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July 16, 2009

FEDERAL EXPRESS

EPA Docket Center, MC 2822T
U.S. Environmental Protection Agency
EPA West, Room 3334
1301 Constitution Avenue, NW
Washington, D.C. 20004

Re: Submission to IRIS and AR-226 Database For PFOA/PFOS: EPA-HQ-ORD-2003-0016

To IRIS Database for PFOA/PFOS:

In response to the Notice issued by USEPA on February 23, 2006, regarding USEPA's efforts to consider perfluorooctanoic acid ("PFOA") and perfluorooctane sulfonate ("PFOS") within the Integrated Risk Information System ("IRIS"), 71 Fed. Reg. 9333-9336 (Feb. 23, 2006), we are submitting the following additional information to USEPA for inclusion in that review, and for inclusion in the AR-226 database:

1. Final Report of the Peer Consultation Panel: Scientific Peer Consultation Process for a Site Environmental Assessment Program as part of the Dupont – EPA Memorandum of Understanding and Phase II Workplan (July 15, 2009); and

2. Link to ATSDR "Draft Toxicological Profile for Perfluoroalkyls" (May 2009) (available at http://www.atsdr.cdc.gov/toxprofiles/tp200.html#bookmark04).

Very truly yours,

Robert A. Bilott

RAB:mdm
Enclosure

CONTAINS NO CBI

320492

11464609.1

cc: Gloria Post (NJDEP)(w/ encl.) (via U.S. Mail)
Helen Goeden (MDH)(w/ encl.) (via U.S. Mail)
Lora Werner (ATSDR)(w/ encl.) (via U.S. Mail)

Final Report

of the

Peer Consultation Panel

conducting the review for the

Scientific Peer Consultation Process for a Site Environmental Assessment Program

as part of the

DuPont – EPA Memorandum of Understanding and Phase II Workplan

Edited by

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Independent Third Party (ITP) Administrator

July 15, 2009

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Technical and administrative assistance for the peer consultation was provided by Kan Shao and Gloria Dadowski of Carnegie Mellon University.

Table of Contents

1. Introduction and Overview

This report summarizes the findings of the Peer Consultation Panel (PCP) convened to review the site environmental assessment program conducted by E.I. DuPont de Nemours and Company (DuPont) under a Memorandum of Understanding (MOU) with the United States Environmental Protection Agency (EPA), Office of Pollution Prevention and Toxics (OPPT). DuPont and EPA are signatories to the MOU in which DuPont has committed to provide EPA with certain data and information on perfluorooctanoic acid and its salts (PFOA) through a PFOA Site Related Environmental Assessment Program. In particular, the studies conducted by DuPont address the fate of PFOA at and near the DuPont Washington Works manufacturing plant located along the Ohio River, just west of Parkersburg, West Virginia.

The peer review is evaluating the scientific quality and completeness of ongoing studies conducted by DuPont and its scientific consultants to characterize past and current releases associated with the site, as well as quantities of PFOA in nearby environmental media, including those media that can lead to human exposure. This data gathering has been conducted through the implementation of phased activities, known as Phase I and Phase II, and set in a Phase II Work Plan. Under the MOU, DuPont used the Phase I and Phase II data along with other relevant information to prepare the following reports:

A. Data Assessment: DuPont Washington Works (OPPT-2004-0113 PFOA Site-Related Environmental Assessment Program), DuPont Corporate Remediation Group, Project No.: 507532/507533 18984356.05013, October 2, 2008.

B. Screening Level Exposure Assessment for DuPont Washington Works Facility, Parkersburg, West Virginia (OPPT-2004-0113 PFOA Site-Related Environmental Assessment Program), Environ, October 2, 2008.

C. Future Data Needs Assessment: DuPont Washington Works (OPPT-2004-0113 PFOA Site-Related Environmental Assessment Program), DuPont Corporate Remediation Group, Project No.: 507532/507533 18984356.05013, October 2, 2008.

The specific goal of the PCP is to evaluate these reports (and related supporting information provided by DuPont and its consultants) to determine whether an affirmative answer can be provided to the charge question posed in the DuPont-EPA MOU:

> Are current PFOA environmental releases and sources of those environmental releases from the Site and the presence of PFOA in environmental media on and around the Site sufficiently understood so that pathways of migration and exposure to PFOA associated with that Site are adequately characterized and assessed on a screening level basis?

1.1 Review Process

The members of the Peer Consultation Panel (PCP) were selected by ITP Administrator Mitchell Small following a public nomination procedure announced on the Carnegie Mellon PFOA Peer Consultation website: http://itp-pfoa.ce.cmu.edu/. The nomination procedure, described at http://itp-pfoa.ce.cmu.edu/pages/peer.html was closed on August 22, 2008. A total of 13 candidates were nominated by the US EPA (6), DuPont (3), Mitchell Small (3), Robert L. Griffin (1), and self nomination (1). Members were chosen based on the need to address particular areas of expertise in the study and the strength of each individual's scientific qualifications. The final committee includes four members nominated by the US EPA, two members nominated by DuPont, two members nominated by Mitchell Small, and one member nominated by Robert L. Griffin (a member also nominated by the US EPA).

The committee received copies of the three DuPont reports on November 3, 2008, and held a first organizational teleconference on November 18, 2008. The first formal meeting of the PCP took place with a publicly announced teleconference on December 23, 2008. Input to the panel on the charge and related information was provided by the representatives of the US EPA and DuPont. There it was decided that the panel would subdivide the review and preliminary writing tasks with major and minor assignments as follows:

Table 1. PCP Focus Areas and Panelist Assignments

Panel Member	Air	Surface water & sediment	Soil & groundwater	Biota	Multi-Media	Human Exposure
Joel Baker			Minor		**Major**	
Kannan Kurunthachalam		Minor		**Major**		
Linda S. Lee			**Major**	Minor		
Paul J. Lioy	Minor					**Major**
Scott A. Mabury	Minor	**Major**	Minor			
Michael McLachlan		Minor			**Major**	
Rosalind A. Schoof			Minor			**Major**
Thomas B. Watson	**Major**			Minor		

The committee conducted further public teleconference meetings on February 23 and March 11, 2009, to discuss their preliminary findings. Following the March meeting, a Final Preliminary Report of the PCP was concluded, serving as the basis for discussion at the public face-to-face meeting of the PCP that was held on March 23-24, 2009, in Parkersburg, West Virginia. The Parkersburg meeting included presentations by the US EPA and DuPont, further discussion of the Preliminary Report by the PCP, and public input. A summary of the Parkersburg meeting is included as Appendix A, including public comments submitted to the PCP during or closely following the meeting (Appendix A.2). Full audio-video documentation of the meeting is found at:

http://itp-pfoa.ce.cmu.edu/pages/announcements.html .

Further revisions to the Preliminary Report were made following the Parkersburg meeting and discussed at a subsequent public teleconference held on May 19, 2009, leading to a draft final report. The draft final report was posted for public comment on June 4, 2009. One set of comments was received on this report; these are presented in Appendix A.2. The PCP undertook minor edits of the final report to address the public comments, and the final report was completed for submission to the US EPA on July 16, 2009. This final report was also posted on the public web site for the Peer Consultation project on that day.

2. Summary of Key Findings and Conclusions

The PCP finds that the three reports reviewed provide a good first conceptualization and analysis of potential pathways of PFOA exposure at and near the Washington Works Site. Furthermore, much of the data that has been collected and analyzed will be useful in estimating the likely magnitude of these exposure pathways and their relative importance on a screening level basis. However, the panel has also found significant limitations and omissions in the datasets and associated modeling for estimating the relative and absolute importance of different exposure pathways, and recommends that a significantly expanded set of data collection and analyses should be conducted to fill critical gaps.

It should be noted that members of the panel did differ in their understanding and expectations of what was meant in the charge by, "adequately characterized and assessed on a screening level basis." Some members interpreted this to mean that the migration and exposure assessment should be at the current state-of-the-art in the scientific literature and practice for such assessments, with full coverage of potential migration and exposure pathways. Others interpreted the term "screening" to imply that a somewhat more initial assessment was intended, which would then encompass a more-limited sampling and evaluation of a more-limited set of pathways. This difference in interpretation is reflected in differences between some of the comments made by different panel members and presented in our findings below.

Key findings include:

2.1 For the Air Monitoring and Dispersion Modeling Assessment:

2.1.1 The conclusion that air emission, transport, and deposition is the primary pathway to contamination of drinking water is plausible, but is not adequately substantiated by the data and analyses that are presented in the reports.

2.1.2 The selection of a two-mile radius around the plant seems insufficient to characterize the spatial extent of impact and potential exposures to PFOA released from the Site. The selection of this domain must be justified or the domain should be expanded and a more detailed characterization of the entire domain is needed.

2.1.3 The temporal resolution of the air monitoring was insufficient to characterize the transport and dispersion of PFOA in the areas likely to be affected by emissions.

2.1.4 The data set used to evaluate the dispersion modeling is inadequate.

2.1.5 There was no attempt to evaluate the air monitoring and modeling by accounting for the released material. There should be an attempt made to perform a mass balance calculation for airborne material.

2.1.6 There is evidence that all airborne sources of PFOA have not been identified. Air monitoring should be performed at the landfill sites to eliminate them as possible sources of airborne PFOA as well as at the facility now known as the Little Hocking Service Center, especially if incineration occurs at this site.

2.2 For the Surface Water and Sediment Assessment:

2.2.1 Ohio River water sampling was very intermittent, and lacking in information regarding time of day or week, plant operation, river flow etc. As such, it is difficult to interpret what the reported river water concentrations mean.

2.2.2 Adequate explanation is not provided for the absence of detectable PFOA in river samples along transects near the site, given the presence of PFOA in Ohio River and drinking water intake samples many miles downstream.

2.2.3 Water samples at the Washington Works outfalls and landfill leachate and surface water samples suggest that these locations could have provided potentially important routes of PFOA transport to groundwater and the Ohio River. More extensive sampling associated with the landfills is needed.

2.2.4 No water samples were collected at other surface water bodies, neither in the study area nor in any stream or river sediments. PFOA in these media could lead to exposure to biota and subsequently through the human food chain.

2.3 For the Soil and Groundwater Assessment:

2.3.1 Substantial soil and groundwater data have been collected and the general routes of exposure have been defined. However, the groundwater flow model has not been adequately validated for use in the assessment.

2.3.2 PFOA air emissions clearly were and still are a large contributor to contamination of drinking water via the air-soil-groundwater route especially within a few mile radius of the site. However, significant contributions to drinking water contamination from additional PFOA transport modes cannot be ruled out.

2.3.3 Collection of additional samples associated with potential contamination of groundwater and migration to off-site streams from the ponds and contaminated layers in or near the water-bearing zones under the former (closed and capped) landfills are warranted as well as some post monitoring of the Riverbank Landfill and Anaerobic Digestion ponds that will have an engineered cap system.

2.3.4 Additional assessment as to whether or not pumping at LHWA induces any unexpected hydraulic connection between the groundwater associated with the Anaerobic Digestion ponds is suggested as well, given the high PFOA concentrations observed in the wells immediately north of the ADP even after pond material was removed.

2.3.5 Clarification regarding the potential off-site transport scenarios that may occur if pumping at the Ranney Well, the DuPont-Lubeck Well Field, or the East Well Field were to cease for some period of time is needed.

2.4 For the Assessment of PFOA in Biota:

2.4.1 Biota can be an important pathway of PFOA exposure to the local populations. There is a need to determine concentrations of PFOA in several biological matrixes to accurately assess exposures. There are data gaps in characterizing PFOA in biological media, which can play an important role in the assessment of the migration of PFOA on and around the Site and subsequent human exposure.

2.4.2 Home-grown produce and domestically produced milk have been identified in the Future Data Needs Assessment report as priorities for future data collection. In addition, it is recommended that PFOA data for farm produce, locally produced meat, fish from surface waters, breast milk samples and game animals (game hen) be collected to account for potential biological matrixes that could contribute to exposures.

2.4.3 Several aspects of the SLEA, as described in the reports, require further, more-adequate justifications. For example, exposure assessment of PFOA from the ingestion of local fish by anglers involved several non-conservative assumptions on fish species, ingestion rates, exposure duration and concentrations in fish. These estimates have introduced uncertainties that could potentially lead to an underestimate of actual exposures by 1 to 2-orders of magnitude. There is a need to refine the exposure models for fish consumption.

2.4.4 Other biological media such as breast milk and game animals should be identified as potential exposure pathways to PFOA for certain subpopulations. Justifications are required to explain why these pathways are not considered in the current report and/or these pathways should be identified in the 'Future Data Needs Report" for future study.

2.5 Assessment of Multimedia Fate, Transport, and Exposure Pathways:

2.5.1 The site conceptual model adequately describes many of the transport pathways to people living close to the source. However, neither the exposure to PFOA nor the pathways of migration for people living more distance from the plant are characterized. This deficit is judged to be particularly serious for the population exposed via river water downstream of the site.

2.5.2 The site conceptual model appears to be factually incorrect in its placement of the SWMU and its correct location, on the rim of the river. The conceptual model also omits a potential transport pathway from the SWMU into the Ohio River and a pathway into groundwater that may also flow away from the Site.

2.5.3 Migration within media (air and water) has been addressed elsewhere in this peer consultation. There appears to be a basic understanding of some intermedia transport

processes (e.g. river water to ground water). However, several intermedia pathways of migration of PFOA are not yet understood at a basic level. Deficits exist particularly regarding the transport of PFOA from surface soil to groundwater, and from air and water to food.

2.5.4 A semi-quantitative description of the mass flows along some partial pathways of migration is presented (e.g. from air to surface soil). However, no assessment along the entire major pathways (e.g. air – surface soil – groundwater – drinking water) is provided.

2.5.5 Data were collected and assessed to evaluate the atmospheric transport and deposition to soil following emissions to air at the Washington Works site. Data were also collected in surface water, but no effort was made to assess the relationship between emissions to surface water and transport via surface water. Measurements were conducted that supported the understanding of the relationship between atmospheric emissions and deposition to terrestrial surfaces, but no effort was identified that evaluated quantitative understanding of the link between atmospheric emissions and the levels in groundwater in the unsaturated or saturated zones. Measurements to assess the transfer of PFOA from air and water to food are fully absent.

2.6 Assessment of Human Exposure:

2.6.1 The SLEA does not make sufficient effort to obtain and use local exposure concentrations, and exposure factors and behaviors for the local population, or to provide sufficient justification for the values used when local data or exposure parameters are not available. The authors used information from EPA guidance documents during the completion of their analyses, and applied general exposure factors to replace missing or unavailable information and data without adequate discussion of their reasoning for relying on these values.

2.6.2 While estimates for drinking water exposure are based upon site data, little or no data are available for the other exposure pathways (e.g. air, soil ingestion, food etc.). All calculations are based upon hypothetical individuals representing a reasonable maximum exposure (RME) or mean typical exposure (MTE) to represent high end and central

tendency levels of exposure, respectively. While this approach is reasonable, many of the activities and the frequency of activities used to estimate exposure to these hypothetical individuals were speculative. At the present time, there is no information provided in the document that assists in providing a validation for the baseline assumption used for each "receptor" person or population.

2.6.3 The SLEA does not explain how the resulting intake estimates will be used in assessing risks. The lack of information regarding how the exposure estimates will be applied may lead to incorrect conclusions in the SLEA. For example, the conclusion that inhalation exposures are low compared with other exposure routes is irrelevant if the lung is a target organ and inhalation risk will be assessed separately from ingestion and dermal exposure.

2.6.4 The levels and types of data collected at the Washington Works Facility and Local Landfill, the Dry Run landfill, and the Letart Landfill, are not comparable. Thus, evaluations between sites are not possible. As a consequence the lack of data across the sites leads to major gaps in the ability to do site-specific screening exposure characterizations.

2.6.5 The five-year exposure duration used in the SLEA is a departure from standard risk assessment approaches and also requires an early explanation in the document.

2.6.6 There is a lack of objective analysis of the relative degree of uncertainty for the different exposure pathways.

2.6.7 The reliance on comparison with drinking water exposures as a basis for discounting the importance of other exposure pathways is particularly problematic and could be misleading. We understand that the intent is to assess the current drinking water status in the next iteration of this document, but this document should not appear to discount the relative importance of other exposure pathways based on a comparison with drinking untreated groundwater because that comparison does not reflect current conditions with widespread water treatment in place, i.e., pathways that seemed minor compared to drinking water exposures prior to water treatment, may now contribute a much greater fraction of total exposures.

2.6.8 The screening exposure assessment should be forward looking in perspective, and utilize the extensive biomonitoring data in the population that now receives the drinking water through the Little Hocking Water Association, other public systems and from private wells. The biomonitoring data should offer insights regarding the current variability in exposures. The conceptual model for exposure needs to consider additional sampling based upon the recently established emissions from the stacks, and the additional data collection efforts described in Section 2.7. These include air and biota monitoring programs that can achieve the goals of a revamped program and the goals of an exposure assessment.

