groundwater contamination investigation area

23.24. Attachment C – Recent ABC article

Myra Thompson

From: Penny Hutchinson
Sent: Monday, 18 May 2015 3:46 PM
To: Sophie Dwyer; Suzanne Huxley; Greg Jackson; Janet Cumming
Cc: Peter Boland
Subject: Groundwater contamination at Oakey in relation to the Army Aviation centre

Dear Sophie, Suzanne, Greg and Janet,
I wonder if it would be possible to meet to discuss this issue? I have been advised that the Department of Defence has been speaking to the CHO and that she would like to take a whole of government approach. I understand that there are plans for a workshop.
We have also had a detailed briefing from the Department of Defence (they came to Toowoomba and met with our CE) so a meeting DDPHU and HPU would be useful to share information (so we are all on the same page) in order to plan for the workshop.

Please advise your availability this week to meet.

Regards
Penny

Dr Penny Hutchinson
Public Health Physician and Director| Darling Downs Public Health Unit
Darling Downs Hospital and Health Service

Darling Downs Public Health Unit
Ground Floor
Browne House
Baillie Henderson Hospital
Cnr of Tor & Hogg St
Toowoomba QLD 4350

P: 07 46998240 | **F:** 07 46998262
E: penny.hutchinson@health.qld.gov.au

Web: http://www.health.qld.gov.au/darlingdowns/

Myra Thompson

From: Sophie Dwyer
Sent: Monday, 18 May 2015 3:48 PM
To: Penny Hutchinson; Suzanne Huxley; Greg Jackson; Janet Cumming
Cc: Peter Boland
Subject: RE: Groundwater contamination at Oakey in relation to the Army Aviation centre

Dear Penny
We are all in agreement with the need to have a discussion. Janet will be in contact regarding a preliminary meeting on Wednesday to scope the issues together.
Regards

Sophie Dwyer
Executive Director, Health Protection
Chief Health Officer Branch, Department of Health| Queensland Government
15 Butterfield Steet, QLD
t. 07 33289266 m.
e. sophie.dwyer@health.qld.gov.au | www.health.qld.gov.au

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Sent: Monday, 18 May 2015 3:46 PM
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Cc: Peter Boland
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Please advise your availability this week to meet.

Regards
Penny

Dr Penny Hutchinson
Public Health Physician and Director| Darling Downs Public Health Unit
Darling Downs Hospital and Health Service

Darling Downs Public Health Unit
Ground Floor
Browne House
Baillie Henderson Hospital
Cnr of Tor & Hogg St
Toowoomba QLD 4350

P: 07 46998240 | **F:** 07 46998262
E: penny.hutchinson@health.qld.gov.au

Web: http://www.health.qld.gov.au/darlingdowns/

Suzanne Huxley

From: Roger Drew <rogerdrew@toxconsult.com.au>
Sent: Wednesday, 22 June 2016 11:56 AM
To: Janet Cumming
Cc: oakey-idc; Suzanne Huxley; Tarah Hagen
Subject: RE: Information as promised.
Attachments: ToxConsult PFC Bibliography (210616).docx; Louis et al (2016) Preconception PFCs & pregnancy loss.pdf

Hi Janet & Suzanne,

We have no problem with Qld Hlth having a copy of our bibliography (attached) on PFAS's. If there is something you need let us know.
I apologise for the bibliography not being separated into subject folders.

However since we have invested a large amount of resource over the last 5 years or so in creating the bibliography, and obtaining the papers, our request for not dispersing the listing is related to protecting/limiting the resource to other commercial operators and their clients.
If you get an FOI, we don't see a problem with release since all the papers are in the public domain.

I also attach a very recent article which you may find interesting.

Regards Roger

Roger Drew, PhD, DABT, FACTRA
Toxicologist & Risk Assessor

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Mobile: +61 412 108 394

Adjunct Associate Professor
Dept Epidemiology & Preventative Medicine
Monash University

From: Janet Cumming [mailto:Janet.Cumming@health.qld.gov.au]
Sent: Friday, 17 June 2016 1:45 PM
To: Roger Drew
Cc: oakey-idc; Suzanne Huxley
Subject: RE: Information as promised.

Hi Roger,
We don't have a date for the release of the information in Germany, except that it is in process.

With regards to the bibliography, we would of course not disperse this information. However, if we were to be subject to a "Right To Information" request, we may not be able withhold it. If you would prefer not to share any or all of it, we would understand.

Re the HBM values. I found a presentation on their website on how they calculate these conservative values. Slide 9 on PFOA highlights the problem
https://www.umweltbundesamt.de/sites/default/files/medien/378/dokumente/martin_kraft_hbm_values_derived_by_the_german_hbm_commission.pdf
Kind regards,
Janet

From: Roger Drew [mailto:rogerdrew@toxconsult.com.au]
Sent: Friday, 17 June 2016 1:23 PM

To: Janet Cumming
Cc: Tarah Hagen
Subject: RE: Information as promised.

Thank you Janet,

The Germans have made an interesting call in nominating 5 ng/mL as a level at which no adverse health effects are not expected.
There will be many people above this level and will create for them, and others, some challenging communication.
Perhaps the answer for us lies in the management purpose of the uniquely German HBM I & II values.

Do you have an idea when this statement will be posted on their website?

I note a July 2015/May 2016 evaluation of the epi literature underpins their deliberation. This is somewhat curious since most other agencies have considered the epi data to be inconsistent and has exposure definition issues.
We will look at the references cited in the statement (it helps my colleague, Tarah, is German) but since it is dated 2014 I doubt it will have the epi analysis within it.