2.7 Summary of Priority Needs for Future Monitoring and Model Development

As part of our review of the current Data Assessment, Screening Level Exposure Assessment, and Future Data Needs Assessment documents, the PCP identified high priority areas for further data collection and model development. These are summarized below and may provide useful input in the design of Phase III studies for the Site. The recommended measurements include data needed to provide better resolved estimates of exposure, as well as for performing a mass balance calculation for historic and current PFOA emissions and environmental inventories.

2.7.1 A coordinated, ongoing air monitoring program is needed, including time coincident measurements of emissions, ambient concentrations, and deposition. Monitoring should include direct stack, ambient, and deposition monitoring at time scales sufficient to characterize long-term, seasonal, and diurnal variations in PFOA emissions, concentrations, deposition, and resuspension. Spatial resolution should be sufficient to address vertical variations in concentration that inform flux-deposition processes, and horizontal variations across key receptor locations, including the Ohio River, the LHWA well field, and more distant locations needed to determine the spatial extent of the Site influence.

2.7.2 A spatially comprehensive synoptic survey of PFOA concentrations in the Ohio River is needed to characterize the spatial extent and source-receptor relationships of water quality impacts from the Site. If possible, samples should be collected on a single

day, extending from the Site to downstream areas known to have drinking water contamination (e.g., at least as far as Crab Creek, ~90 miles downstream). Samples should be obtained in the immediate vicinity of each of the major outfalls to the Ohio River and downstream (in line with the river current) and from selected tributary creeks and shallow water bodies (e.g., Brinker Run for Letart Landfill and Lee Creek for Dry Run Landfill) that flow through the landfills. PFOA concentrations should be measured for co-located water, sediment and fish samples.

2.7.3 An intensive sediment survey is needed for the Ohio River in areas immediately adjacent to the Washington Works outfalls, upstream and downstream of the outfalls, and downstream of the landfill sites. Transects should be designed to capture the extent of PFOA contamination related to a specific outfall and should include differential depth analysis. A sediment transect running from the Site across the river to the LHWA should also be surveyed to check for the existence of possible seepage zones emanating from the Riverbank Landfill (RBL) that could lead to PFOA transport to Ohio River water drawn by the LHWA well field.

2.7.4 Pump and tracer tests are needed to further explore possible hydraulic connections between the Ohio River waters near the Site and groundwaters on both sides of the river. The tests should include coincident monitoring of water levels in wells on both sides of the river in response to planned or imposed changes in pumping rates at the Ranney Well, the DuPont-Lubeck Well Field, the East Well Field, and the LHWA well field. Tracer tests should be implemented to test for possible groundwater pathways in or under the river bed between the former ADP area and the LWHA well field. In addition, PFOA monitoring should be conducted in these areas at existing and new wells along the banks of the river.

2.7.5 PFOA sampling of biological matrixes representing potential sources of exposure to local populations is needed to screen and characterize these pathways, including home-grown produce and domestically produced milk (already identified in the Future Data Needs report), farm produce, locally produced meat, breast milk, game animals, and possibly additional fish species. These studies should be conducted in conjunction with ongoing biomonitoring surveys of the local population to better coordinate exposure and biomarker estimates.

2.7.6 A multimedia mass balance model should be developed to synthesize the available information on PFOA mass flows and environmental inventories. The model should be able to track and predict changes in emissions, transport, inventories and exposure over time. It should also be used to test whether the available information provides a consistent and sufficiently certain understanding of PFOA transport and exposure pathways from the facility, and to help guide further data collection needs.

3. Detailed Findings

3.1 Air Monitoring and Dispersion Modeling

3.1.1 Identification and Characterization of Transport Pathways

The Screening Level Exposure Assessment (SLEA) report states that

> "The results of this assessment indicate that ingestion of drinking water is the primary exposure pathway for potentially exposed populations in the vicinity of the Washington Works facility and Local Landfill, Dry Run Landfill, and Letart Landfill" (p. ES-5)

The possible transport pathways from the Site are identified in the conceptual model (Figure 1.2). Deposition of airborne PFOA is the primary pathway to contamination of drinking water in the conceptual model. Characterization of this pathway is essential for an accurate SLEA.

3.1.2 Source Characterization

Air emissions from the Site were 29,900 lbs. in 2000 and were reduced to 300 lbs. in 2006. An air emissions inventory was developed for 11 permitted sources at the Site using calculations based on a quantity of PFOA emitted per unit of production, a loss factor, and a scrubber efficiency factor. There was no direct monitoring of atmospheric emissions during the air monitoring studies. There was no monitoring of emissions at landfill sites.

3.1.3 Air Monitoring Program

Domain

All air monitoring was conducted within a two-mile radius of the Site even though Figure 5.7 shows PFOA in residential water supplies at levels above 5.0 µg/L outside of the 2-mile radius (Data Assessment, Figures 5.7 and 5.2).

Sampling

Air sampling was accomplished by collecting 24-hour integrated samples using two sampling methods. The first method used OSHA Versatile Sampling Tubes (OVS) and collected samples at approximately one L min^{-1}. The second method used high volume samplers (HVS) collecting at a rate greater than 1000 L min^{-1}. Limits of detection (LOD) and quantitation (LOQ) for both methods were determined using the signal to noise ratio of the analytical method (Data Assessment, Appendix 2.2). In Phase 1 monitoring there was an LOD=40 ngm^{-3} and an LOQ=70 ngm^{-3} for OVS sampling and LOD= 0.4 ngm^{-3} and LOQ= 0.7 ngm^{-3} for the HVS (Data Assessment, Appendix 5.2). Phase 2 confidence limits had to be calculated from the footnotes in Table 5.2 of the report and are given here in Table 1. High volume samplers were used with cascade impactors to produce particle size distributions. The above ground elevation of the intake tubing was 3.6 feet.

Table 1: Limits of detection and quantitation for Phase 2 OVS and HVS sampling (data from Data Assessment, Table 5.2)

Sampler	Rate ($Lmin^{-1}$)	Volume (L)	Volume (m^3)	analytical LOD (ng)	Sampling LOD (ngm^{-3})	sampling LOQ (ngm^{-3})
OVS	1.00	1,440	1.44	0.6	0.42	2.08
HVS	1,000	1.4E6	1,440	0.6	4.17E-04	2.08E-03

Phase 1 monitoring was conducted from November 2003 to March 2004 and consisted of 6 events measured at 5 locations. Duplicate samples were collected at one location. Air emissions during the sampling of this phase were approximately 5000 lbs. per year (Data Assessment, Figure 4.1).

Phase 2 monitoring was conducted from August to October 2005 and consisted of 9 events with samples collected at 9 locations. Duplicate samples were collected at one location. Because of improvements in the analytical method resulting in lower detection limits between Phase 1 and Phase 2 monitoring, and because the high-volume samplers were operated at 1000 times higher flow rates than the OVS samplers, the data from the Phase 2 HVS samples were considered to be "more representative of actual air concentrations" and were used in the model comparison and the SLEA. Air emissions during this phase were less than 500 lbs. per year (Data Assessment, Figure 4.1).

Results

There was no vapor phase material detected on the OVS tubes XAD resin in either Phase 1 or Phase 2 monitoring.

The concentration range reported in Phase 1 data from the OVS samplers ranged from non-detect, less than the LOD of 40 ngm^{-3}, to 900 ngm^{-3}. Median particle diameter is less than 1 micron, with ~60% of the particles less than 0.3 microns (Data Assessment, Appendix 5.1).

The Phase 2 data were substantially different from those reported for Phase 1. This is likely a consequence in the significant reduction in emissions from 2003 to 2005, but is not discussed in the report. Concentrations seen in HVS samples ranged from 0.01 to 75.9 ngm^{-3}. Approximately 60% of the PFOA particles collected during the 9 events were less than 1.3 μm in diameter (Data Assessment Table 5.5)

There are significant discrepancies in the Phase 2 monitoring data.

The maximum concentration seen in Phase 2 was in the samples collected on October 11 and 12 during event 8 at location 10/11. The HVS sample designated 10/11 was collected at the site fence line (Data Assessment, Figure 5.2). Two OVS samples were also collected at this location. A comparison of these OVS and HVS samples reveals significant unexplained differences in reported results. The HVS samples had concentrations of 73.5 and 75.9 ngm^{-3} of PFOA. One of the two OVS samples had no PFOA above the LOD of 0.4 ngm^{-3} while the other OVS sample had a concentration of 36.8 ngm^{-3}. The HVS value of 70 ngm^{-3} is 35 times the LOQ of the OVS

samplers. The reasons for the differences between the two sampling methods and the two OVS samplers are not explained.

The winds during Phase 2 Event 8 were from the north east at 1.54 to 3.09 ms^{-1}as measured at both onsite and offsite meteorological stations (Data Assessment, Appendix 5.2, Figures B-8 and B-17). The samplers at locations 10/11 were upwind of the manufacturing site. The reason that the maximum concentration was seen when the winds were coming from a direction where there was no known PFOA source is not explained.

Another significant discrepancy is presented in the report

> "Air concentrations tend to decrease with distance from the Site in all directions except in the northeast quadrant where there is a slight increase at the 2-mile monitoring station. This increase cannot be explained definitively, but may be a result of terrain issues since this point is elevated and closer to the plume centerline "
>
> (Data Assessment, p 42).

This implies that there is a significant quantity of PFOA above the surface and that there is transport and deposition outside the monitored area. Limiting monitoring to 3.6 feet above the surface and within a 2 mile radius from the known air emissions sources is unlikely to account for all the material released from the site.

The results from Phase 1 and 2 air monitoring show significantly higher PFOA concentrations than measurements reported by the European Food Safety Authority from two studies examining PFOA background levels (EFSA, 2008). Measurements made in the United Kingdom found airborne exposures of 0.226 to 0.828 ngm^{-3} in March and 0.006 to 0.222 ngm^{-3} in November of 2005. The same report presents results of a study conducted in rural Norway where measured PFOA levels ranged from 1.4×10^{-3} to 1.7×10^{-3} ngm^{-3}. These PFOA levels are an order of magnitude lower than the lowest values seen using the HVS sampling method.

3.1.4 Air Modeling

> "It is important to ensure traditional modeling approaches are applicable to perfluorinated compounds, which are known to have unusual properties."
>
> (Data Assessment, Appendix 5.3 p 1.)

The performance of two different models, ISCST3-PRIME and AERMOD, were evaluated by comparing each model's predictions with the results of the Phase 2 HVS measurements. PFOA source data input to the models was generated from an emissions inventory calculated from production correlation factors. The dependence of model performance on meteorological input was tested using data from two weather stations. One set of data were from an observing system at the Washington Works Site within the Ohio River Valley. The other were from an offsite meteorological tower located outside of the valley in Little Hocking OH, approximately one mile from the facility and at a higher elevation than the on-site station.

AERMOD predictions were either close to, or over predictions of measured PFOA concentrations. Only 15% of the AERMOD predictions were less than the observed values. The performance of AERMOD was essentially the same when on-site or off-site meteorological input data were used.

ISCST3-PRIME predictions were less than measured PFOA concentrations approximately half the time with either on-site or off-site meteorological input, but exhibited less precision that the AERMOD predictions. There was better performance using the off-site meteorological input data – the number of close approximations was increased. The under prediction was attributed to errors in the model results when the plume centerline is above the mixing height.

The conclusion of the model evaluation was that AERMOD performed better than ISCST3-PRIME because it made predictions that were closer to measured vales and erred on the side of over prediction. The superior performance of AERMOD is attributed to a better representation in the model of turbulent conditions and interactions with complex terrain. The report states that

> "AERMOD provides conservative ambient predictions of PFOA near a manufacturing facility that is useful for permitting or assessment purposes."
>
> (Data Assessment, p. 44)

There was no effect on predicted PFOA concentrations when deposition was included in the AERMOD calculations.

Evaluation of Air Monitoring and Dispersion Modeling in the Environmental Assessment Program

Examination of the air monitoring and modeling programs and the data they produced raises a number of questions about the sources, transport, and fate of PFOA in the area around the site. The atmospheric transport pathway is not well understood. The Site-Released Environmental Assessment Program (SLEA) is not based on an adequate understanding of the sources and transport mechanisms of PFOA in the environment.
Specific deficiencies in the analysis are:

1. The airborne PFOA sources are insufficiently characterized.

The site emission factors were developed from production correlation factors that apply empirically derived formulas to determine emissions from production history. There was no attempt made to verify the production factors from direct emissions measurement during either of the air monitoring phases. At a minimum, there should be further explanation of the measurements that were used to determine these formulas and data on the validation of these calculations with actual stack monitoring. Actual stack monitoring during air monitoring would be even better.

There was no air monitoring at the landfill sites. The assumption made in the assessment was that the sites had engineered covers that prevented emissions. The fact that the highest levels of PFOA seen during Phase 2 occurred when the wind was coming from the northeast, upwind of the site suggests that there is a strong local source other than the industrial plant. This source should be identified. Air monitoring should be performed at the landfill sites to eliminate them as possible sources or airborne PFOA.

2. The spatial resolution of the air monitoring was insufficient to characterize the transport and dispersion of PFOA in the areas likely to be effected by emissions.

The sampling domain was limited to 2 miles around the site. Figure 5.7 shows that there is well contamination above 5 μgL^{-1} outside that radius. Figure 5.2 shows average air concentrations over the nine Phase 2 events for all sampling locations. These range from 0.05 to 25 ngm^{-3}. These values are well above those reported from urban and rural monitoring in Europe (EFSA 2008). However, the extent of the area impacted by PFOA emissions from the site is not established by the air monitoring program. Atmospheric transport and deposition cannot be accurately assessed, or the effects of the site delineated, without extending the study domain until the measured PFOA concentrations are at or near atmospheric background levels.

There was no air sample collected at a height greater than 3.6 meters above the surface. Measurements in the vertical dimension are necessary to fully characterize the PFOA transport regime and provide data for model verification.

3. The temporal resolution of the air monitoring was insufficient to characterize the transport and dispersion of PFOA in the areas likely to be effected by emissions.

There is no discussion of the seasonality of atmospheric concentration levels. The behavior of PFOA in the environment is likely to be temperature dependent and therefore both diurnal and seasonal. It is also possible that there may be daily or seasonal cycles of surface deposition and reemission to the atmosphere of PFOA, particularly in summer. Air monitoring with diurnal time resolution is necessary to capture temperature dependent deposition and re-suspension cycles. Monitoring should be conducted in winter and summer so the dependence of atmospheric concentration on seasonal temperature extremes can be characterized.

4. The data set used to evaluate the dispersion modeling is inadequate.

Model performance was evaluated against a data set that was inadequate for the reasons listed above. The result that adding deposition to the atmospheric transport models did not affect the predicted atmospheric concentrations cannot be corroborated with the limited data set used to evaluate the model. Since atmospheric deposition is assumed to be the primary environmental pathway for PFOA leading to transport to affected aquifers, wet and dry deposition should be measured directly.

5. There was no attempt to perform a mass balance. The monitoring and modeling cannot be assessed if there is not some attempt to see if all the released material can be accounted for in the environment. One way to accomplish this would be to perform inverse modeling. Another would be to extend the air monitoring in both the horizontal and vertical dimensions and attempt an empirical mass balance. Both modeled and empirical mass balances should be performed.

3.1.5 Data Needs

Stack sampling is necessary to verify the emissions inventory.

Vertical sampling is necessary to establish a three dimensional concentration profile and provide data for mass balance calculations.

Extended horizontal sampling to distances where the influence of local sources disappears and PFOA levels representative of atmospheric background levels are seen.

Air monitoring at landfill sites is necessary to eliminate them as additional local sources of airborne PFOA.

Air monitoring with diurnal time resolution is necessary to determine daily temperature dependent deposition and detect deposition and re-suspension cycles.

PFOA wet and dry deposition measurements should be part of the air monitoring program.

Winter and summer air sampling is necessary to determine the temperature dependence of deposition and transport processes.

Modeled and measured mass balance calculations are necessary to account for all emissions and validate the monitoring, modeling, and exposure assessments.

Long-term periodic measurements are essential to establish a baseline for levels of PFOA in the environment and quantify the effectiveness of emissions reductions.

3.2 Surface Water and Sediment

Overview: The only actual surface water samples obtained and analyzed for PFOA were from the Ohio River, during three dates in 2002. For purposes of this review the more extensive outlet emissions from the Site (Washington Works) and the companion landfills (Local, Dry Creek, and Letart) were included; some putative surface water samples appear to have been taken/analyzed from these landfills as well. These "outlet" samples were obtained at various time points, depending on location, from the early 1990s up to 2008.

The report does not list any other surface waters monitored. Further, there are **no** sediment samples in the report. The SLEA used mean Ohio River water PFOA concentrations averaged from 60 total samples, over half of which were below the analytical LOQ.

It does not appear that we sufficiently understand the current emissions and pathways of PFOA migration out of the Site and thus the answer to the question in the charge appears to be negative. In addition, there is insufficient information or data to understand how historical emissions lead to the current contamination of groundwater that results in the primary route for human exposure. It could be that the historical contamination of off-Site groundwater could have occurred through multiple mechanisms in contrast to what is occurring at present.