For Qld Health internal use we will send our bibliography early next week. It would be appreciated however if you didn't disperse it further.

Regards Roger

Roger Drew, PhD, DABT, FACTRA
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Monash University

From: Janet Cumming [mailto:Janet.Cumming@health.qld.gov.au]
Sent: Friday, 17 June 2016 10:02 AM
To: rogerdrew@toxconsult.com.au
Cc: oakey-idc
Subject: Information as promised.

Good Morning Roger,
As promised at the meeting on Wednesday, the link our on-line bibliography at CiteULike is http://www.citeulike.org/user/wqunit/tag/pfas.

I have also this morning received a reply from Umwelt Bundesamt regarding their Human Biomonitoring values for PFOS and PFOA, which I have attached for your information.

Kind Regards,
Janet

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Title: Preconception perfluoroalkyl and polyfluoroalkyl substances and incident pregnancy loss, LIFE Study

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Preconception perfluoroalkyl and polyfluoroalkyl substances and incident pregnancy loss, LIFE Study

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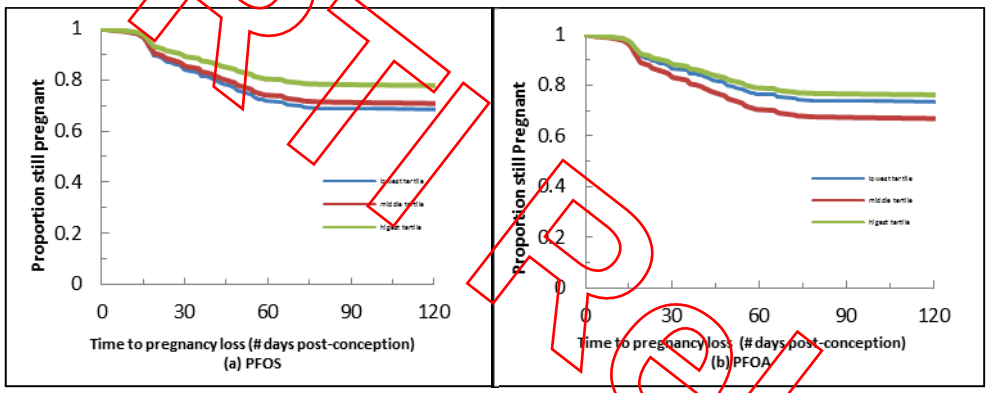

Highlights

- Incidence of hCG pregnancy loss was 28%.
- 7 PFASs were measured women's serum upon enrollment.
- None of the 7 PFASs were associated with an increased risk of pregnancy loss.
- PFNA and Me-PFOSA-AcOH were associated with a significant reduction in risk.

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Abstract

Equivocal findings are reported for perfluoroalkyl and polyfluoroalkyl substances (PFASs) and self-reported pregnancy loss. We prospectively assessed PFASs and pregnancy loss in a cohort comprising 501 couples recruited preconception and followed daily through 7 post-conception weeks. Seven PFASs were quantified: 2-N-ethyl-perfluorooctane sulfonamide acetate (Et-PFOSA-AcOH); 2-N-methyl-perfluorooctane sulfonamido acetate (Me-PFOSA-AcOH); perfluorodecanoate (PFDeA); perfluorononanoate (PFNA); perfluorooctane sulfonamide (PFOSA); perfluorooctane sulfonate (PFOS); and perfluorooctanoate (PFOA). Women used home pregnancy test kits. Loss denoted conversion from a positive to a negative pregnancy test, onset of menses or clinical confirmation (n=98; 28%). Chemicals were log transformed and rescaled by their standard deviations to estimate adjusted hazard ratios (HRs) and 95% confidence intervals. No significantly elevated HRs were observed for any PFASs suggesting no association with loss: Et-PFOSA-AcOH (1.04; 0.87, 1.23), Me-PFOSA-AcOH (0.79; 0.61,

1.00; p<0.05), PFDeA (0.83; 0.66, 1.04), PFNA (0.86; 0.70, 1.06), PFOSA (0.74; 0.50, 1.09), PFOS (0.81; 0.65, 1.00), and PFOA (0.93; 0.75, 1.16).

Keywords: cohort, epidemiology, miscarriage, perfluoroalkyl, perfluoroalkyl acids, polyfluoroalkyl**,** pregnancy loss, reproductive toxicity

1.1 Introduction

Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are chemicals with numerous commercial applications. Their chemical and thermal stability properties make PFAAs resistant to biodegradation and, thereby, become a source of environmental exposure for populations [1,2]. Common uses of PFASs include the manufacture of stain, water and soil resistant fabrics and carpeting, and also oil-resistant coatings for food packaging, fire-fighting foams, paints [3,4]. We use the term PFASs consistent with the recent call for harmonization of terminology for the weighing of human health effects [5].

Initial concern about the environmental impact of PFASs emerged in 2001 with the publication of data suggesting widespread exposure amongst wildlife and human populations [6,7]. In animals, such ubiquitous exposure stemmed from PFASs being readily absorbed without an ability for effective metabolism or elimination. Long half-

lives are also reported in humans (ranging from 3.8 years for perfluorooctanoate (PFOA) to 4.8 years for perfluorooctanesulfonate (PFOS) and 7.3 years for perfluorohexane sulfonate (PFHS)), though species and sex differences have been reported [8,9].