3.2.1 Ohio River

In addition to air emissions indirectly impacting surface water, direct discharges of PFOA to the Ohio River through the site outfalls, erosion of soils and leaching and runoff from solid waste management units (anaerobic digestion ponds and river bank landfill) and runoff from the three landfill sites could contribute to PFOA contamination of the surface waters, especially the Ohio River. The Ohio River is a potential pathway of transport of PFOA from the site and the landfills. PFOA in the Ohio River has migrated downstream to public water supply well fields located adjacent to the Ohio River that are recharged by river water (as evidenced by high levels of PFOA in downstream public water supplies).

A quick calculation of potential Ohio River PFOA concentrations for 2002, when ~5,000 lbs of PFOA were released via aqueous discharges (Fig 4.1), yields a well-mixed average value of approximately 0.025 ppb PFOA. This assumes an average flow rate of 100,000 cfs [data on Ohio River flow at Parkersburg: National Weather Service, Advanced Hydrologic Prediction

Service; 100,000 cfs is the 75-90 percentile flow rate, however, the river would be expected to have somewhat higher flow downstream.] The value of 0.025 ppb is helpful to keep in mind when comparing actual Ohio River data.

Ohio River Monitoring (Phase I) was carried out in the summer and fall of 2002 with specific dates of sampling June 27 (Thursday), July 10 (Wednesday), and October 17 (Thursday). No information was provided that outlined the rationale for selection of sample day, location, or why the sampling was spread out over five months. According to Figure 5.12 (with min/max values and sample number; total 50 samples), there were 12 Ohio River transects taken during this period with 3 transects above the Site, 5 transects within the two-mile radius, and four additional transects downstream as far as Racine Lock and Dam (~50 miles from Site).

The report says Fig 5.12 data are tabulated in Table 5.12 but the table only has values for transects near the Site and Letart.

PFOA values were ND above the Site, ND to NQ adjacent and immediately downstream of the site, below which PFOA was detected and quantifiable 50 miles downstream to Transect 12 (2 samples; ~0.100 ppb) with the highest value at Transect 8 where PFOA was ~1 ppb. PFOA dissipation appears moderate since Transect 9 and 10, sampled the same day, had PFOA at 0.28 ppb at the upstream location and ~5 miles downstream it was 0.23 ppb. At transect 12, the furthest downstream sampled, PFOA values were ~0.100 ppb. It is unknown why further locations downstream were not reported since groundwater had detectable PFOA at Pomeroy (60 miles) and apparently even to Crab Creek (~90 Miles) where a GAC system was being installed (to be completed Sept 2008). The summary section in the report incorrectly reports that PFOA was only detected "18 miles downstream". It is clear that PFOA was transported at least 50 miles from the Washington Works Site, and likely further given PWS contamination, though no surface water samples are reported further downstream than Racine. The lack of assessment of the extent of PFOA migration and exposure to downstream locations is a major omission in this report.

It is puzzling that PFOA was ND or NQ at all locations near the Site though it is noted that these samples were all taken on June 27th while the detects downstream were taken in July or October. Outfall 005 (Site discharge farthest downstream) had PFOA concentrations of 76.2, 36.3, and 17 ppb on June 27, July 10, and Oct 17, 2002 respectively. It is noted that the PFOA discharge on July 11, 2002, the day after the river sampling, was 230 ppb. Despite this close proximity to a

well known source, lack of detection in surface waters collected within 200 feet of the outfall is surprising. Is this due to a one-time sampling event (e.g., when the plant was shut down or after heavy rains or a weekend)? Some explanation needs to be put forth as to why there was no PFOA in surface water in these three transects next to the Site. If the data were not collected to represent annual average, or at least representative values (taking into account seasonal, annual and daily variations), estimates of average exposure from such measurements are subject to high uncertainties.

Additional sampling was carried out at two dates in each of 2004 and 2005, in the Ohio River at and near the Outfall 005; for reasons unknown the outfall itself was not apparently sampled on those days. Near the outfall, i.e. 5 ft to 20 ft from the bank, PFOA concentrations were generally between 1 and 6 ppb with concentrations dissipating out to "300 ft from the bank". It is unknown what the specific transect, relative to the outfall, was sampled in the river.

Overall, there were 68 samples included in the SLEA (Transects 1 to 12 from 2002 and 04/05 samples near outfall 005), of which 39 were ND or NQ for PFOA. In summary, river water sampling was so intermittent, and lacking in information regarding time of day or week, plant operation, river flow etc, that it is difficult to have a sense of what the river water concentrations mean.

3.2.2 Washington Works Outfall Data

Extensive sampling is reported for four active (001, 002, 005, 105) and two historical (003, 007) aqueous discharge outfalls during the years 2001 and 2008; data are found in Table 5.17 and Appendix 5.9. Current outfalls range along the Site from the most downstream part of the site to the most upstream. Outfall 005 reportedly has the most "volume" but no data is provided to support this. Site 001, apparently the most upstream outfall, which places it upstream of the Little Hocking Water Association supply field, had a mean PFOA concentration of 21 ppb (high of 79.2 ppb) while 005 itself had an average of 56 ppb (high of 879 ppb). The report suggests these outfalls are the only significant source of PFOA to the Ohio River.

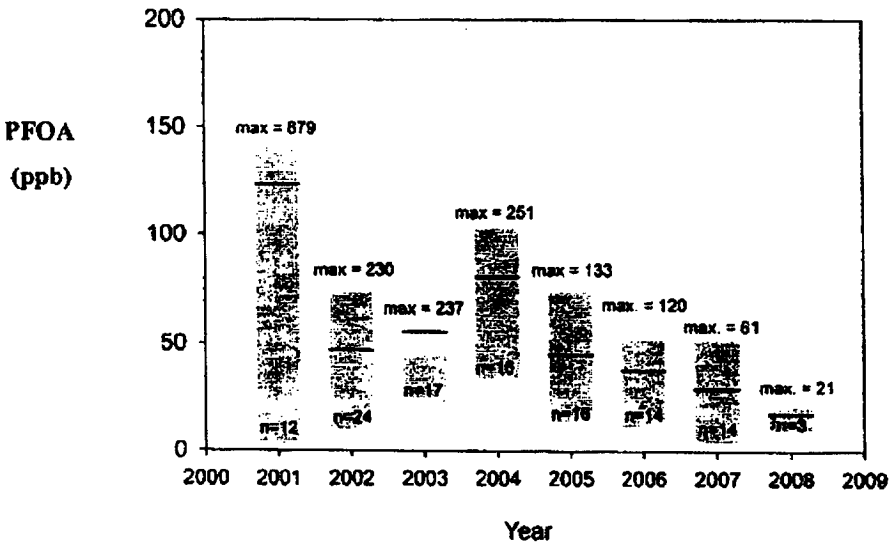

Figure 1. Summary of PFOA concentration measurements at Outfall 005.

The figure above is the annual data for Outfall 005 showing the mean value in ppb (red line), the top of the box is the 75th percentile and the bottom the 25th percentile for PFOA; the maximum observed value and the number of samples are indicated. The data suggest significant variability in PFOA discharge concentrations and no clear year to year reduction, at least between 2002 and 2004. The outfall data are generally consistent with the PFOA water emissions reported in Figure 4.1 where emissions declined modestly between 2002 and 2006. The 2001 water emissions, the first year reported in the figure above, were much lower at ~11,000 lbs than the 2000 emissions, which were reported to be ~48,000 lbs.

Note: Figure 3.6 indicates additional Washington Works Site surface water outfalls that were sampled on a weekly or monthly basis. These include outfalls 102, 105, and 305. However, we were unable to find data presented for any of these outfalls.

3.2.3 Landfill Surface and Leachate Analysis for Local, Dry Run, and Letart

Outlets, streams, leachate pipes, and related samples appearing in Tables 5.18 to 5.20 all indicate measurable quantities of PFOA, including occasional very high values such as 4200 ppb in the

Upper Pond at Letart. Both active and historical locations are indicated though it is unclear why some monitoring locations were deleted. For instance the Upper Pond at Letart had 11 samples taken between 1991 and 1996 (480 to 4200 ppb) but values after 1996 are not provided. Similarly, Lower Pond, also at Letart, was sampled between 1991 and 2000 (mean value 1200 ppb), with nothing later reported.

Both Dry Run and Local Landfills had mean PFOA concentrations in the 10s to a 100 or so ppb while Letart was the most contaminated with mean PFOA values for outlets LCH1 approaching 800 ppb. All of these sites would have presumably contributed to off-site transport of PFOA, directly or indirectly, to the Ohio River. At Dry Run Landfill, one unnamed "stream" had 24 ppb PFOA measured in 1996 with the only other sample taken producing a value of 6.28 ppb (2005).

3.2.4 Other Surface Waters

There are several surface water bodies within the 2 mile radius of the site which were not sampled and analyzed. These include lakes and ponds – e.g., Washington Lake (found on the map, located near the site) – located within the 2 mile radius of the site. There also appears to be several ponds located in the farmlands within the 2 mile radius. Farm animals can drink water from such ponds and this would be a potential source to farm animals and food chain contamination. It thus appears that PFOA has not been monitored in any of the surrounding surface waters other than the Ohio River.

3.2.5 Washington Works Site Potential for Additional PFOA Transport to Ohio River

The Site Conceptual Model (Figure 1.2) is inaccurate in at least one aspect, since it shows the Solid Waste Management Units or SWMUs to the south of the Fluoropolymer plant (away from the river), which is incorrect. The anaerobic digestion ponds (ADPs) and the Riverbank Landfill (RBL) are actually perched just above the river north of the plant itself. The figure biases the discussion around the potential for the SWMUs to be a source of PFOA to nearby surface waters (i.e., Ohio River) through leachate or stormwater runoff. Note that the Chemosphere paper by Davis et al (2007; 67:2011-2019) leaves the SWMU out of their Figure 3 altogether.

3.2.6 Sediments

Sediment samples were not collected from any of the water bodies in or around the Site although there is a potential that runoff from several contaminated sites including the solid waste management units (SWMU) can result in the migration of PFOA. There is a need for monitoring

of sediments from the Ohio River near the outfall, upstream and downstream of the Site, and the three landfill areas to assess the migration of PFOA through sediment transport. Sediment data are also used in exposure assessment, for specific scenarios involving contact with sediments, e.g., groundskeeper/maintenance workers at the site (e.g., SWMU) and in landfill areas or off-site recreational boaters, and trespassers. Furthermore, sediment analysis is important for the assessment of pathways of migration of PFOA from the site and the landfills. Sediments are also important pathways of exposure to fish and benthic organisms. Human exposure to sediment can occur as a result of incidental ingestion and dermal absorption. Because no sediment PFOA data are available, such exposures have not been assessed.

3.2.7 Analytical Comment

LC/MS/MS requires one to know the ions of whatever analyte is of interest. For perfluorinated carboxylic acids (PFCAs) analysis one has to specifically put in both a parent and a fragment ion for each analyte of interest. It is unfortunate that these analyses were done such that only the ions associated with PFOA were monitored by the mass spectrometer (MS) detector and apparently no other analyte of interest. It is surprising since many other relevant fluorinated chemicals, such as the suite of PFCAs C6 through C15 as well as PFOS, can be co-analyzed in the exact same chromatographic run simply by adding all the associated ions to the multiple reaction monitoring (MRM) table in the MS analysis set up. Therefore, the only additional costs would be for standards and interpretation time. Note that the simultaneous monitoring of the known suite of perfluorinated chemicals is now the norm and not the exception. Therefore, although our charge is focused on PFOA, we would be remiss if we did not recommend that LC/MS/MS analyses conducted in the future should include simultaneous monitoring of the relevant suite of perfluorinated chemicals to obtain the additional information that will likely be useful in the ongoing assessment of PFOA.

3.2.8 Specific Data Needs

1) All figures/tables should identify locations and dates when samples were taken (e.g. PWSs in Table 5.11 & Fig 1.3).

2) A few creeks and shallow water bodies (e.g., Brinker Run for Letart Landfill and Lee Creek for Dry Run Landfill) that flow through the landfills and sediments in these creeks should be analyzed, as these creeks are conduits for PFOA to the Ohio River. High concentrations of PFOA are expected in these creek sediments and in water and several

exposure scenarios are possible. Fish, sediment and water should be collected from these creeks for PFOA analysis and exposure assessment.

3) Further Ohio River water sampling/analysis needs to be done to measure the extent of river water migration of PFOA emanating from the Site. Historical emissions, likely of high concentration, appear to have resulted in the contamination of the public water system at Crab Creek which is ~90 miles downstream. This suggests that river transport is significant and likely has reached very far downstream. The river water samples taken to date have been few in number and apparently not coordinated with plant operations. Sufficient samples need to be obtained in order to capture an accurate assessment of annual emissions, how these vary by time of day, season, etc. The current data set, with respect to size and breadth, does not appear to be consistent with the significant historical emissions inventory from the Site.

4) The RBL and the ADP SWMU need to be correctly represented on the Site Conceptual Model. It is important to obtain the necessary samples to demonstrate that PFOA is not currently moving from the SWMU into the Ohio River or to the River via subsurface migration northward. From a simplistic examination of the maps/aerial photos supplied it is difficult to imagine how PFOA could be released from the Site and be transported over 90 miles downriver while not impacting the Little Hocking Water Association supply wellfield located 700 feet across the River.

5) A detailed explanation is needed of how historical and current emissions inventories are obtained for both water and air emissions.

3.3 Soil and Groundwater

3.3.1 Background

Groundwater is a primary drinking water source in the study area, thus a major target of concern with regards to PFOA exposure. Therefore, assessing PFOA sources to the groundwater and ensuring that these sources and their magnitudes are properly identified is critical in assessing current and future exposure. Groundwater contamination at this Site can occur through four primary pathways: (1) Wet deposition of air emitted PFOA and PFOA-laden particles onto surface soil followed by leaching through the soil profile into subsurface aquifers, with subsequent migration in the direction of groundwater flow; (2) leaching through the landfill into the aquifer; (3) runoff from the landfill onto nearby surface soil followed by percolation through

the soil to the aquifer; and (4) recharge of PFOA-laden river water, which could include PFOA released from the upper silty and clay alluvial zone during pumping. Each of these pathways are discussed below with regards to whether or not the sources and the pathways at the Washington Works Site and subsequent impacted sites are sufficiently characterized for the purpose of assessing exposure, and what additional data are needed to fill the data gaps.

The general routes of exposure have been defined and substantial soil and groundwater data have been collected. Overall, PFOA air emissions clearly contribute to contamination of drinking water via the air-soil-groundwater route, although the report leads to concerns that there may be additional PFOA transport modes to drinking water. For example, the wind characterization shown for the DuPont Washington Works Site (Figure3-3) shows that wind transport occurs in all directions, winds to the SW are presented as most prevalent. The report then states that "residences that are located downwind of the Site have higher concentrations of PFOA than do residences upwind of the Site." (page 47 in Data Report I). However, Figure 5.7 shows PFOA in groundwater serving as a residential water supply at $\geq$ 2.5 ppb (orange and red circles) at 8 sites south and west of the site while there are 9 sites to the north and east. Although presentation and interpretation of results in the report are inconsistent, data presented later in the report specifically with regard to the Little Hocking Water Association (LHWA) clearly exemplifies the role of PFOA transport via wind from the DuPont Washington Work sites, even if not in the apparently more prevalent SW wind direction shown in the Rose Wind (Figure 3-3). The latter will be discussed in more detail in section 3.3.3 below.

3.3.2 Washington Works Site

3.3.2.1 Landfill Areas. This site of about 450 acres includes the fluoropolymer manufacturing plant and a Riverbank Landfill (RBL) area that within it contains three former anaerobic digestion ponds, which both sit on the river bank north of the plant. The ponds managed liquid and solid wastes from the fluoropolymer manufacturing processes until 1988 when the pond contents and upper few feet of clay liner and pond berm material were removed, backfilled, capped with topsoil, and vegetated. Although in Section 4.2 of the DA Report 1, it states that solid wastes were taken off-site and incinerated, later it is clear that there were solid wastes placed in some of the on-site SWMUs. The RBL itself was utilized from 1948 until the late 1960s and handled waste that "could contain PFOA".

The Riverbank Landfill and the Anaerobic Digestion Ponds are (were) located within the floodplain adjacent to the Ohio River and along the edge of the upper terrace. The Riverbank Landfill was closed and is covered with top soils and vegetated. The Riverbank Landfill and the ponds are supposed to be getting an engineered cap system that will eliminate exposure and prevent further infiltration and leaching of waste related materials. Depending on how this area sits on the riverbank, a cap for only limiting infiltration may not be sufficient, but the designs for this cap are outside the scope of this assessment report. If undisturbed, the aquifer under the Washington Works site would discharge to the Ohio River. The Anaerobic Digestion Ponds were closed and material removed (1988); however, according to the well data as late as 2003 as detailed below, there are still residuals in the underlying soil that are leaching PFOA.