Concern about possible developmental toxicity associated with PFAAs arose from recognition that they readily cross the placenta and enter the fetal circulation [10]. This observation coupled with ubiquitous exposure prompted epidemiologic investigation of PFASs and human development, which largely focused on PFOA and PFOS. In reviews focusing on PFASs and developmental toxicity in animals, exposure has been associated with diminished fetal growth and mortality among other outcomes [9,11]. Conversely, a recent systematic review focusing on human exposure concluded that PFOS and PFOA concentrations were inconsistently associated with diminished birth weight [12].

In terms of potential reproductive toxicity, a small body of literature has focused on fecundity, as measured by time-to-pregnancy (TTP), with equivocal results. Of the various PFASs assessed in cohorts of women and/or couples recruited prior to conception for whom TTP was prospectively measured, some but not all PFASs were associated with a longer TTP [13,14]. However, studies of pregnant women for whom PFAS exposures were quantified at varying times during pregnancy and assessed in relation to retrospectively reported TTP have generated equivocal findings [15-18]. While important, this latter body of evidence is restricted to women capable of achieving pregnancy and may exclude the highest exposed women if PFASs are

associated with delayed conception or infertility. With regard to men, specific PFASs have been associated with changes in semen quality in a few studies, though again with equivocal results [19-22].

Another important endpoint – pregnancy loss – has been assessed for a few populations, including one highly exposed geographic residential population [23-26]. Overall results from various cross-sectional and case control analyses of various subsamples of this geographically exposed population (C8 Health Project) did not support an association between measured or pharmacokinetic-modeled serum concentrations of PFOS and PFOA and self reported pregnancy loss, as measured by retrospective recall of miscarriage and stillbirth [23-25]. The prevalence of pregnancy loss appeared to range from 12% to 17%. A follow-on study of a subset of women with pregnancies between 2008-2011 in this community who had serum samples quantified for PFOS and PFOA in 2005 -2006 also observed little evidence of an association, except when restricting the analysis to women's first pregnancy where a 34% increased odds of pregnancy loss was observed [26]. This restriction, however, carries the assumption that the first pregnancy is representative of all pregnancies [27], which may or may not be upheld. Of note is a much higher (≈22%) prevalence of miscarriage in this follow-on study than earlier estimates for the overall group based upon retrospective reporting. Among women participating in the Danish Odense Child Cohort Study in 2010-2012, pregnant women's serum perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) concentrations measured before 12 weeks gestation were associated with a

significantly higher adjusted odds of miscarriage when comparing women in the highest to lowest tertile (AOR 16.5 and 2.67, respectively), and despite the women's concentrations being low relative to previously published work [28]. Moreover, neither PFOA nor PFOS concentrations were associated with miscarriage for this study cohort underscoring the importance of assessing a spectrum of PFASs.

In light of equivocal findings generated from research involving only two study populations (U.S. and Denmark), we assessed the relation between seven serum PFAS concentrations and incident pregnancy loss in a prospective cohort of women recruited prior to conception and followed through pregnancy until a loss or delivery. A unique aspect of our study is having measured human chorionic gonadotropin (hCG) detected pregnancies, including those occurring early in pregnancy or the interval at greatest risk for loss and often before women enter prenatal care.

1.2 Materials and Methods

A prospective cohort design was used with preconception recruitment of couples who were discontinuing contraception for purposes of trying for pregnancy. Given the study outcome was pregnancy loss, we restricted the cohort to female partners of couples participating in the LIFE Study [29].

1.2.1 Study population and cohort

Among the 501 participating female partners, 347 (69%) had an observed hCG pregnancy. Briefly, women were recruited between 2005-2009 from 16 counties in Michigan and Texas using population based marketing and angler registries, respectively. Eligibility criteria were intentionally minimal to reflect the heterogeneity of fecundity at the population level: 1) in a committed relationship; 2) ability to communicate in English or Spanish; 3) female partner aged 18-40 years and male partner aged 18+ years; 4) menstrual cycles between 21-42 days; 5) no history of injectable hormonal contraception in past year; 6) no clinically diagnosed infertility; and 7) off contraception <2 months. All women's urines were tested prior to enrollment to ensure they were not already pregnant. Three twin pregnancies were excluded from analysis, given their dependent data structure and high-risk status for adverse pregnancy outcomes. The final study cohort comprised 344 women with singleton pregnancies. Full human subjects approval was obtained from participating institutions, and women provided written informed consent before any data collection. Complete details are provided elsewhere [29].

1.2.2 Data collection

Upon enrollment, trained research assistants interviewed women about their lifestyles and medical/reproductive histories. Weight and height were measured using standardized anthropometric protocol [30] for quantifying body mass index (BMI; weight in kg / height in m^2). Women were trained in the daily completion of journals designed for recording daily cigarette and alcohol use, menstruation, sexual intercourse

and home pregnancy test results. These journals were completed daily through 7 post-conception weeks then monthly until delivery. Research assistants trained women in the proper use of the Clearblue® Fertility Monitor (Inverness Medical Innovations, Waltham, MA), which is a urinary test kit that tracks estrone-3-glucuronide and luteinizing hormone (LH) to predict the day of ovulation and used as the estimated day of conception. Women were encouraged to time intercourse on high or peak fertility days to maximize their chances of conceiving. The monitor is reported to be 99% accurate in detecting the LH surge, a marker of ovulation, relative to the gold standard of ultrasonography [31]. Also, women tested their urine each month on the day of expected menstruation using the Clearblue® digital pregnancy test, which has demonstrated sensitivity and reliability for detecting 25 mIU/mL of hCG, and demonstrated accuracy by women [32]. Pregnancy loss denoted a conversion from a positive to a negative pregnancy test, clinical confirmation, or onset of menstruation depending upon gestational dating. Upon enrollment into the cohort and before pregnancy, blood samples were obtained from all participating women and before pregnancy. Of the 344 women becoming pregnant, 332 (97%) women had sufficient serum remaining for the analysis of PFASs while concentrations were imputed for the 12 women without remaining serum.

1.2.3 Laboratory analysis

PFASs were quantified using published methods that included isotope dilution high-performance liquid chromatography-tandem mass spectrometry with adherence to

quality assurance and control [33,34]. Seven PFASs were quantified (ng/mL) in serum: perfluorodecanoate (PFDeA), PFNA, PFOA, PFOS and its precursors, perfluorooctane sulfonamide (PFOSA), 2-(N-ethyl-perfluorooctane sulfonamido) acetate (Et-PFOSA-AcOH) and 2-(N-methyl-perfluorooctane sulfonamido) acetate (Me-PFOSA-AcOH). The limits of detection (LODs) were 0.1 for PFNA, PFOSA, and PFOA and 0.2 for the remaining PFASs.

1.2.4 Statistical analysis

The descriptive phase of analysis sought to characterize the cohort by pregnancy and completion status to assess potential biases (e.g., attrition). Statistical significance was determined using either the Chi-square or the Kruskal-Wallis tests. Next, we assessed the distributions of PFASs to have a better understanding of the degree of exposure relative to earlier studies, and by pregnancy status. The analytic phase included the use of Cox proportional hazard modeling techniques to estimate hazard ratios (HRs) and corresponding 95% confidence intervals for each PFAS and the time to pregnancy loss [35]. For these analyses, time denoted the number of days from observed ovulation as measured by the peak (LH) day detected by the fertility monitor and reported date of loss. We used peak LH day for estimated conception given that the ovum's survival time for fertilization is reported to be approximately 24 hours. Approximately 17% (n=59) of menstrual cycles had missing fertility monitor data for ovulation during the conceptive cycle; the average day of ovulation as recorded by the monitor for other observed cycles was taken as the day of ovulation. For an additional 16 women (5%), fertility monitor

data on ovulation was not available for any menstrual cycles requiring us to assume ovulation was 14 days prior to the first positive pregnancy test [36].

We modeled each PFAS separately to fully inspect its association with pregnancy loss, including modeling it in its continuous form after log transformation (x+1) and then rescaling by its standard deviation to aid in the interpretation of HRs, and modeling in tertiles to assess linearity. We used all machine-measured concentrations without substituting values below the LOD to avoid introducing bias when estimating human health effects [37,38]. Adjusted models included age (continuous), BMI (≤24.9 lean/normal, 25.0-29.9 overweight, ≥30.0 obese), prior pregnancy loss conditional on prior pregnancy history (no prior pregnancy, prior pregnancy but no loss and prior pregnancy and a loss), any alcohol consumption during pregnancy (no/yes), and any cigarette smoking during pregnancy (no/yes). We recognize the varying perspectives about whether or not to adjust for prior losses (39), and decided to do so but to condition on whether the woman had a prior pregnancy rather than simply modeling prior loss as a dichotomous outcome (yes/no). We imputed PFAS concentrations for 12 women without available serum for the quantification of PFASs for inclusion in the analysis of HRs (n=344) to minimize selection bias. Specifically, our imputations were done under the missing-at-random assumption and implemented Markov Chain Monte Carlo methods (40). We also repeated the analysis with each PFAS analyzed in tertiles.

1.3 Results

Overall, the study cohort comprised mostly white college educated women who were employed with health insurance and residing in households with an annual income of ≥$50,000 (Table 1). On average, women were aged 29.8 (±SD, standard deviation = 3.9) years and had a mean BMI of 27.0 (±6.7). We found little evidence to suggest systematic differences in baseline characteristics relative to completion status with one possible exception. The 24 women who withdrew from the study tended to be younger than women completing the study but only when age was categorized (p=0.03). The incidence of pregnancy loss was 28% (n=98), with all losses occurring before 21 weeks post-conception.

The distributions of PFASs are shown in Table 2 and reflect that most women had concentrations above the laboratory LODs with the exception of Et-PFOSA-AcOH and PFOSA, where only 3% and 8% of concentrations were >LOD, respectively. Virtually all women had PFOS and PFOA concentrations above the LOD. Median concentrations of PFASs were similar between women becoming pregnant or not (infertile) except for slightly higher median concentrations for PFOSA (1.2 and 1.1, respectively). Of note, the concentrations of PFASs were relatively similar to those reported for participants in the NHANES biomonitoring study during a comparable time period but despite an older age distribution for NHANES [http://www.cdc.gov/exposurereport/pdf/fourthreport.pdf].

No evidence of an increased risk of pregnancy loss was observed for any of the 7 PFAAs (Table 3). Contrarily, two PFASs were associated with a significant reduction in the risk of pregnancy loss even after adjustment. These findings included: Me-PFOSA-AcOH when modeled continuously (HR 0.79; 95% CI 0.62, 1.00; p<0.05) and PFNA (HR 0.57; 95% CI 0.34, 0.94) when modeled comparing the 3rd versus 1st tertiles, respectively. Also of note is almost the complete absence of HRs above 1 for any of the PFASs with the

exception of Et-PFOSA-AcOH when modeled continuously and PFOA when comparing the 2nd and 1st tertiles.