PFOA concentrations measured in soil, surface water (seeps), and groundwater near the Riverbank Landfill and the Anaerobic Digestion Ponds indicate that PFOA from the land-filled materials did migrate to on-site soil and groundwater. The report claims no groundwater has moved off the Site due to production well pumping of groundwater, specifically the Ranney Well located to the East of the ADP. A schematic of this is highlighted in the SCM (Fig 1.2; see also Fig 3.8) though as noted above, the location of the SWMU is incorrect since it is actually perched just above the river. Interestingly, the report states that the contents of the ADP ponds and the upper few feet of clay liner and pond berm material were removed in 1988. Ground water monitoring wells are arrayed around the RBL and the ADP in which two wells in particular (P04-MW02 and RO4-MW02) are located immediately north of the ADP in the narrow area between the Ohio River and the ADP itself. These two monitoring wells were in operation between 1998 and 2003 and 1999 and 2003, respectively. These two wells were accessing groundwater from the "primary aquifer" and "perched water in clay" and ranged in PFOA concentration between 8000 ppb (1998) and ~44,000 ppb (2003) and from 9,000 (1999) to 309,000 (2003) ppb, respectively. The most recent monitoring well data provided for the 2 wells (2002-2003) (P04-MW02 and RO4-MW02 2002-2003 data in Appendix 5.9-Table B) show very high PFOA concentrations (10^4 to 10^5 µg/L). Also there are high concentrations (10^2 to 10^3 µg/L) in a well that appears to reside within the former ADP (Figure 3-6; Q04-MW02). In addition, from Figure 3.8 showing the draw down due to the pumping of the Ranney well, it is not clear if the water associated with the 2 wells north of the ADP are actually being captured by Ranney well pumping. Therefore, it is challenging to simply rule out the potential for significant transport of PFOA from the former ADP into the Ohio River and/or into groundwater moving to the North

and potentially the Little Hocking Water Association wells. A targeted groundwater tracer test may prove worthwhile for clarifying this uncertainty.

3.3.2.2 On-site Wells. According to the report and the supporting appendices, pumping of three on-site well fields near and parallel to the river (the Ranney Well, the DuPont-Lubeck Well Field, and the East Well Field) lowers the groundwater level to below river stage causing the river to recharge the aquifer zones rather than what would normally occur, that is, recharge of the river by groundwater. A United States Geological Survey (USGS) report (#2004-5088) summarizing the Survey's geohydrology assessment and simulation of groundwater flow in the Ohio River alluvial aquifers, including the Parkersburg area, indicates that the intense pumping (~ 4.78 million gallons of water per day) in the Parkersburg well field has resulted in a cone of depression in the water table that is approximately 2 miles long parallel to the Ohio River and 1 mile wide. Their simulations estimate that approximately 75% of the water pumped in the Parkersburg well field by design is derived from river water and only 25% actually captures water from the alluvium. Given that the majority of water in the Parkersburg well field is drawn from the riverbed, the simulations estimate typically short 5-year time-of-travel distances. USGS estimates a 5-year time-of-travel-area of approximately 1.18 mi^2), which is generally considered to be confined to the riverbed and the areas between the cones of depression in the well field. For the Parkersburg upper silty-clay confining layer, hydraulic conductivities are relatively small (1 to 3 ft/d), thus small changes in the hydraulic conductivity of this confining unit have pronounced effects on simulated heads.

The large cones of depression that result due to the intense pumping of the localized cluster of industrial wells on the river band and the Neal Island complicate groundwater flow and lead to questions regarding how good the capture is by these wells and what level of pumping must be maintained, etc. Assuming good capture in conjunction with closure and proper capping of the River Bank area, this should minimize recharge of the river with PFOA-contaminated groundwater. Groundwater modeling simulations calibrated for the site have been made to try to assess the effect of pumping on the Ohio River-aquifer flow paths, as presented in Appendix 3.2. With the pumping there is a ground water divide in the central part of the site (as also implied in the USGS report) such that groundwater flows to the east toward the East Well Field on the eastern side of the divide and to the west on the western side of the divide, which ultimately flows either north toward the Ranney Well, or southwest toward the DuPont-Lubeck Well Field. From the northwestern corner of the site, groundwater flows southeast toward the DuPont-Lubeck Well

Field. Overall, groundwater modeling results, which assume continuous pumping of the on-site production wells, show that the pumping of production wells at the site does not allow for off-site migration of water within the site aquifer, with the exception of some off-site migration potentially occurring in the northwest corner of the site due to Blennerhassett Island where the river is not cut as deep yet and only connects to the upper alluvial zone. Also pumping by two GE wells (ID 3 and 4) can induce offsite migration of groundwater at the NW corner of the site. Given the complexity of the site, the multiple wells being pumped, the changing dynamics of the Ohio River including a series of locks and dams that are operated to pool the river as needed, it may be an over simplification to assume that there is no off-site transport of PFOA-laden groundwater at the Washington Works site. Some targeted groundwater tracer tests should be done to test this assumption and remove the present uncertainty.

3.3.3 LHWA Site

At LHWA, all wells are drawing from the lower alluvium, which is described as sand to gravel to silty sand and has a hydraulic conductivity of 100 to 300 ft/day (USGS report 200-5088). Several additional soil borings and monitoring wells were installed in the LHWA area to better characterize PFOA contamination and pathways; however, this information was not well synthesized in the report. Synthesis of the water monitoring data (Table 4.1 in Appendix 5.8), depth of the wells installed (review of the in-field recordings of the soil borings in Appendix 5.8), and the soil concentration data with depth (Tables 4.6 and 4.7 in Appendix 5.8) supports the finding that much of the PFOA present is likely from wet deposition (or wet deposition and runoff) followed by percolation into the soil profile and subsequently groundwater.

Some of the key data sets compiled from multiple sections of the report and associated appendices are presented in Figure 2. Several observations are apparent. First, contamination is much greater in the shallow wells that are drawing water primarily from the upper alluvium compared to the deeper wells drawing water from the lower alluvium, which is being replaced by river water. Secondly, PFOA concentrations are much higher in the upper 0 to 1 interval followed by a decrease in concentration with depth with a small rise in concentration again somewhere in the 17-25 interval depending on the core. It is clear by the higher concentrations observed in the top one foot of the soil borings in 2006 that substantial PFOA air emissions were still occurring at that time (although to a much lesser extent). Seeing small rises further down in the soil profile reflects the variable nature of weather-dependent wet and dry deposition coupled

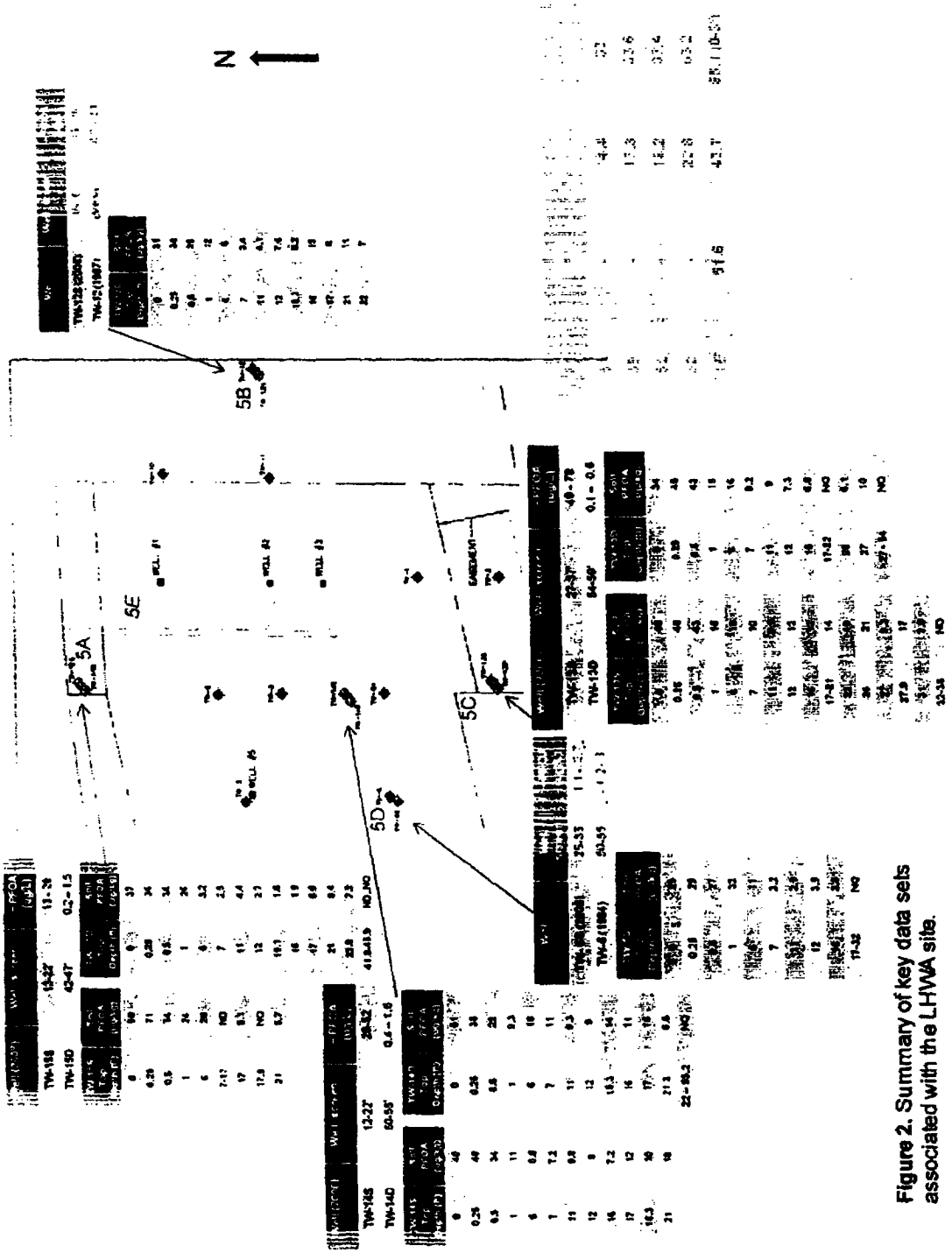

Figure 2. Summary of key data sets associated with the LHWA site.

with evapotranspiration and potential variations in actual PFAO air emissions for which no detailed data were provided. PFOA is only weakly sorbed to soils, with a partition coefficient of order of magnitude comparable to that of benzene (PFOA organic-carbon normalized partition coefficient, K_{oc} of ~ 10^2 reported by Higgins and Luthy 2006 and DuPont 2003). Thus it is expected that PFOA will move easily from the surface to the subsurface with rain events.

Third, clearly there was still a considerable amount of recent PFOA deposition from the air as can be seen from the 2005 grass and surface soil data summarized in Figure 2, even though a two-order magnitude decrease in PFOA air emissions occurred, from 29,900 lbs in 2000 to 300 lbs in 2006. In addition, rain sampling in August 2005 at a site (Station 5 in Figure 5.3) on or in immediate proximity of the LHWA had the highest rain concentrations (~53 ppt , Table 5.4). Changes (which hopefully consistently reflect improvements) on an annual basis from 2000 to 2006 were not detailed in the report, thus it is difficult to extract what the current air emission contributions are to present PFOA air deposition to soil. For example, how different were emissions in 2005 that parallel 2005 grass/soil data collection versus in 2006 which may parallel or contribute to surface concentrations noted in the 2006 soil borings? Such information would help to anticipate the expected impacts on surface soil, surface water, and subsequently groundwater from deposition of air-borne PFOA after 2006 at the LWHA site as well as in the radius known to be impacted by theses pathways. In the case of the LHWA site, the low elevation of the LHWA site means it is also subject to surface runoff of PFOA air emissions that are deposited on the higher elevation land north and northwest of the LHWA site.

While air emissions by 2006 have dropped two orders of magnitude compared to 2000, the 2006 sampling and analysis of plants near the facility show substantial PFOA concentrations on plant surfaces. Much of this mass was clearly from surface deposition and free to mobilize to the soil surface and percolate to the aquifer (based on the difference between analysis of washed and unwashed plant material). Substantial concentrations were also measured in the surface soils in 2006 (Table 5.16 for the borings at LHWA), which indicates that regular deposition of PFOA-bearing particles is still occurring within the current domain of 'allowable' air emission and releases. Therefore, given the high mobility of PFOA, the current level of 'permissible' emissions will continue to contribute to loadings in the subsurface and groundwater. This loading could be occurring for large distances away from the site in multiple directions. This adds support for the need for further data collection of PFOA and PFOA-laden particle air emissions within and beyond the current 2-mile radius outlined in the current analysis, including measuring current deposition at the LWHA site.

In addition to the Washington Works site emissions that were a topic of the DuPont report, during our site visit we learned of another waste disposal facility (Little Hocking Service Center) located just west (< 1 mi) of the LHWA site. This additional waste facility receives (or did receive) wastes that may contain PFOA for incineration from another DuPont facility. It is not clear if incineration is still occurring on this site or what other activities have occurred or are still occurring at this site. Current air emissions, where appropriate, should be assessed from this facility as they could contribute to the level of PFOA observed at the LHWA site through atmospheric deposition. At the same time the local meteorology needs to be better characterized to help develop better models for predicting the current levels in the local atmosphere. In addition, the DuPont report should include a clear summary of the past and current activities at the site as well as details on anything stored above or below ground at the site. If this is not known, a comprehensive survey should be performed and reported on accordingly.

Although it does appear that PFOA air emissions have been a substantial contributor to PFOA groundwater contamination, a rough mass balance estimation would help to validate whether this route could indeed yield such extensive and high PFOA concentrations in groundwater. Also is should be noted that the presence of PFOA in rainwater alone is not sufficient proof of the air-soil-groundwater transport pathway given the essentially universal observation of PFOA in rain across North America (see Scott et al., 2006). The absence of mass balance calculations for this transport pathway makes it very difficult to interpret the observed data and make inferences regarding likely past, present, and future trends in PFOA concentrations and potential exposures.

Some of the data (e.g., high PFOA concentrations in a deep soil boring in 2002 between LHWA and the river bank (LHWAS2 in Appendix 4.1) suggest that other sources may contribute, including the potential that pumping may have induced the flow of water from the river along specific flow paths, pulling with it contaminated water leaching from the Anaerobic Digestion Ponds. (The same process of pumping that causes the river to recharge adjacent groundwater, and has been proposed to minimize off-site transport of leachate from the Washington Works Site), may occur at the LHWA site as well. In places where the river water intersects groundwater naturally or where it is induced (e.g., by well pumping), sediment can serve as a PFOA source to groundwater. It is also plausible that this is a highly sorptive and/or impermeable lens at this depth but it was hard to decipher the boring log from 2002, which states that problems were encountered with the temporary boring.

3.3.4 Local, Dry Run, and Letart Landfills

In some cases the panel differed with some of the conclusions about soils underlying the landfills being sufficient to minimize leaching from the landfills; however, since the landfills have been or will soon be capped, details of our concerns in this area with regards to 'current' PFOA sources and emissions may not be warranted. Prior to capping, runoff or percolation of precipitation through the PFOA-containing materials released and leached PFOA to the bottom of the landfill and then followed the direction of water flow, including along the clay bottom of the landfill and into underlying clays and fractured bedrock below the landfill. Covering of the landfills should substantially reduce leaching from the landfill as some of the limited data show.

The Local Landfill (three landfill cells) was covered in 1980 with low-permeability soil that reduced infiltration of precipitation. Surface water and leachate from these cells flow to leachate collection ponds, then to storm sewers on-site and discharge to the Ohio River. At Dry Run Landfill, a permanent engineered cap was constructed in 2007, which should eliminate precipitation infiltrating through the landfill. A GAC-treatment system was installed in 2006 that removes PFOA from surface water discharging from the landfill's permitted outlet. Leachate at the Dry Run Landfill is sump pumped and treated at the Washington Worksite. The Letart Landfill, which contributed the highest levels of PFOA, was permanently closed and an engineered cap installed in 2001, which again should eliminate infiltration of precipitation through the landfill. Concentrations from the landfill in 2002 (post cap) are still substantial in some cases (Table 5.20). In 2006, a GAC treatment system was installed to remove PFOA from surface water and leachate discharging from the site's permitted outlet into the Ohio River. It is not clear if recent data have been collected for the area under the Letart landfill ponds where historically high concentrations were noted, and if PFOA in these zones is available for transport to groundwater and off-site. Therefore, although covering and capping of the landfills has reduced leaching and much of the surface water and leachate is being captured and treated, some additional data are needed on the PFOA concentrations currently in the water-bearing aquifer zones that can migrate off-site to small streams.

3.3.5 Comment on Ranking of Exposure Pathways Related to Groundwater for SLEA

There have been three separate residential water supply surveying and sampling programs pre- and within Phase I and II to date, which included public works and private wells. For water supplies with ≥ 0.05 µg/L (initial sampling program) or ≥ 0.5 µg/L PFOA (later sampling programs) levels, treatment systems were set up for the most part or alternate water sources were

provided. The range in concentration of PFOA measured in residential drinking-water supplies is from 'not detected' to a maximum of 22.1 µg /L. However, in assessing exposure from this water source, a conservative approach was taken (concentration data from pre-GAC treated water were used), which typically may be considered a safer approach, except in this report, the relative importance of all other modes of exposure are being decided based on this conservative approach used for drinking water. As discussed further in Section 3.6, this bias could result in inappropriately discounting other exposure pathways. Exposure estimates should be made for GAC-treated or alternate water supply versus untreated water before comparing drinking water exposures with other pathways.