1.4 Discussion

In the first cohort study with preconception serum measurement of 7 PFASs and daily follow-up of women to identify hCG pregnancies commencing at approximately 2 weeks post-conception, we observed no association between any chemicals in this class of compounds and increased risk of pregnancy loss. While most HRs were below one irrespective of whether they were modeled continuously or in tertiles, two were significantly associated with significant reductions in risk, i.e., Me-PFOSA-AcOH and PFNA. Given the uncertainty and divergent thinking about the inclusion of gravidity or parity in models as previously discussed (39), we repeated the analysis without prior history of loss conditional on parity variable and observed consistent findings. Specifically, little change was observed in the HRs for either Me-PFOSA-AcOH when modeled with or without it (0.79; 95% CI 0.62, 1.00 and 0.78; 95% CI 0.62, 0.99, respectively) or PFNA (0.57; 95% CI 0.34, 0.94 and 0.58; 95% CI 0.35, 0.95). Still, extreme caution is needed when interpreting the findings for Me-PFOSA-AcOH, as 97% of concentrations were below laboratory limits of detection. PFOSA is a precursor compound of PFOS, which may be one reason why it is not widely detected in people. Conversely, all but 2% of women had PFNA concentrations above the LOD with an observed 43% reduction in risk of pregnancy loss when comparing women in the highest versus lowest tertiles. This finding is in sharp contrast to an odds ratio of 16.5 (95% CI 7.39, 36.63) reported for PFNA in the Danish Odense Child Cohort Study when

concentrations were modeled continuously using a case-cohort type of analysis [28]. While serum concentrations were similar for the two studies, important differences exist including our prospective ascertainment of both pregnancies (n=344) and losses (n=98) and having preconception measurement of PFASs for women. The Danish study was within a larger pregnancy cohort study that restricted women to those with PFASs measured before 12 weeks gestation and for whom miscarriages occurred before 22 weeks gestation (n=56). The comparison group comprised a random sample of women giving birth (n=336), followed by a matched case-control analysis. While our findings do not support those reported in this study, they are in general agreement with findings from the C8 Health Project, a residential community exposed to PFASs via contaminated drinking water. Of note is the considerably higher (28%) incidence of loss in our study than that reported in the former study (range 12%-22%) [23-26], most likely a reflection of our preconception cohort design and daily monitoring of pregnancy and ensuing losses rather than relying on self reported loss. Our incidence of pregnancy was based upon sensitive digital home pregnancy tests is remarkably similar (25% to 31%) to that reported in earlier preconception cohort studies that relied on daily urine testing for hormonal profiles and incident pregnancy loss (41-43). As such, our findings are not likely to be systematically affected by under-ascertainment of post-implantation pregnancies or losses. We recognize we are unable to assess PFASs and pre-implantation loss, given our cohort was not undergoing assisted reproductive technologies where fertilization and implantation can be measured. Currently, there

are no biomarkers for either conception or implantation suitable for population-based research.

While we find no evidence of an adverse relation between any of the 7 PFASs and pregnancy loss in our cohort study, it is important to interpret the findings within the continuum of human fecundity. We are aware of research suggesting that specific PFASs such as PFOSA and PFNA are associated with newly diagnosed endometriosis [44], a gynecologic condition associated with infertility [45], and with a longer TTP or infertility as described above [14,15,46]. If PFASs are indeed associated with gynecologic disorders and/or a longer TTP, it remains possible that only the least exposed women will become pregnant making is more challenging to observe a relation between exposure and pregnancy loss. However, only the median PFOSA concentration differed significantly for women achieving pregnancy or not (infertile) in our cohort, but the absolute differences are small given the high percentage of concentrations below LOQ. Of note is our earlier report that PFOSA was positively associated with a longer TPP (14). Still it remains possible that PFOSA reduces the probability of pregnancy without impacting its continuation once established.

There are important limitations that need to be weighed when interpreting our findings beyond potential type II errors or residual confounding. Other notable limitations include the relatively small number of PFASs quantified for analysis albeit larger than published work, and our assessment of individual compounds rather than mixture-

based approaches. In light of evolving methods for the analysis of mixtures coupled with very few data focusing on this specific study question, we specifically sought to explore each PFAS relative to pregnancy loss. Model specification is another important consideration and we strove for parsimonious models supported by biology, to the extent possible. This included adjustment for age, measured BMI, prospectively measured alcohol consumption and cigarette smoking during pregnancy, and prior history of pregnancy loss modeled as a function of past pregnancy history rather than simply modeling parity as a dichotomy (nulliparous versus parous). The reason being is that nulliparous women comprise two potentially distinct groups of women, particularly if PFASs affect pregnancy probabilities: 1) women who have never been pregnant and 2) women with previous pregnancies but no live births. We believe these are potentially different groups of women and such differences require conditioning on pregnancy history to distinguish an informative from a non-informative history.

The available data focusing on the relation between PFASs and pregnancy loss is insufficient at this time to definitively determine whether they are potential reproductive or developmental toxicants. Future research designed for preconception enrollment of women/couples who are prospectively followed throughout pregnancy is needed if we are to more completely answer this question and to do so within the context of couples' complete reproductive performance, viz., is risk consistent across pregnancies. This strategy also will help inform about competing risk scenarios where infertility prevents pregnancy which is a necessary criterion for loss, in providing

empirical data to aid model specification particularly related to prior reproductive performance, and in delineating the toxicokinetics of these compounds during sensitive windows of human development. Ultimately, such research will help to develop empirically supported risk communication. As noted in the recent Madrid Statement on Poly- and Perfluoroalkyl Substances, the ubiquitous nature of PFASs reflecting their environmental persistence and bioaccumulation supports the need for research to fill critical data gaps [47].

1.5 Conclusions

We found no evidence of an adverse relation between any of the 7 PFASs under study and pregnancy loss. The extent to which the findings reflect the exclusion of exposed women who are unable to achieve pregnancy remain to be established.

Acknowledgements

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Table 1. Baseline characteristics of the study cohort by pregnancy loss status (n=344).

Characteristics	Total n=344	Pregnancy Loss n=98	No Pregnancy Loss n=222	Lost To Follow-Up n = 24
	n (%)	n (%)	n (%)	n (%)
Age (years):				
≤24	25 (7)	5 (5)	19 (9)	1 (4)
25-29	159 (46)	43 (44)	99 (45)	17 (71)
30-34	116 (34)	31 (32)	82 (37)	3 (13)
≥35	44 (13)	19 (19)	22 (10)	3 (13)*
Mean (±SD)	29.8 (3.9)	30.3 (4.1)	29.6 (3.8)	29.3 (3.7)
Body mass index (kg/m2):				
Lean/normal (≤24.9)	170 (49)	44 (45)	111 (50)	15 (63)
Overweight (25.0-29.9)	89 (26)	23 (24)	62 (28)	4 (17)
Obese (≥30.0)	85 (25)	31 (32)	49 (22)	5 (21)
Mean (±SD)	27.0 (6.7)	27.8 (6.7)	26.6 (6.6)	26.9 (7.3)
Race/ethnicity				
Non-Hispanic White	285 (84)	82 (85)	180 (82)	23 (96)
Non-Hispanic Black	6 (2)	3 (3)	3 (1)	0 (-)
Hispanic	29 (9)	7 (7)	21 (10)	1 (4)
Other	21 (6)	5 (5)	16 (7)	0 (-)
Education:				
≤ High school	15 (4)	6 (6)	9 (4)	0 (-)
College	325 (96)	91 (94)	211 (96)	23 (100)
Income:				
<$50,000	44 (13)	11 (12)	30 (14)	3 (13)
$50-99,999	163 (49)	53 (56)	96 (44)	14 (58)
≥$100,000	128 (38)	30 (32)	91 (42)	7 (29)
Employed:				
No	70 (20)	22 (22)	44 (20)	4 (17)
Yes	274 (80)	76 (78)	178 (80)	20 (83)
Has health insurance:				
No	15 (4)	6 (6)	6 (3)	3 (13)
Yes	326 (96)	91 (94)	214 (97)	21 (88)
Research site:				

Characteristics	Total n=344	Pregnancy Loss n=98	No Pregnancy Loss n=222	Lost To Follow-Up n = 24
Michigan	65 (19)	18 (18)	42 (19)	5 (21)
Texas	279 (81)	80 (82)	180 (81)	19 (79)
Prior miscarriage:				
No, nulligravid	133 (39)	37 (38)	86 (39)	10 (42)
No, gravid	141 (41)	36 (37)	93 (42)	12 (50)
Yes	68 (20)	24 (25)	42 (19)	2 (8)
Cigarette smoking during pregnancy:				
No	301 (89)	83 (87)	198 (89)	20 (95)
Yes	38 (11)	13 (14)	24 (11)	1 (5)
Alcohol consumption during pregnancy:				
No	157 (46)	49 (51)	99 (45)	9 (43)
Yes	182 (54)	47 (49)	123 (55)	12 (57)

*p=0.03 for 3-way comparison

SD, standard deviation

Table 2. Distribution of serum PFAS concentrations (ng/mL) by pregnancy status (n=389).

PFAA (ng/mL)	**LOD**	**% <LOD (n=332)**	**Pregnant (n=332)**		**% <LOD (n=57)**	**Infertile (n=57)**	
			Md	**IQR**		**Md**	**IQR**
Et-PFOSA-AcOH	0.2	97	0	0, 0	96	0	0, 0.1
Me-PFOSA-AcOH	0.2	26	0.3	0.1, 0.5	26	0.3	0.1, 0.4
PFDeA	0.2	9	0.4	0.2, 0.6	5	0.3	0.2, 0.5
PFNA	0.1	2	1.2	0.7, 1.7	0	1.1	0.8, 1.4
PFOSA*	0.1	92	0	0, 0	81	0	0, 0
PFOS	0.2	0	12.2	8.3, 17.8	0	12.1	7.1, 17.1
PFOA	0.1	0.3	3.3	2.2, 4.9	0	3.2	2.5, 4.3

NOTE: Infertile women represent women who did not become pregnant after 12 months of trying.

*p<0.05

IQR, interquartile range; LOD, limits of detection; Md, median

2-N-ethyl-perfluorooctane sulfonamide acetate (Et-PFOSA-AcOH),
2-N-methyl-perfluorooctane sulfonamido acetate (Me-PFOSA-AcOH)
perfluorodecanoate (PFDeA)
perfluorononanoate (PFNA)
perfluorooctane sulfonamide (PFOSA)
perfluorooctane sulfonate (PFOS)
perfluorooctanoate (PFOA)

Table 3. Serum PFAS concentrations modeled continuously and in tertiles and risk of pregnancy loss (n=344).