3.3.6 Specific Data Needs

- Additional data associated with potential contamination of groundwater and migration to off-site streams from the ponds and contaminated layers in or near the water-bearing zones under the former (closed and capped) landfills are warranted including some post monitoring of the water-bearing zones associated with the Riverbank Landfill and Anaerobic Digestion ponds that will have an engineered cap system.
- Additional assessment as to whether or not pumping at LHWA induces any unexpected hydraulic connection between the groundwater associated with the Anaerobic Digestion ponds is suggested as well, given the high PFOA concentrations observed in the wells immediately north of the ADP even after pond material was removed. Modelling in conjunction with previously reported data from USGS for the Parkersburg region was used to how industrial pumping on both sides of the Ohio River affected PFOA transport on and from the Washington Works site. Validation of this modelling effort with the collection of additional data is needed to remove the current uncertainty that exists. Options include monitoring for PFOA of existing or new wells on the bank of the river, monitoring of water level measurements on both sides of the river to determine drawdown in conjunction with recorded pumping conditions. Further, tracer tests should be used to delineate potential pathways between the LWHA and former-ADP area in/under the river bed, which will significantly reduce the source of uncertainty associated with only a modelling effort.
- Clarification regarding the potential off-site transport scenarios that may occur if pumping at the Ranney Well, the DuPont-Lubeck Well Field, or the East Well Field were to cease for some period of time is needed.

- During the site meeting, questions arose regarding underground injection wells at the WWP site, which were later confirmed in public records. Although this practice has ceased, it should be mentioned in the report as well as details on the characteristics of the injections (what, when, how much, under what pressure) and what the potential was for migration (horizontally and vertically)

3.4 Biota

The review is focused on the accuracy, scientific quality, and adequacy of the data for PFOA in biota for evaluating biota as a pathway of PFOA migration and exposure by humans. In particular, the completeness of the biota PFOA data for screening level exposure assessment (SLEA) is evaluated.

Three types of biological samples have been analyzed for the determination of PFOA levels in this study. These are fish samples (n=20 for the Site plus n=20 for the background), meadow voles (from Little Hocking Water Association, n=10), and grass samples (from off-Site and on-Site locations). The PFOA data for fish filet have been used in human exposure assessment with anglers as receptors. The PFOA data for grass have been used in the extrapolation of concentrations that could be found on home-grown produce. Based on this extrapolation, home-grown produce has been identified as an important potential source of exposure in the local population. However, this extrapolation has introduced some uncertainties and the screening level exposure assessment (SLEA) has identified this data gap for future study and refinement. While home-grown produce and domestically produced milk have been identified as important data gaps (i.e. in the future data needs report), other biological matrixes which are potential pathways of migration of PFOA to humans in the vicinity of the Site have not been discussed. The following sections describe these pathways and resulting data gaps and uncertainties in SLEA for PFOA exposure from biological media.

3.4.1 Farm produce and local population/farmers

The overall conclusion of the SLEA is that ingestion of drinking water (both public service district and private sources) has been the greatest route of PFOA exposure by the local population (within a 2-mile radius from the Site). However, groundwater and surface water (from the Ohio River or other streams or ponds) may be used as a source of drinking water for livestock and for irrigating crops by local farms. Thus, locally produced meat, milk, farm- and home-grown

produces (fruits and vegetables), can be potential routes of exposure in populations which consume these products. Although the reports have argued that airborne deposition has been the only source of PFOA to crops and crop products, studies have documented that PFOA is efficiently transferred from contaminated soil to crops, including corn stalks, by systemic uptake (Stahl et al., 2009; Archives of Environmental Contamination and Toxicology, in press). Feeding of livestock with fodder and other crops grown on PFOA contaminated soils can result in food-chain transfer of PFOA in and around the Site and the landfill areas. Currently, no data are available for locally grown farm produce and home-grown produce (fruits and vegetables), meat (beef and poultry), milk and eggs. The "Future Data Needs Assessment Report" has acknowledged the existence of this data gap and suggested the need for future studies to address it.

According to the USEPA, approximately 37% of households in the South have home gardens. Modeled exposure analysis has indicated that consumption of locally grown crops, meat products, and milk could contribute exposures similar in magnitude to intakes of PFOA obtained via ingestion of drinking water. A community exposure study conducted in the vicinity of the Washington Works Site (Little Hocking Water Association) found an association between serum PFOA and servings of home-grown fruits and vegetables (Emmett et al., 2006). There are two potential data needs that have been identified in the SLEA report; (1) locally grown produce from home gardeners and (2) locally produced milk to assess exposures in farmers and home gardeners. However, locally produced meat including beef, and locally produced crops (from the farms), have not been identified as potential routes of PFOA exposure to the local population. Farm produce and home grown produce in the vicinity of Dry Run Landfill and Letart Landfill were not studied for PFOA contamination.

Overall, there are uncertainties in the estimation of exposure to PFOA by farmers and the local population who consume locally grown farm produces and home-grown produces. There is a need to determine concentrations of PFOA in home-grown vegetables and fruits, locally grown farm produce (including fodder), milk, and meat (beef and poultry). This should be done not only for the homes located within a 2-mile radius of the Site, but also for the farms located along the Ohio River. Data for biota (farm produce, home-grown produce, milk, and meat) from the Dry Run Landfill and Letart Landfill are needed to accurately assess the exposures in these locations. Thus there exist data gaps and uncertainties in exposure assessment for farmers and local populations consuming locally-produced food products.

A specific concern is raised in the specification of the root uptake model presented in Appendix 3 of the SLEA. There uptake is modeled based on the 'Kow', which is really not directly applicable for ionizables without considering several other parameters (pH, ionic matrix, type of ion), and is particularly inappropriate for a compound like PFOA.

3.4.2 Fish and Anglers

The relative importance of consumption of locally caught fish (in the vicinity of the Site and the landfills) as a route of exposure to PFOA by anglers and others who consume locally-caught fish has not been adequately assessed in the SLEA. For the SLEA, data from two species, with a total of 20 samples (n=10/species; largemouth bass and channel catfish), caught near Washington Works outfall in October 2005 have been used. No fish samples were collected from other surface water locations along the Ohio River or near landfills, although several of these surface waters are accessible to anglers and local populations. Filet data were used in the calculation of exposure point concentrations (EPCs). The more typical exposure (MTE) and reasonable maximum exposure (RME) values for PFOA in fish filet collected from the Site were 1.4 and 2.7 ng/g, wet wt, respectively. This value appears to have been derived by averaging PFOA concentrations found in fish from a background location (n=20) in addition to Washington Works facility samples (Table 5.7 of data assessment and Table 3-2 of SLEA). Although no considerable difference was found for PFOA levels in largemouth bass filet collected near the Site's outfall and the background location, the representation of PFOA data from two fish species with a limited number of samples collected at one point in time introduces uncertainties in the exposure assessment. In other words, PFOA levels determined in the two species of fish (largemouth bass and channel catfish) may not represent conservative or health-protective concentrations for fish consumed by anglers in the study area.

PFOA levels in fish can vary depending on the species, feeding habits, gender, and time of sampling (pre-spawning versus post-spawning). Largemouth bass and channel catfish samples were collected in October, which represents a post-spawning season. There is a consumption advisory for largemouth bass and channel catfish collected along the Ohio River (Ohio EPA, 2008), including Washington County, which suggests that these fish may not represent what anglers would catch or consume. In a recent survey of Ohio River tailwater anglers, 51% of anglers interviewed were fishing for multi-species, 1% were fishing for black bass (includes largemouth bass), 5% for catfish, 15% for hybrid striped bass, and 27% for sauger and walleye

(US Fish and Wildlife Service, 2004). In order to obtain a representative EPC value for fish, PFOA data from two species (n=20) collected at one point in time are not adequate unless it has been demonstrated that PFOA concentrations are expected to be no higher in other frequently consumed species. The current estimate of PFOA exposure for anglers is not demonstrated to be conservative and may be an underestimation of the actual exposure.

No data for PFOA in fish from waterbodies near the landfill areas (Dry Run and Letart Landfills) are available. PFOA data for fish from Lee Creek, in the general vicinity of the Dry Run Landfill, are not available. Fish tissue PFOA data from the Ohio River in the immediate vicinity of Letart Landfill are not available. The assumption that fish may not contribute to significant PFOA exposure (relative to drinking water) near landfills is not adequately justified, especially in the absence of data. For example, the current model suggests that PFOA exposure from fish consumption is 2 to 4-fold lower than that by drinking water in the vicinity of Letart Landfill (Page 6-6, Sec 6 SLEA report). However, a two-fold increase in EPC concentration for fish (from 1.4 ng/g to 2.8 ng/g) or a two-fold increase in ingestion rate would make the above assumption inaccurate. Furthermore, the SLEA is expected to provide a conservative assessment of exposures with a due consideration of all potential pathways of exposure. Several surface waters within the 2-mile radius of the Site have not been sampled for fish (e.g., Lake Washington) and these waterbodies are accessible to the local public and anglers.

For the exposure assessment of PFOA by anglers (Table B-25 SLEA report), fish ingestion rates of 0.095 g/kg-day (for MTE) and 0.56 g/kg-day (for RME) have been used (for adults). These values are based on the general population fish ingestion rates (6.65 g or 39 g for an adult weighing 70 kg/d; http://www.epa.gov/waterscience/fish/files/consumption_report.pdf). These values potentially underestimate fish ingestion rates for anglers. Ingestion rates of freshwater fish by subsistence anglers are provided in Table 10-84 of the USEPA (1997)'s Exposure Factor Handbook. The 95th percentile value for subsistence anglers is 170 g/day (95th percentile) and the mean fish intake rate is 59 g/day (Table 10-85 of EPA's Exposure Factor Handbook). The values used in the assessment are approximately 4- to 9- fold lower than the values suggested by the US EPA for anglers' typical ingestion rates. There is a need to evaluate differences in exposures between 'subsistence' and 'recreational' anglers and fish consumers.

If a conservative exposure screening does not screen out the fish consumption pathway, a survey (of local anglers) would provide more reliable information regarding type and frequency of fish

species caught and the consumption amount. If the fish consumption pathway is carried through to the next stage of risk assessment, collection of several species of sport-fish and subsistence fish from several locations along the river (to take into account the migratory patterns of fish) at different seasons is recommended for the calculation of EPC.

3.4.3 Breast Milk and Infants

Several population groups (receptors) have been identified for the SLEA. The exposure assessment considered adult, adolescent and child populations to reflect different behaviors and physiological parameters. One population group that is not identified as a receptor for the SLEA is 'infants'. There is a potential for elevated exposure to PFOA by infants via the ingestion of breast milk of the local mothers. The serum levels of PFOA in the local population (e.g., population from Little Hocking Water Association – 423 ng/mL in 2004; Emmett et al., 2006) are 100-fold higher than the U.S. general population (4 ng/mL) levels. The SLEA has identified that there exists a relationship between drinking water concentrations and breast milk concentrations of PFOA and that infant exposures from the ingestion of breast milk might be similar in magnitude to the estimated drinking water exposures for children (Page 3-26). The early life stages are very sensitive to exposure to toxicants and it is important to provide information on exposure pathways and exposure levels in infants in the vicinity of the Site. There is a need to conduct a conservative screening analysis for infant exposures via breast milk based upon current conditions of emissions and treatment to determine if there is a need to collect breast milk samples in the area (in the vicinity of the Site and the landfill areas as well as some reference/background locations).

3.4.4 Game Animals and Hunters

Hunting and gaming has been identified as a recreational activity in the region. Among several receptor populations and sources identified for the SLEA, ingestion of game animals was not identified as a pathway of exposure. Ingestion of harvested game can be a source of exposure. However, no game animals have been collected and analyzed for PFOA. A few grass samples collected within 2 miles from the Site contained several tens to a few hundreds of ng/g concentrations of PFOA. Herbivorous animals (deer, rabbits) can be exposed to PFOA through consumption of grass and other plants. There is a need to conduct a conservative screening analysis for this pathway to determine if it is necessary to analyze PFOA in deer, rabbit, pheasant, turkey, quail, and duck for the assessment of exposures in hunting and gaming populations. While home grown produce has been identified as a pathway of exposure, home raised game are

not considered as a pathway of exposure. Home raised game animals including chicken can be a source of human exposures to PFOA.

3.4.5 Summary of Key Concerns Regarding Biota Measurements

Overall, while it is acknowledged that considerable effort has been put forward in developing these reports and compiling all the available data from the Site, there are data gaps, especially in characterizing PFOA in biological media, which can play an important role in the migration of PFOA on and around the Site. Furthermore, biota can be an important pathway of PFOA exposure to the local populations. There is a need to determine concentrations of PFOA in several biological matrixes to accurately assess exposures. Although home-grown produce and domestically produced milk have been identified in the Future Data Needs Assessment, it is recommended that PFOA data for farm produce, home-grown produce, locally produced meat, milk, fish from surface waters, breast milk samples and game animals (game hen) are needed, to account for potential biological matrixes that would contribute to exposures. Several aspects of the SLEA, as described in the reports, require further, more-adequate justifications. For example, exposure assessment of PFOA from the ingestion of local fish by anglers involved several non-conservative assumptions on fish species, ingestion rates and concentrations in fish. These estimates have introduced uncertainties that could potentially lead to an underestimate of actual exposures by up to 1 order of magnitude. There is a need to refine the exposure models for fish consumption. Other biological media such as breast milk and game animals should be identified as potential exposure pathways to PFOA for certain subpopulations. Justifications are required to explain why these pathways are not considered in the current report and/or these pathways should be identified in the 'Future Data Needs Report" for future study.

3.5 Multimedia Fate, Transport, and Exposure Pathways

The foregoing chapters of this peer consultation have addressed the assessment of PFOA levels in specific media. Here we consider multimedia issues in the reports, and in particular whether the report has addressed multimedia transport of PFOA such that the pathways of migration from release to exposure are adequately characterized on a screening level basis.

For the pathways of migration from release to exposure to be adequately characterized on a screening level basis, we expect the following to be satisfied:

1. The major pathways of migration from the source to the exposure media should be identified.
2. A basic understanding of the processes governing this migration and the major factors influencing these processes should be demonstrated.
3. A semi-quantitative description of the mass flows along the major pathways of migration from the source to the exposure media should be presented.
4. Sufficient field data should be presented to demonstrate that the basic understanding of the major processes and the semi-quantitative mass flow calculations are roughly consistent with the reality in the study area.

Our conclusions can be summarized as follows:

1. The site conceptual model adequately describes many of the transport pathways to people living close to the source. However, neither the exposure to PFOA nor the pathways of migration for people living more distance from the plant are characterized. This deficit is judged to be particularly serious for the population exposed via river water downstream of the site.
2. The site conceptual model appears to be factually incorrect in its placement of the SWMU and its correct location, on the rim of the river. The conceptual model also omits a potential transport pathway from the SWMU into the Ohio River and a pathway into groundwater that may also flow away from the Site.
3. Migration within media (air and water) has been addressed elsewhere in this peer consultation. There appears to be a basic understanding of some intermedia transport processes (e.g. river water to ground water). However, several intermedia pathways of migration of PFOA are not yet understood at a basic level. Deficits exist particularly regarding the transport of PFOA from surface soil to groundwater, and from air and water to food.
4. A semi-quantitative description of the mass flows along some partial pathways of migration is presented (e.g. from air to surface soil). However, no assessment along the entire major pathways (e.g. air – surface soil – groundwater – drinking water) is provided.
5. Data were collected and assessed to evaluate the atmospheric transport and deposition to soil following emissions to air at the Washington Works site. Data were also collected in surface water, but no effort was made to assess the relationship between emissions to surface water and transport via surface water. Measurements were conducted that

supported the understanding of the relationship between atmospheric emissions and deposition to terrestrial surfaces, but no effort was identified that evaluated quantitative understanding of the link between atmospheric emissions and the levels in groundwater from the unsaturated or saturated zones. Measurements to assess the transfer of PFOA from air and water to food are fully absent.

3.5.1 Pathways of Exposure from the Site to Exposure Media

The site conceptual model adequately describes the likely dominant transport pathways to exposure media close to the Site. These include emissions to air – atmospheric transport – deposition to soil – transport to groundwater – contamination of drinking water / food, emissions to surface water – transport to groundwater – contamination of drinking water /food, and leakage from waste sites to groundwater – contamination of drinking water / food.

However, the transport pathways to exposure media more distant from the site are not addressed in the reports. One of these is atmospheric transport beyond the study area – deposition to soil – transport to groundwater – contamination of drinking water / food. A mass balance approach was not reported in assessing the atmospheric dispersion of PFOA emitted at the sites, and hence it is not possible to evaluate the degree of attenuation of PFOA deposition with distance from the plant.