PFAA	Unadjusted HR (95% CI) Continuous PFAS	Adjusted HR (95% CI)* Continuous PFAS	Unadjusted HR (95% CI) 3rd vs. 1st Tertile	Unadjusted HR (95% CI) 2nd vs. 1st Tertile	Adjusted HR (95% CI)* 3rd vs. 1st Tertile	Adjusted HR (95% CI)* 2nd vs. 1st Tertile
Et-PFOSA-AcOH	1.04 (0.89, 1.23)	1.04 (0.87, 1.23)	0.44 (0.09, 2.23)	NA	0.46 (0.09, 2.47)	NA
Me-PFOSA-AcOH	0.80 (0.63, 1.00)	**0.79 (0.62, 1.00)+**	0.75 (0.45, 1.23)	0.91 (0.55, 1.53)	0.73 (0.44, 1.22)	0.84 (0.50, 1.42)
PFDeA	0.86 (0.69, 1.08)	0.83 (0.66, 1.04)	0.77 (0.47, 1.25)	0.86 (0.51, 1.43)	0.68 (0.41, 1.14)	0.83 (0.49, 1.40)
PFNA	0.89 (0.73, 1.09)	0.86 (0.70, 1.06)	0.62 (0.38, 1.01)	0.79 (0.47, 1.32)	**0.57 (0.34, 0.94)**	0.74 (0.44, 1.25)
PFOSA	0.72 (0.49, 1.06)	0.74 (0.50, 1.09)	0.35 (0.06, 1.98)	NA	0.36 (0.06, 2.05)	NA
PFOS	0.85 (0.69, 1.04)	0.81 (0.65, 1.00)	0.66 (0.39, 1.10)	0.87 (0.54, 1.41)	0.60 (0.35, 1.03)	0.81 (0.50, 1.33)
PFOA	0.97 (0.79, 1.18)	0.93 (0.75, 1.16)	0.90 (0.54, 1.49)	1.43 (0.89, 2.31)	0.83 (0.48, 1.44)	1.40 (0.85, 2.31)

NOTE: Serum PFAS concentrations were log transformed and rescaled by their standard deviation for analysis when analyzed continuously. Concentrations for 12 women with insufficient serum for analysis were imputed.

*Adjusted for age (continuous), BMI (categorical), prior pregnancy loss conditional on previous pregnancy (no prior pregnancy, previously pregnant without loss, previously pregnant with loss), any alcohol consumption during pregnancy (yes/no), and any cigarette smoking during pregnancy (yes/no).

NA, not appropriate for analysis as 2nd tertile is same as first tertile of zero after rounding.

2-N-ethyl-perfluorooctane sulfonamide acetate (Et-PFOSA-AcOH),
2-N-methyl-perfluorooctane sulfonamido acetate (Me-PFOSA-AcOH)
perfluorodecanoate (PFDeA)
perfluorononanoate (PFNA)
perfluorooctane sulfonamide (PFOSA)
perfluorooctane sulfonate (PFOS)
perfluorooctanoate (PFOA)

[+]p<0.05 before rounding, p=0.0482

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Janet Cumming

From: Janet Cumming
Sent: Friday, 17 June 2016 10:02 AM
To: 'rogerdrew@toxconsult.com.au'
Cc: oakey-idc
Subject: Information as promised.
Attachments: HBM I values for PFOA and PFOS in blood plasma_ 9 Mai 2016.docx

Good Morning Roger,
As promised at the meeting on Wednesday, the link our on-line bibliography at CiteULike is http://www.citeulike.org/user/wqunit/tag/pfas.

I have also this morning received a reply from Umwelt Bundesamt regarding their Human Biomonitoring values for PFOS and PFOA, which I have attached for your information.

Kind Regards,
Janet

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Janet Cumming

From: Roger Drew <rogerdrew@toxconsult.com.au>
Sent: Friday, 17 June 2016 1:23 PM
To: Janet Cumming
Cc: Tarah Hagen
Subject: RE: Information as promised.

Thank you Janet,

The Germans have made an interesting call in nominating 5 ng/mL as a level at which no adverse health effects are not expected.
There will be many people above this level and will create for them, and others, some challenging communication. Perhaps the answer for us lies in the management purpose of the uniquely German HBM I & II values.

Do you have an idea when this statement will be posted on their website?

I note a July 2015/May 2016 evaluation of the epi literature underpins their deliberation. This is somewhat curious since most other agencies have considered the epi data to be inconsistent and has exposure definition issues.
We will look at the references cited in the statement (it helps my colleague, Tarah, is German) but since it is dated 2014 I doubt it will have the epi analysis within it.

For Qld Health internal use we will send our bibliography early next week. It would be appreciated however if you didn't disperse it further.

Regards Roger

Roger Drew, PhD, DABT, FACTRA
Toxicologist & Risk Assessor

ToxConsult
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Adjunct Associate Professor
Dept Epidemiology & Preventative Medicine
Monash University

From: Janet Cumming [mailto:Janet.Cumming@health.qld.gov.au]
Sent: Friday, 17 June 2016 10:02 AM
To: rogerdrew@toxconsult.com.au
Cc: oakey-idc
Subject: Information as promised.

Good Morning Roger,
As promised at the meeting on Wednesday, the link our on-line bibliography at CiteULike is http://www.citeulike.org/user/wqunit/tag/pfas.