A second transport pathway to exposure media distant from the site is river water – groundwater – drinking water. This pathway should be given particular attention, since attenuation of the PFOA concentration in river water with distance from the sites is expected to be very low due to the persistence and hydrophilicity of the chemical. Since bank filtration is a common method for obtaining drinking water, this pathway could result in high exposures for populations distant from the Site

3.5.2 Understanding of the Processes Governing PFOA Migration

Migration within media (air and water) has been addressed elsewhere in this peer consultation. The key transport processes between media are:

- Water – groundwater
- Atmosphere – surface soil
- Surface soil – groundwater

- Groundwater – drinking water
- Groundwater – food
- Atmosphere – vegetation – food

Water – groundwater exchange of PFOA is postulated to be the consequence of advection of water between the two media, presumably with little retention of PFOA in solid material. The similar concentrations measured in groundwater and aquifer material (e.g. Appendix 4.1) makes this a plausible assumption. The presence of unexplained high levels of PFOA in soil with high organic matter (see below) suggests, on the other hand, that retention in sediment could be a relevant factor in this process. Nevertheless, this is an appropriate worst case approach for a screening level evaluation.

Atmosphere – surface soil transport was assessed using the model AERMOD and good results were obtained, suggesting that there is sufficient understanding of this process.

The information on surface soil – groundwater transport provided in the reports is inconsistent. In Appendix 5.3 it is argued that the surface soil samples represent long term accumulation, while elsewhere in the report (e.g. Part 1, sections 4.3 and 5.2.4) it is argued that PFOA is highly mobile in soil and will be washed out of surface soil in single rain events. This indicates that there is not a basic understanding of PFOA transport from surface soil into the sub-surface unsaturated zone.

Transfer from groundwater to drinking water is not a controversial issue for these chemicals. Information on the efficiency of purification techniques is available.

There is very poor understanding of the transfer from groundwater to food. This is acknowledged in the reports.

The transfer of PFOA from the atmosphere to grass is not sufficiently understood. Observations suggest that at least 75 % of the residues in grass are from atmospheric deposition (Part 1, section 5.4.4) while modeling suggests that it is just 1-5 % (Part 2, Table C-3). Consequently the transport from the atmosphere into food is also not understood. This is acknowledged in the reports.

3.5.3 Quantification of PFOA Mass Flows Along the Major Pathways of Migration

A quantification of PFOA mass flow from the atmosphere to surface soil is presented in Appendix 5.3. However, no assessment along the entire major pathways (e.g. air – surface soil – groundwater – drinking water) is presented. Here it would be important to differentiate between the contribution of current and past emissions to current exposure, and to assess how both the exposure and the relative contribution of current and past emissions can be expected to change in the future as a result of control activities.

3.5.4 Site-Specific Empirical Evidence to Support the Semi-Quantitative Understanding of the Major Pathways of Migration

Water – groundwater

The transfer of PFOA following air emissions to surface soil was studied and reported on in Appendix 5.3. Good agreement was found between predicted and observed concentrations in surface soils. This work is considered sufficient for a screening level assessment.

Although information on PFOA emissions to the Ohio River as well as PFOA concentrations in the Ohio River is available, no effort was made to assess whether this information was internally consistent. If the levels in the river are higher than predicted from the emissions, this would give evidence of further sources, and vice versa.

No empirical evidence was identified to support the understanding on PFOA transport from surface soil to groundwater (or rather, to resolve the contradictions outlined in 3.5.2). Appendix 4.1 presents evidence on the vertical distribution of PFOA in soil and groundwater at several locations. However, no evidence is presented on vertical fluxes and how these relate to chemical concentrations in surface soil and environmental conditions.

No measurements have been done on pathways leading to food. This is appropriately identified as a future data need in the reports.

3.6 Human Exposure

Earlier sections of this peer consultation have addressed the adequacy of characterization of PFOA concentrations in exposure media. This section addresses broad issues related to utilizing those data in estimating human intakes in the screening level exposure assessment (SLEA). We

begin by revisiting the conceptual exposure model and commenting on its completeness, and then address the general exposure assessment methodology, exposure point concentration calculations, specific exposure parameters, and the uncertainty analysis. We conclude our assessment by discussing how limitations in the exposure assessment may affect the reliability of the conclusions and identification of data needs.

3.6.1 Conceptual Exposure Model

Updated conceptual exposure models are described in SLEA Section 3.2 and presented in SLEA Figures 3-3 and 3-4. With the exceptions noted below, the exposure pathways and routes of exposure included in the model appear appropriate, though in many cases they are not yet well developed for the local conditions. This is an essential component of a revised plan for exposure assessment and the collection of samples to appropriately support that assessment. The selected receptors also represent an appropriate range of activities by which people might contact the affected exposure media; however, no effort was made to sample time-activity patterns of the local population, or to validate the appropriateness of the selected receptors to behaviors exhibited by those potentially exposed to releases from the Site. Generally, Figure 3-3 provides a clear pictorial description of PFOA release and transport processes (although, as noted above, the location of the ADP and RBL is incorrect and misleading). Consistent with standard risk assessment methodology, Figure 3-4 documents the exposure media and exposure routes relevant for the various receptors. For each receptor/exposure medium combination, symbols indicate the completeness of the exposure pathway and data availability. Several comments are provided on this figure:

- According to the figure domestic use of groundwater is anticipated to result in both ingestion and dermal exposures. Inhalation exposures are not included. We recognize that PFOA is water soluble and typically present as an ion, and consequently not expected to volatilize from hot water; however, inhalation should still be included in the conceptual model with a note regarding the limited potential for exposure via this route.
- For sediment, for all receptors both ingestion and dermal exposures are reported as being either incomplete (i.e., "—") or potentially complete but with expected exposures less than other receptors (i.e., "O"). This is not logical. A shaded circle or black circle must apply to at least one receptor for this medium. We recommend that shaded circles be applied for both the offsite swimmer and offsite angler for ingestion and dermal contact with sediment.

- As described above, it is recommended that consumption of game and exposure of infants via breast milk be added as exposure pathways.

3.6.2 General Exposure Assessment Methodology

The general approach used in the SLEA is consistent with EPA guidance for calculating intake estimates for use in risk assessment. *The main limitations in the general methodology are that i) the SLEA does not make sufficient effort to obtain and use local exposure concentrations, and exposure factors and behaviors for the local population; and ii) the SLEA does not explain how the resulting intake estimates will be used in assessing risks.* These issues are each addressed.

A Screening level exposure assessment for perfluorooctanoic acid (POFA) was completed by *Environ* to provide a first-order analysis of potentially completed exposure pathways (media) and exposure routes (entry into the body) among the three sites that were the subjects for study. The sites used in the analyses were the Washington Works Facility and Local Landfill, the Dry Run Landfill, and the Letart Landfill. In each case the screening exposure characterization suggested drinking water to be a major route of exposure to PFOA. The estimates for drinking water are based upon site data, and the authors used various assumptions (some of which not explained) about whom and how they would be exposed to PFOA. Little or no data are available for the other exposure pathways (e.g. air, soil ingestion, food etc.)

The authors used information from EPA guidance documents during the completion of their analyses, and applied general exposure factors to replace missing or unavailable information and data. Five or six types of individuals were selected as the target receptors at each location. These included: offsite resident/home gardener, offsite resident farmer, offsite commercial worker, offsite creek visitor or recreational visitor, offsite angler, and offsite recreational swimmer. For the drinking water route of exposure these are reasonable populations. However, many of the activities and the frequency of activities used to estimate exposure to these hypothetical individuals were speculative. All calculations are based upon a reasonable maximum exposure (RME) or mean typical exposure (MTE) to represent high end and central tendency levels of exposure, respectively. In principle this analysis plan was a logical undertaking.

At the present time, there is no information provided in the document that assists in providing a validation for the baseline assumption used for each "receptor" person/population. In most cases, the analysts use national data on percentages or frequency of activities to base their exposure

estimations for each location, but fail to describe the uncertainties associated with applying these assumptions to the population being evaluated. Demography and land use patterns in the study area are not given. There is a need to describe demography and land use patterns to evaluate if the SLEA is appropriate and covers all of the population in the region. The demographic characterization should describe the population distribution, industries and occupations, agricultural land use, livestock production, anglers and type of fish, game animals and hunters.

Further, as described in earlier sections, there is limited PFOA concentration data available for exposure routes other than drinking water in two of the three locations (the Dry Run landfill, and the Letart Landfill). The available PFOA data were collected primarily around or near (within 2 miles of) the Washington Works Facility, and some data were available for multiple exposure pathways. However, the number of data points is limited for some pathways even for the Washington Works Facility site, e.g. fish. No PFOA air concentration or fish concentration data were available for the other two locations. Further, data were not collected for PFOA in homegrown crops and other food product at any of these locations. As a result, extant data were used in the analyses, but not from locations of similar character. For the homegrown food consumption estimates, there is no justification provided for the assumption that the national values used would be reliable for estimating exposure in a location near a major source of PFOA or a site of PFOA disposal. The authors rely on modeled estimates of PFOA concentrations in home grown food, meat and animal products (milk, and edible fish). For produce the model includes direct deposition and root uptake based on soil and groundwater EPCs. Since it is clear that drinking water can be a major pathway for exposure, consideration of the use of local tap water contaminated with PFOA in the preparation of food should be addressed, in addition to the uptake while food is being raised. The lack of data for site-specific exposure characterization is also identified as a limitation of the current study in our review of other media concentrations, including biota, presented above.

Except for drinking water, which has a reliable database for estimating local exposure at all three locations, most of the data and estimates are presented as part of an *uncertainty analysis*. While an uncertainty analysis is certainly appropriate, it must first be preceded by a thorough documentation of what was done to obtain as much local data as possible, and how these data were used to obtain best estimates for the targeted exposures. Unfortunately, there is little or no local data that was collected or used to serve as a basis for many of the exposure route estimates completed for each location. Local data were neither used to estimate PFOA exposures for most

routes considered, nor to validate and compare against the national estimates that were generated. This raises questions regarding the significance of other (non-drinking water) exposure pathways and the levels contributed by different pathways to one or more of the routes of exposure. The information base for the exposure assessment is not site specific, which is a major weakness that permeates the screening exposure characterizations. What actually is required are sampling programs to collect data for the observed routes of exposure. Such data could be used to support or contradict the conclusion of an uncertainty or sensitivity analysis.

The SLEA is also generally lacking in any discussion of background exposures to PFOA in the general U.S. population as a separate section that is divorced from the site specific exposure assessment. This information is needed to properly assess incremental exposures associated with the site. Information on PFOA in packaging and PFOA released by various cooking utensils and practices would be a valuable addition to any revised analysis plan to deal with confounders in the analysis of contributions associated with food consumption. A list of confounder sources that will have PFOA also needs to be identified to determine the significance of the local contributions versus the general contributions to PFOA for many different exposure pathways and sources.

The different activities selected to represent the receptor populations need additional documentation. This could be accomplished by a survey of the population to see if, for example, people do swim in the Ohio River, fish in the Ohio River and eat the caught fish at the frequencies defined by the analysts. Further, it would be interesting to see what percentage of the population eat home grown or raised food and animal products that is contaminated by PFOA. Local surveys are needed for these and related exposure factors.

The calculations of intake dose after exposure do not take into account variation in relative bioavailability of chemicals in different exposure media and, at a minimum, known physiological factors about absorption for different routes of contact. In all cases the authors assume a default relative bioavailability value of 100%. This may be an incorrect assumption, and can lead to overestimation of the potential dose. On the other hand, an activity, showering does not include inhalation of PFOA, and swimming does not include dermal absorption (See table B.1 in the report). Dermal effects have not been observed for some workplace populations so the dermal contact may be deminimus for irritation, but how well is it absorbed? This can influence the

significance of bathing or showering on the internal dose. The potential impacts of these uncertainties should be addressed in the SLEA.

The panel also notes concern regarding the estimation of the dermal exposure permeability coefficient. For exposure assessment by dermal contact through surface water (while swimming), a K_p (permeability coefficient) value of 1.5×10^{-6} cm/hr has been used. This value was obtained from an in vitro study (which does not represent dynamic in vivo conditions of body temperature, blood circulation, pH, etc that a swimmer would experience) based on the reference Fasano et al. 2005. The study by Fasano et al, used APFO, not the PFOA anion. As the report has indicated, there are differences in the behavior of these two forms of PFOA. Furthermore, the APFO concentration used in the in vitro study was 20% salt, not environmentally relevant ppb or ppt level water concentrations. Fasano et al. have cautioned in their article that "in vivo predictions using an in vitro derived value should be used with caution until an appropriate in vivo validation study (e.g., an in vivo dermal exposure with measured blood levels of APFO) is conducted". Owing to this uncertainty associated with the use of this K_p value in the exposure assessment from surface water, the value should be deemed non-conservative or an underestimate of the actual exposure. An assessment of exposure using such laboratory-based in vitro values would require inclusion of uncertainty factors.

3.6.3 Interpretation of Significant Exposures in Light of Potential Health Risks

For most chemicals intake estimates are combined with inhalation and oral toxicity values to estimate cancer and noncancer risks for inhalation and for ingestion and dermal contact combined. There are no generally accepted toxicity values for PFOA, so reliance on the standard approach would rely on the development of such values. Alternatively, it could be possible to combine the intake estimates with a PBPK model to predict serum PFOA levels. The serum levels could then be compared with both background levels and levels suspected of causing adverse effects in humans. The lack of information regarding how the exposure estimates will be applied may lead to incorrect conclusions in the SLEA. For example, the conclusion that inhalation exposures are low compared with other exposure routes is irrelevant if the lung is a target organ and inhalation risk will be assessed separately from ingestion and dermal exposure.

Other concerns we have with the analysis include:

- the lack of detail provided to document specific exposure parameters,

- the lack of objective analysis of the relative degree of uncertainty for the different exposure pathways, and
- conclusions about the relative importance of different exposure pathways that fail to acknowledge present reduction in drinking water exposures due to treatment of groundwater prior to use.

The reliance on comparison with drinking water exposures as a basis for discounting the importance of other exposure pathways is particularly problematic and misleading. We understand that the intent is to assess the current drinking water status in the next iteration of this document, but this document should not appear to discount the relative importance of other exposure pathways based on a comparison with drinking untreated groundwater because that comparison does not reflect current conditions with widespread water treatment in place, i.e., pathways that seemed minor compared to drinking water exposures prior to water treatment, may now contribute a much greater fraction of total exposures.

To address this issue, we recommend that the executive summary and introduction specify that in this document "current" exposures are defined as those occurring during the five-year period from 2002 through 2006. It should also be noted in these two places that a subsequent analysis will address exposures following the installation of water treatment systems. We recommend that the next analysis also consider the variation in drinking water exposures based on variations in the effectiveness and variability of water treatment over time for both public water systems and private well users.

The five year exposure duration used in the SLEA is a departure from standard risk assessment approaches and also requires an early explanation in the document. Most risk assessments use a longer exposure period to assess chronic exposures. Again, because the risk assessment approach has not been described the implications of the use of a subchronic exposure period are not clear. Assuming only noncancer endpoints will be evaluated, and using an averaging time matched to the five year exposure duration, the estimated intakes should still provide an accurate indication of exposure. However, this needs to be explained. The only way the panel could determine that the correct approach had been used was to comb laboriously through Appendix B to find the averaging times used.

3.6.4 Exposure Point Concentration Calculations

As described in the SLEA Appendix B (Section B.1), EPCs were calculated using standard EPA ProUCL tools, except that the distributions of the datasets were not tested. Instead nonparametric methods were used, specifically the bias-corrected accelerated (BCA) method using the Kaplan-Meier approach. Also in some cases mean values were used as inputs to ProUCL for individual sampling locations with more than one sampling result. Overall, review of the exposure concentrations presented in Table B-4 suggests that the method used to calculate EPCs has a limited impact on the values used on the SLEA.

In contrast, as noted in Section 3.6.2, the modeled EPCs for produce, crops, meat, milk, poultry and eggs have a high degree of uncertainty and do not consider the potential added exposures from preparation of food using contaminated tap water.

3.6.5 Specific Exposure Parameters

As has been described above, in many cases inadequate documentation is provided to determine the conservatism of specific exposure parameters. The significance of this limitation is that it is not readily possible to asses the reliability of comparisons among exposure pathways. Appendix B (Section B.2 and associated tables) includes summaries of exposure parameters and notes regarding sources for the values selected; however, there is no discussion to support or justify the values. While some of the values selected are default values typically used by EPA at most sites, others are known to vary greatly from site to site. For example, the residential soil ingestion rates selected are those typically used by EPA, and their degree of conservatism can be directly assessed. In contrast, there are no widely applicable consumption rates for fish, homegrown produce and other local foods that can be applied at all sites without discussion to describe the rationale for their selection for a specific site. The reader of the SLEA cannot readily determine if the selected values are adequately conservative to capture the range of likely exposures. This deficiency directly limits the ability of the PCP to determine if there are critical data gaps associated with these exposure pathways.

3.6.6 Uncertainty Analysis

The SLEA is essentially a pathway screening analysis. For that reason the uncertainty analysis should include detailed discussions for each pathway and related routes of exposure that describe the underlying uncertainties in the available data and exposure parameters. Consistent with EPA guidance for uncertainty analyses, the discussion should specify the decisions made to address

these uncertainties, and the impact on the degree to which the resulting exposure estimates may over- or under-estimate exposures. We understand that a summary of this sort is provided in Table 6-1 (to support the data needs assessment); however, that table does not address uncertainty in the exposure parameters, and also does not clearly address the overall degree of conservatism in the exposure estimates.