I have also this morning received a reply from Umwelt Bundesamt regarding their Human Biomonitoring values for PFOS and PFOA, which I have attached for your information.

Kind Regards,
Janet

Dr Janet Cumming BSc(Hon) PhD
Advanced Environmental Health Scientist (Water)
Water Unit, Health Protection Branch
Prevention Division
Department of Health
15 Butterfield Street, Herston Qld 4006

PO Box 2368
Fortitude Valley BC 4006
Phone: 07 3328 9346
Fax: 07 3328 9354

Janet Cumming

From: Janet Cumming
Sent: Friday, 17 June 2016 1:45 PM
To: 'Roger Drew'
Cc: oakey-idc; Suzanne Huxley
Subject: RE: Information as promised.

Hi Roger,
We don't have a date for the release of the information in Germany, except that it is in process.

With regards to the bibliography, we would of course not disperse this information. However, if we were to be subject to a "Right To Information" request, we may not be able withhold it. If you would prefer not to share any or all of it, we would understand.

Re the HBM values. I found a presentation on their website on how they calculate these conservative values. Slide 9 on PFOA highlights the problem
https://www.umweltbundesamt.de/sites/default/files/medien/378/dokumente/martin_kraft_hbm_values_derived_by_the_german_hbm_commission.pdf
Kind regards,
Janet

From: Roger Drew [mailto:rogerdrew@toxconsult.com.au]
Sent: Friday, 17 June 2016 1:23 PM
To: Janet Cumming
Cc: Tarah Hagen
Subject: RE: Information as promised.

Thank you Janet,

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Myra Thompson

From: Siemionow, Stef MS <stef.siemionow@defence.gov.au>
Sent: Friday, 17 June 2016 11:33 AM
To: Sophie Dwyer; HProtSD_dchocorro
Cc: Hannon, Stacey MS; Gray, Lauren MS; Giltrap, Daniel MR
Subject: Letter regarding mental health and counselling support services for residents of the Oakey investigation area [DLM=For-Official-Use-Only]
Attachments: 2016.06.16 Letter from A-ASEE to Sophie Dwyer, Queensland Health - Mental health and counselling support services for residents of the Oakey investigation area.pdf

For-Official-Use-Only

Good morning Sophie,

Please find attached a letter from Defence's Acting Assistant Secretary Environment and Engineering to yourself regarding mental health and counselling support services for residents of the Oakey investigation area.

Kind regards,

Stef Siemionow
Directorate of Policy and Governance
PFC Environmental Management Program
Environment and Engineering Branch | Infrastructure Division | Department of Defence
BP26-2-B069 | 26 Brindabella Circuit | Canberra Airport ACT 2609
☎ 02 626 68041 | ✉ stef.siemionow@defence.gov.au

Australian Government
Department of Defence
Estate and Infrastructure Group

Stacey Hannon
Acting Assistant Secretary
Environment and Engineering
Brindabella Business Park (BP26-2-B009)
PO Box 7925
Department of Defence
CANBERRA ACT 2610
☎: (02) 6266 8060
💻: Stacey.hannon@defence.gov.au

ASEE-ID/OUT/2016/AF25557500

Ms Sophie Dwyer
Executive Director
Health Protection Branch
Queensland Health
147-163 Charlotte Street
BRISBANE QLD 4000

Dear Ms Dwyer

Mental health and counselling support services for residents of the Oakey investigation area

Defence is investigating the extent and levels of the compounds perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in soil and water in the vicinity of Army Aviation Centre Oakey (Oakey). Further to informal discussions between representatives of Defence and Queensland Health, I am writing to seek your advice regarding the availability of existing mental health and counselling support services for Oakey residents, and whether there are any actual or perceived barriers to residents accessing these services.

Defence appreciates the mental health pressures that some members of the Oakey community are experiencing in association with PFOS and PFOA investigations. Defence is seeking to complete its work as promptly as feasible to provide the Oakey community with greater certainty regarding the investigations. Notwithstanding the focus on timely completion of this work, Defence is also seeking to better understand any barriers to residents of the Oakey community in accessing mental health and counselling support services.

Defence understands that the Australian Government funds a range of telephone and internet counselling services, as well as funding for clinical mental health services that may be available in Oakey or in a nearby location such as Toowoomba. Defence understands that in many areas of Australia these types of services may not be fully utilised, and it would be helpful to understand if this applies to clinical mental health services available to the residents of Oakey. Defence is also seeking your advice regarding broader mental health services that may be available to Oakey residents, including those delivered by the Queensland Government or local health providers.

Specifically, Defence would be grateful for your advice as to:

a. Whether there are ample clinical mental health and counselling support services available to the Oakey community?

b. Are these clinical services fully utilised?

c. Are there any actual barriers to residents accessing these services (such as payment, transport, operating hours)?

d. Are there any perceived barriers (such as stigma of participation, lack of awareness)?

e. Whether Queensland Health considers there are initiatives that may assist in overcoming actual or perceived barriers, or complement the available services?

f. Is there any gap in services that may benefit the Oakey community?

This advice will assist Defence and the Department of Health (Commonwealth) in informing the Australian Government after the 2 July 2016 Federal election.

Defence would be pleased to discuss this matter with your Department. My point of contact for this matter is Ms Lauren Gray, Director Policy and Governance, on (02) 6266 8257 or lauren.gray@defence.gov.au.

I look forward to continuing to work with you on this matter.

Yours sincerely,

Stacey Hannon
Acting Assistant Secretary
Environment and Engineering Branch
16 June 2016