For example, soil ingestion is not mentioned in the uncertainty sections and Table 6-1 indicates only that there is low contribution to intake, that a limited downwind dataset was conservatively applied to areas lacking soil data and that there is medium level of uncertainty in the dataset. The uncertainty sections should note the dataset limitations as described in Table 6-1, but should also describe the key assumptions for exposures parameters. These would include noting that the default EPA soil ingestion rates are likely to overestimate chronic daily soil ingestion rates, particularly at the upper percentiles used for the RME, and also that it was assumed that all ingested PFOA would be systemically absorbed, comparable to absorption of dissolved PFOA in drinking water, an assumption that may overestimate exposure substantially.

The uncertainty analysis should be the primary tool available to the PCP to understand which exposure pathways screen out, and therefore, do not need additional data collection or analyses to more fully characterize migration and exposure to PFOA (as directed in the charge). The absence of a comprehensive uncertainty analysis limits the ability of the PCP to execute the charge.

3.6.7 Conclusions and Identification of Data Needs

Major findings regarding the SLEA include the following:

1. Except for possibly drinking water, the screening exposure analysis does not appear to represent the local community "situations" since most of the data that are used are from other locations and would not be representative of any of the three sites.
2. The exposure analysis receptor scenarios selection process has not provided information on the actual local behaviors of the population that support the selected activities. The applicability and degree of conservatism of the assumptions used must be articulated.
3. The EPCs for PFOA found in food is based on deposition and uptake models. Local data on PFOA in home grown and raised foods are necessary, and the consumption practices for local foods need detailed evaluation for use in the exposure assessment.

4. The RME and MTE estimations use many assumptions that are not valid or justified for the local situation. Further, no effort has been made to tie the screening results to a known acute or chronic health outcome. What do the values for the RME or MTE mean in terms of potential health effects? There is no health slope factor or referenced dose provided, or comparison with data available from other locations where health effects have be demonstrated after exposures to PFOA have been identified.

5. There are PFOA data and questionnaire information available from the C-8 study for the local area. Further other studies external to the local area that can help to define the exposure issues and data needs more clearly are needed to conduct a screening analysis. A focus of attention should clearly be on proving that a major source of local exposure is drinking water.

6. The Washington Works Facility and Local Landfill should be the focus of any immediate revision for screening characterization since there are actual data available. Concurrently, the data needs must be thoroughly discussed and weaknesses removed with a better PFOA data collection plan.

7. Any revisions to the Dry Run Landfill, and the Letart Landfill screening exposure characterization must include a logical plan for data collection and re-analysis is finalized for the Washington Work facility that can be used in each of these locations.

8. The screening exposure assessment should be forward looking in perspective, and utilize the extensive biomonitoring data in the population that now receives the drinking water through the Little Hocking Water Association, other public systems and from private wells. The biomonitoring data should offer insights regarding the variability in exposures. The conceptual model for exposure needs to consider additional sampling based upon the recently established emissions from the stacks, and develop air and biota monitoring programs that can achieve the goals of a revamped program.

Section 6 of the SLEA presents the evaluation of potential future data needs. If the suggested changes are made to the uncertainty sections, the conclusions and identification of data needs can draw on the uncertainty assessment to make the basis for conclusions clearer. Our particular concern with the data needs discussion and Table 6-1 is the reliance on comparison of intakes from other exposure pathways with drinking water intakes to determine the relative contribution to intake. For example, Table 6-1 indicates that beef, poultry and eggs do not represent a data need because the screening model suggested intakes from these foods is 3 to 10-fold lower than drinking water intake. This logic is not relevant due to the present situation in which drinking water exposure for most residents has apparently been markedly reduced. Consequently, these

pathways could currently be contributing a substantial relative proportion to present day exposures. Section 6 and Table 6-1 must be revised to screen pathways without relying on comparison with drinking water intakes from 2002 through 2006.

3.7 Summary of Priority Data Needs for Future Study Phases

In anticipation of future data collection for PFOA characterization at and near the Site, we attempt here to describe what we believe to be the highest priority areas for further monitoring and modeling. These are reviewed below and may provide useful input in the design of Phase III studies for the Site. The recommended measurements include data needed to provide both better resolved estimates of exposure for the local populations, as well as for performing a mass balance calculation of historic and current PFOA emissions and environmental inventories.

3.7.1 Comprehensive Air Monitoring

PFOA air emissions were and appear to still remain a large contributor to contamination of drinking water via the air-soil-groundwater route, especially within a few mile radius of the site and possibly beyond. Although DuPont reports a substantial (two-order-of-magnitude) decrease in air emissions by 2006, the amount of PFOA actually being emitted now or in the past is not reported. Without this information, it is not possible to perform mass balance calculations for transport through the surrounding environment. A coordinated, ongoing air monitoring program is needed, including time coincident measurements of emissions, ambient concentrations, and deposition. Monitoring should include direct stack, ambient, and deposition monitoring at time scales sufficient to characterize long-term, seasonal, and diurnal variations in PFOA emissions, concentrations, deposition, and resuspension. Spatial resolution should be sufficient to address vertical variations in concentration that inform flux-deposition processes, and horizontal variations across key receptor locations, including the Ohio River, the LHWA well field, and more distant locations needed to determine the spatial extent of the Site influence. Air sampling should be extended to distances (horizontally) where the influence of local sources disappears and PFOA levels representative of atmospheric background levels are seen. This strategically holistic data set will not only quantify current emissions and exposure, but when coupled with a mass balance modeling approach (see Section 3.7.6 below), will enable the estimation of environmental loadings and exposures associated with historic emissions.

3.7.2 Spatially Extensive Surface Water Monitoring

A spatially comprehensive synoptic survey of PFOA concentrations in the Ohio River is needed to characterize the spatial extent and source-receptor relationships of water quality impacts from the Site. Given the small number of randomly collected Ohio River water samples that contain detectable levels of PFOA, a more-targeted sampling campaign should be pursued to address the extent to which fugitive emissions of PFOA travel downstream of their entry point. The sampling should be done, if possible, during one day to provide a snapshot of Ohio River contamination. The sampling day would necessarily be planned for a time period when actual releases are occurring at the Washington Works Site. Specific samples should be obtained in the immediate vicinity of each of the major outfalls and downstream, in line with the current (as opposed to a transect running perpendicular to the bank), and should extend downstream as far as possible, but in any case should include areas known to have drinking water contamination (e.g. at least as far downstream as Crab Creek or ~90 miles). Water samples and attendant sample concentrations should be constructed to yield quantifiable PFOA concentrations in all surface water samples. A few creeks and shallow water bodies (e.g., Brinker Run for Letart Landfill and Lee Creek for Dry Run Landfill) that flow through the landfills and sediments in these creeks should also be analyzed, as these creeks are conduits for PFOA to the Ohio River. High concentrations of PFOA are possible in these creek waters and sediments. Coincident fish, sediment and water samples as part of the synoptic water quality survey.

3.7.3 Intensive River Sediment Sampling

Bottom sediment samples need to be obtained from the Ohio River in areas immediately adjacent to Washington Works outfalls, upstream, and downstream, as well as downstream of the landfill sites. Transects should be designed to capture the extent of PFOA contamination related to a specific outfall and should include differential depth analysis. A related need is to sample a sediment transect running from the Site across the river to the LHWA. This transect would be designed to detect the existence of any seepage zones emanating from the Riverbank Landfill (RBL) that could potentially have released PFOA that subsequently migrates to the LHWA. Careful study and design will be needed to determine the appropriate depth(s) of sediment retrieval along with monitoring of the water-bearing zones associated with the Riverbank Landfill and Anaerobic Digestion ponds pre and/or post instalment of an engineered cap system, to thoroughly examine this potential PFOA transport pathway.

3.7.4. Groundwater Pump and Tracer Tests

Pump and tracer tests are needed to further explore possible hydraulic connections between the Ohio River waters near the Site and groundwaters on both sides of the river. These are needed to support assessments of the potential for off-site transport scenarios that may occur with changes in pumping of the Ranney Well, the DuPont-Lubeck Well Field, or the East Well Field, and whether or not pumping at LHWA induces any unexpected hydraulic connection between the groundwater associated with the Anaerobic Digestion ponds and waters that eventually enter the LHWA well field. Modeling in agreement with previously reported data from the USGS for the Parkersburg region indicates a groundwater divide under the Ohio River, which inferred minimal PFOA transport off the Washington Works Site. However, this modeling effort is in need of further validation, given the very high PFOA concentrations observed in the wells immediately north of the ADP (even after pond material was removed) and what appears to be increases in PFOA concentrations in the water being pumped out by the LHWA. The latter may be due to only contributions from wet/dry deposition and run off down the west slope of deposited PFOA; however, sufficient uncertainty warrants further data collection. Options include monitoring for PFOA in existing or new wells on the bank of the river and monitoring of water level measurements on both sides of the river to determine drawdown in conjunction with recorded pumping conditions. Further, tracer tests should be used to delineate potential pathways between the LWHA and the former-ADP area in/under the river bed. These pumping and tracer studies should significantly reduce the uncertainty associated with these potential groundwater-river water pathways.

3.7.5 Additional Biological Monitoring

There is a need to determine concentrations of PFOA in several biological matrixes to accurately assess exposures via biota to local populations. Although home-grown produce and domestically produced milk have been identified in the Future Data Needs Assessment, it is recommended that PFOA data also be collected for farm produce, locally produced meat, fish from surface waters, breast milk samples and game animals (game hen). These studies should be conducted in conjunction with ongoing biomonitoring surveys of the local population to better coordinate exposure and biomarker estimates. These studies could potentially point to other environmental media and routes of exposure requiring sampling and characterization, such as household dust or water distribution systems downstream of centralized water treatment.

3.7.6 Implementation of Multimedia Model to Evaluate PFOA Mass Balance in Nearby Environment

A multimedia mass balance modelling approach should be used to synthesize the available information on PFOA mass flow and PFOA mass inventory. This modelling should incorporate available mechanistic understanding of the transport and behaviour of PFOA in all relevant media, and address changes in emissions, transport, inventories and exposure over time. It should be used to test whether the available information gives a consistent and sufficiently resolved picture of PFOA exposure pathways related to the facility, and to identify and define future data collection needs.

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Appendix A

A.1 Summary of March 23-24, 2009 Public Meeting
Parkersburg, West Virginia

Registered Attendees:
ITP Administrator:
Mitchell Small

Peer Consultation Panel (PCP) members:
Joel Baker; Kannan Kurunthachalam; Linda Lee; Paul Lioy; Scott Mabury; Michael McLachlan; Rosalind Schoof; Thomas Watson;

DuPont and Consultants:
David Boothe; Cathie Barton; Andrew Hartten; Kathy Davis (URS); Tim Bingham; Steve Washburn (Environ)

EPA:
Cathy Fehrenbacher, Laurence Libelo, Deborah Sherer

The public:
Robert Griffin, Little Hocking Water Association; Linda Aller, Bennett and Williams; Tony Fletcher, London School of Hygiene and Tropical Medicine (C-8 Science Panel)

ITP assistants:
Gloria Dadowski; Kan Shao

Meeting called to order at 1:00PM March 23, 2009, EDT.

Welcome and Introduction
by Dr. Mitchell Small

DuPont and EPA are signatories to the MOU in which DuPont has committed to provide EPA with certain data and information on perfluorooctanoic acid and its salts (PFOA) through a PFOA Site Related Environmental Assessment Program for the Washington Works manufacturing plant and surrounding areas.

This peer consultation is evaluating the scientific quality and completeness of studies conducted by DuPont and its consultants to characterize past and current releases associated with the site, and quantities of PFOA in nearby environmental media, including those media that can lead to human exposure.

This data gathering has been conducted through phased activities, known as Phase I and Phase II, to prepare the following reports:

1. Data Assessment: DuPont Washington Works, DuPont Corporate Remediation Group, October 2, 2008.

2. Screening Level Exposure Assessment for DuPont Washington Works Facility, Parkersburg, West Virginia, Environ, October 2, 2008.
3. Future Data Needs Assessment: DuPont Washington Works, DuPont Corporate Remediation Group, October 2, 2008.

The specific charge question posed in the DuPont-EPA MOU is:

"Are current PFOA environmental releases and sources of those environmental releases from the Site and the presence of PFOA in environmental media on and around the site sufficiently understood so that pathways of migration and exposure to PFOA associated with that Site are adequately characterized and assessed on a screening level basis?"

The process for the PCP member selection was:

a. Selected by ITP Administrator Mitchell Small following a public nomination procedure announced on website: http://itp-pfoa.ce.cmu.edu/ (closed on August 22, 2008)

b. 13 candidates nominated by US EPA (6), DuPont (3), Mitchell Small (3), Robert L. Griffin (1), and self (1)

c. Members chosen based on the need to address particular topics in study and strength of scientific qualifications

d. Committee includes members nominated by US EPA (4), DuPont (2), Mitchell Small (2), and Robert L. Griffin (1).

In order to do the evaluation, we identified six major topic areas, principally by media and discipline. For each area: air, surface water and sediments, soil and groundwater, biota, multimedia, and human exposure; one or more panel members were assigned as major reviewers who have principle responsibility writing that section of the report. Minor (secondary) assignments were also made for each section. PCP member assignments are shown on the following page.

For each section, one of the lead (major) panelists will report on the Panel's findings in the Preliminary Report.

Overview of agenda today:

- 1:00 – 1:10 Welcome and overview of peer consultation process
- 1:10 – 1:20 Welcome by representative of US EPA
- 1:20 – 1:30 Introduction to members of the PCP
- 1:30 – 2:10 Presentation by DuPont on scientific studies and reports
    - 2:10 –2:40 Questions
- 2:40 – 5:25 Reports by PCP Members on Preliminary Report findings for each of six topic areas
    - 15 minute presentations
    - 10 minutes questions
- 5:25 – 5:40 Summary of discussions and plans for second day of meeting

Panel Member	Air	Surface water & sediment	Soil & groundwater	Biota	Multi-Media	Human Exposure
Joel Baker			Minor		**Major**	
Kannan Kurunthachalam		Minor		**Major**		
Linda S. Lee			**Major**	Minor		
Paul J. Lioy	Minor					**Major**
Scott A. Mabury	Minor	**Major**	Minor			
Michael McLachlan		Minor			**Major**	
Rosalind A. Schoof			Minor			**Major**
Thomas B. Watson	**Major**			Minor		

Welcome and Introduction from EPA
By Cathy Fehrenbacher

Cathy Fehrenbacher expressed appreciation for the assistance from both Dr. Small and the Peer Consultation Panel because this is a very important agreement between the Agency and DuPont. She would like to encourage the Panel to pay close attention to the Charge. She also briefly summarized the process for the Phase III commitment. EPA is happy to answer any questions from the Panel, although EPA is primarily here to listen in the meeting.

Self-introduction of PCP members

Thomas B. Watson, Ph.D.
Tracer Technology Group Leader
Brookhaven National Laboratory
Expertise: Atmospheric Tracer Technology and Applications; Atmospheric Transport, Diffusion and Dispersion; Atmospheric Chemistry

Scott A. Mabury, Ph.D.
University of Toronto
Department of Chemistry (Professor and Chair)
Expertise: environmental fate, disposition, and persistence of chemical pollutants, particularly interested in the influence of fluorine.

Paul J. Lioy, Ph.D.
Environmental and Occupational
Health Sciences Institute (EOHSI)
UMDNJ – Robert Wood Johnson Medical School
Exposure Science Division, Environmental and Occupational Health Sciences Institute
Expertise: exposure and risk assessment.

Rosalind A. Schoof, Ph.D., DABT
Integral Consulting Corporation, Inc.
Expertise: exposure assessment, particularly bioavailability and dietary intake of metals.

Kannan Kurunthachalam, Ph.D.
Research Scientist
Wadsworth Center, New York State Department of Health &
Professor, Department of Environmental Health and Toxicology
State University of New York at Albany
Expertise: understanding the environmental distribution and fate of organic pollutants.

Michael McLachlan, Ph.D.
Stockholm University
Department of Applied Environmental Science (ITM)
Deputy Head of Department
Expertise: fate, bioaccumulation and persistence of organic chemicals

Joel Baker, Ph.D.
Professor
Interdisciplinary Arts and Sciences
University of Washington Tacoma
Expertise: fate and transport of organic pollutants in environment

Linda S. Lee, Ph.D.
Purdue University
Department of Agronomy
Expertise: fate and transport of contaminants in the environment, primarily focusing on soil and water.

Welcome and Introduction from DuPont

By David Boothe:

Mr. Boothe first expressed appreciation to Dr. Small, the PCP, and EPA.

The DuPont team includes: David Boothe (Team Lead), Cathie Barton (Air Programs), Andrew Hartten (Monitoring Program Lead), Kathy Davis (Data Analysis & Reporting), Tim Bingman (Exposure Assessment Lead) and Steve Washburn (Exposure Assessment Consultant, Environ)

Mr. Boothe briefly provided an overview of the MOU process, the history of this project and related information and studies for this study.
Community studies/projects include the C-8 Science Panel (www.c8sciencepanel.org); Penn/Emmett Studies—Little Hocking Community and C-8 Health Project (see WVU School of Medicine Website).

The emissions of PFOA from the Washington Works Site have been significantly reduced over the period 1999 to 2006. Some language needs to be clarified from the MOU, this study focus on the "current presence of PFOA in environmental media". Further, the MOU also allows quantitative, semi-quantitative and qualitative data to be used in the study for the description of exposure. EPA Guidelines were used for exposure assessments and the Screening Level Exposure Assessment (SLEA) is step 1 in a phased approach to focus future work on potentially significant pathways.

Andrew Hartten:

Mr. Hartten gave a brief update about the sites studied, a quick overview of the sampling program, the analytical program, and how the data were translated and interpreted for use in the SLEA.

Four sites covered by the Data Assessment Report include the DuPont Washington Works Site and three landfills: the Letart Landfill, Dry Run Landfill, and the Local Landfill. These sites were briefly reviewed.

The scope of the multimedia sampling program includes: ambient air and rainfall, water and subsurface soil (residential water supplies; public water supplies; Ohio River water; subsurface soil and groundwater at the LHWA; site and landfill surface water and groundwater), surface soil and grass; small mammals and fish. Thousands of samples were collected and analyzed from these media.

A number of scientists analyzed the collected data and new methods development was implemented for some of the media, including air, soil, grass and biota as part of the MOU work. All measurement results (100%) were reviewed by participating laboratories and internally by DuPont, while 10% of the data were reviewed by a third party.

The sources of PFOA releases were identified: air emissions and permitted outfall emissions; on-site SWMUs; landfilled materials; single point releases. The presence of PFOA in environmental media was evaluated: multi-media sampling; in general, air, rainfall, soil, and groundwater show decreasing PFOA with distance from the Site. The pathways of migration are understood: air emissions on-site to on-and off-site environmental media; permitted outfall emissions on-site to the Ohio River and to off-site environmental media; landfills via groundwater flow and leachate. Sufficient understanding and data to conduct the SLEA and relevant spatial and temporal data analyses were carried forward for use in the SLEA.

Tim Bingman:

Mr. Bingman introduced the general background and information about the Screening Level Exposure Assessment.

The purpose of the SLEA is to characterize current human exposures and the potential for future exposures in the vicinity of the Washington Works Site and associated landfills, based on available data. The general scope of the assessment was defined by the Memorandum of Understanding: quantitative assessment of any exposure pathway for which data are available; qualitative or semi-quantitative assessment for pathways where data are not available to permit quantitative evaluation. The USEPA guidelines for exposure assessment, 1992, as specified in the MOU and various other relevant guidelines on

exposure assessment and risk characterization from USEPA, 1989-2006, provided the relevant guidance for the SLEA.

There were five main steps in the SLEA process:

(1) Conceptual Exposure Model Development:

Identify the: Chemical sources; Transport routes; Exposure points; and the Human exposure routes

(2) Exposure Area Identification:

Identified public service districts for drinking water; evaluated data from private drinking water sources; evaluated other data from other media

(3) Exposure Point Concentration (EPC) Calculation:

Used data from the Data Assessment Report; encompassed data from the relevant time period; calculated EPCs, RMEs (reasonable maximum exposures) and MTEs (more typical exposures) for all relevant media

(4) Potential Exposure Estimate Calculation:

Integrated EPCs with human activity patterns and physiological characteristics; calculated RME and MTE exposure estimates for both adults and children

(5) Uncertainty Evaluation:

Described potential uncertainties in exposure estimates for pathways with monitoring data; modeled exposure contributions for pathways lacking data; identified potential data gaps for further consideration

General findings of the SLEA are:

•Calculations based on monitoring data indicate that ingestion of untreated drinking water was the primary exposure pathway

•Intakes from drinking water ingestion are expected to decrease as a result of decreases in drinking water concentrations resulting from mitigation and remediation measures

•In specific limited subpopulations of farmers and gardeners, screening-level modeling indicates that exposure from consumption of locally-grown crops and locally-produced milk could be similar in magnitude to intakes from drinking water

Question session:

Dr. Kurunthachalam:

Are soil samples from local farms available in the Reports? Did these reports consider that irrigation waters from the Ohio River could contaminate the farmland soil?

Andrew Hartten:

Some data might be in the multimedia data report. The area just shown in the Data Assessment Report is the sampling location for soil, there are a lot of areas that are farms, but the access to residential properties needs to be negotiated. The soil concentration in the SLEA was added to an additional concentration from irrigation.

Dr. Baker:

Was the role of flooding and transport of fine sediment to the surrounding area taken into account in the conceptual model?

Andrew Hartten:
It is not largely considered. What is considered is that the data collected in the investigation did include areas that were historically subject to flooding. In addition, there were some flood situations represented in the datasets, such as 2004 and 2005. Conclusions can be drawn by the PCP based on these available data.

Dr. Baker:
In Figure 4.1 which summarizes about water and air emissions between 1999 and 2006, what data have been shown? Which locations are included or summed to obtain the emissions in each year? How many data points or estimates are used for each year?

David Boothe:
Obviously, we don't have continuous online monitors at outfalls for PFOA. So, we did some combination of sampling from both water streams and air streams, along with using the operations systems data for the work site. Therefore, this is a result from sampling data and reported operating conditions from time to time. These emissions are from our manufacturing operations.

Dr. Lee:
Were any of the wastes from the work site land applied?
David Boothe:
Sludge materials from the water treatment process were land applied in landfills prior to the 90 s.

Dr. Mabury:
Was there any other disposal activities on-site, such as a deep injection well?

David Boothe:
Specifically, with respect to deep injection wells, there was no injection of any of these types of wastes.

Dr. McLachlan:
The idea of Tim's presentation is to present information and gather information on current and potential for future exposures. However, what was presented is for the past. Would you say that the potential pathways for the future are also well addressed? Is this understanding correct?

Tim Bingman:
The word "current" is applied to the initial phase of this assessment when the contract of the MOU was activated in 2004. The MOU goes on to say that after the Phase III data collection, there will be a subsequent edition of this document that will in fact define the future state in contrast to the state at the time of MOU signature.

Dr. Small:
In the on-going detailed exposure health studies that were mentioned in the community, is anyone working on the indoor environment, in particular dust as a source of PFOA or related compounds? Also, are any of them are taking samples of breast milk?

David Boothe:
We don't know detail information about these independent studies at this point. They have all the information about this study, and they deliver findings through publications.

Dr. Small:
Is anyone considering an isotopic study as a part of the hydrogeological evaluation to find out different sources of water in the aquifers?

David Boothe:
No. No one is trying to conduct an isotopic study.

Reports by PCP Members on Preliminary Report findings

Air monitoring and dispersion modeling
by Dr. Thomas Watson

There were some important findings in two major topic areas:

1. Air Monitoring:

The airborne PFOA sources are insufficiently characterized. There was no attempt made to verify the production factors from direct emissions measurements during either of the air monitoring phases. There should be further explanation of the measurements that were used to determine these formulas and data on the validation of these calculations with actual stack monitoring.

The temporal and spatial resolution of the air monitoring was insufficient to characterize the transport and dispersion of PFOA in the areas likely to be affected by emissions. There is no discussion of the seasonality of atmospheric concentration levels. The behavior of PFOA in the environment is likely to be temperature dependent and therefore both diurnal and seasonal. It is also possible that there may be daily or seasonal cycles of surface deposition and reemission to the atmosphere of PFOA, particularly in the summer. Monitoring should be conducted in the winter and summer so the dependence of atmospheric concentration on seasonal temperature extremes can be characterized. Air monitoring with diurnal time resolution is also necessary to capture temperature dependent deposition and re-suspension cycles. Atmospheric transport and deposition cannot be accurately assessed, or the effects of the site delineated, without extending the study domain until the measured PFOA concentrations are at or near atmospheric background levels.

2. Mass Balance:

Mass balance calculations need to be done at many levels.

A mass balance should be checked at the 2-mile radius domain level.

There was no air sample collected at a height greater than 3.6 meters above the surface. Measurements in the vertical dimension are necessary to fully characterize the PFOA transport regime and provide data for model validation.

Air monitoring with diurnal time resolution is necessary for capturing the pattern of temperature-dependent deposition. Monitoring also should be conducted in winter and summer so that seasonal temperature extremes can be characterized.

Surface water and Sediment
by Dr. Scott Mabury

Based on the basic information provided in the reports, it is clear that PFOA was transported at least 50 miles from the Washington Works Site, and likely further given PWS contamination, though no surface water samples are reported further downstream than Racine. The lack of assessment of the extent of PFOA migration and exposure to downstream locations is a major omission in this report.

Ohio River Monitoring was carried out in the summer and fall of 2002 with specific dates of sampling June 27, July 10, and October 17. No information was provided that outlined the rationale for selection of sample day, location, or why the sampling was spread out over five months.

Overall, there were 68 samples included in the SLEA (Transects 1 to 12 from 2002 and 04/05 samples near outfall 005), of which 39 were ND or NQ for PFOA. In summary, river water sampling was so intermittent, and lacking in information regarding time of day or week, plant operation, river flow etc, that it is difficult to have a sense of what the river water concentrations mean.

Sediment samples were not collected from any of the water bodies in or around the Site although there is a potential that runoff from several contaminated sites including the solid waste management units (SWMU) can result in the migration of PFOA. There is a need for monitoring of sediments from the Ohio River near the outfall, upstream and downstream of the Site, and the three landfill areas to assess the migration of PFOA through sediment transport.

Soil and Groundwater
by Dr. Linda Lee

Based on the information provided in the USGS report, some concerns about whether there are some hydrological connections underneath the river to the Little Hawking site are much diminished. The hydrological analysis that had been done is reasonable and acceptable.

At LHWA, soil concentrations support the inference that much of the PFOA present is likely from wet deposition followed by percolation into the groundwater. Given that emissions are still occurring (although to a much lesser extent) and the variable nature of weather-dependent wet and dry deposition, having variable concentrations in the soil and subsurface profile is really not surprising. However, the extent to which air emissions of PFOA contamination have contributed to the groundwater contamination is not clear. No mass balance was done to see whether this route could yield such extensive and high PFOA concentrations in groundwater.

While air emissions by 2006 have dropped two orders of magnitude compared to 2000, the 2006 sampling and analysis of plants near the facility show substantial PFOA concentrations on plant surfaces of which much of this mass was clearly from surface deposition and free to mobilize to the soil surface and percolate to the aquifer.

Further, the observation that "residences that are located downwind of the Site have higher concentrations of PFOA than do residences upwind of the Site" would support the predominance of the air-soil-groundwater pathway; however, as previously noted, the results shown in Figure 5.7 of the Data Assessment report are not consistent with this statement.

Biota

by Dr. Kannan Kurunthachalam

There are several possible pathways for exposure to PFOA, including: Air-Produce-Consumers; Water-Fish-Anglers; Air/Water-Soil-Farm Produce-Consumers; Local produce-consumers/infants; Air/water-Grass-game animals-hunters.

Fillet of twenty fish (largemouth bass and channel catfish) were collected near outfalls in Oct 2005, while twenty reference fish samples were collected upstream for comparison. Grass samples were collected on-site in the 2 mile radius. Small mammal (meadow vole) plasma/liver samples were collected from the Little Hocking Water Association site and all results were ND.

Fillet from the twenty fish collected in October 2005 were analyzed and a more typical exposure (MTE) concentration of 1.4 ng/g and reasonable maximum exposure (RME) concentration of 2.7 ng/g have been derived for exposure assessment in anglers.

The MTE and RME from two fish species, ten for each, from onsite is not representative of the exposure distribution that could be present in the site area. More species from multiple locations along the river and other surface waters are needed for representative exposure concentrations in fish.

The report mentions that fish may not contribute to significant PFOA exposure (relative to drinking water) near landfills. The current exposure model suggests that the exposure rate from fish consumption is 2-4 fold lower than that from drinking water (for the Letart landfill). Therefore, the problems include: First, no fish were collected from landfill area water bodies. Second, fish data used in the model are not representative. Third, based on bioaccumulation factors in the literature, 10-fold higher PFOA levels than what were measured in two species are typical. This would result in 10-fold higher exposures than what was modeled. Fish ingestion rates used for anglers are also low. It is important to separate subsistence fishing and recreational fishing. EPA's exposure factor handbook suggests fish ingestion values of up to 170 g/day.

Hunting has also been identified as a possible exposure pathway. Potential PFOA exposure can occur through the consumption of game meat through food chain transfer but no game animals have been analyzed. Analysis of game such as deer, turkey, duck, rabbit, pheasant, quail and home-raised poultry is needed if this pathway is to be evaluated for its significance.

Mean serum PFOA levels in an affected population are typically 100 fold higher than the US general population mean value (~400 versus 4 ng/mL). Blood and breast milk PFOA concentrations are positively correlated. There is a potential for local area infants to be exposed to high levels of PFOA through breast milk consumption. Infant exposure needs to be assessed (this is a sensitive subpopulation; breast milk monitoring is needed).

Multimedia Fate, Transport, and Exposure Pathways
by Dr. Michael McLachlan and Dr. Joel Baker

The criteria for a screening level assessment should include: identifying major pathways of migration; basic understanding of the governing processes; semi-quantitative description of mass flows along the major pathways; and a basic level of field validation of the above.

Indentifying pathways has been done reasonably and a plausible site conceptual model is presented. One pathway that was not considered is downstream users and consumers of Ohio River water.

The first process is atmospheric deposition, which was modeled with AERMOD and measured in surface soil and vegetation. The results were consistent, suggesting basic understanding.

The second process is surface to groundwater. There are some contradictory statements in the documents, e.g. section 6.1.4 vs. sections 4.3 and 5.2.4, so basic understanding is apparently insufficient.

For the pathway of surface water to food, there were also some contradictions between models and measurements and knowledge. Proper measurements are needed.

Overall, the big picture is missing: a multimedia mass balance is needed; this should consider available information on chemical mass flow and chemical mass inventory; should incorporate available process understanding; should address changes in the past and prospects for the future; and should provide exposure source allocation vs. time. Further, it should include the use of downstream river monitoring and Washington works emissions monitoring to estimate the contribution of other sources to the river and to assess downstream exposure.

Further data are needed to verify the conceptual model: (1) Resample local vegetation and soils with sufficient density to verify reduced atmospheric deposition loadings from emission controls; (2) Enhanced sampling around landfills to better understand exposure pathways and to document efficacy of controls; (3)Transfer from groundwater to food, especially near riverbanks downstream of facility; (4) Extend multi-media calculations (especially air-soil-vegetation-groundwater) downstream to include all areas with elevated PFOA in groundwater.

Human Exposure
by Dr. Paul Lioy and Dr. Rosalind Schoof

The preliminary assessment should be recast in terms of some benchmarks made in this meeting, taking into consideration, what will be the major pathways of possible exposure and where are the populations at risk?

The Charge required the PCP to determine whether all the data gaps that need to be filled have been identified in the report. What the PCP is trying to do is to answer the following question: as the SLEA is currently presented, is it adequate for the PCP to actually make the determination whether all the data gaps have been identified? At the very beginning of the report, there is a failure to explain to the reader the scope and limitations of the SLEA study and report.

Another major comment is: uncertainty analysis should be done for each pathway, and that will facilitate the review of the PCP. Except for drinking water, which has a reliable database for estimating local exposure at all three locations, most of the data and estimates are presented as part of an uncertainty

analysis. While an uncertainty analysis is certainly appropriate, it must first be preceded by a thorough documentation of what was done to obtain as much local data as possible, and how these data were used to obtain best estimates for the targeted exposures. Unfortunately, there is little or no local data that was collected or used to serve as a basis for many of the exposure route estimates completed for each location.

Day-One Meeting adjourned at 5:30PM.

Day-Two Meeting started at 8:45AM, March 24, 2009

Dr. Small briefly introduced the agenda for this meeting.

Explanation of Memorandum of Understanding (MOU)
by Cathy Fehrenbacher

Some terms needs to be clarified.

"Exposure to PFOA Associated With The Site," as used in the Charge, refers to current exposures and the potential for future exposures from the presence of PFOA in Environmental Media as a result of Current or Past Manufacturing Activities at the site, but does not include an assessment of exposures that may have occurred in the past.

"Associated with The Site," as used in the Charge, includes any current environmental release or presence in Environmental Media of PFOA on and off the site resulting from Current or Past Manufacturing Activities at the site. "Current or Past Manufacturing Activities" at the site refers to all activities that may have resulted in the current presence of PFOA in environmental media both on and off the site without regard to distance from the site, including but not limited to waste disposal activities that occurred off-site, such as landfills that received materials from the site; land application materials originating from the site; off-site treatment facilities receiving waste material from the site; and air emissions that may have deposited off the site, except that "Current or Past Manufacturing Activities" does not encompass commercial products manufactured at the site and distributed in commerce.

"Environmental media," as used in the Charge, refers to air, surface water, groundwater, soil, sediment, biota, wastewater, waste streams, landfills, landfarms, water discharges and offsite disposal of all types.

More detailed explanation of other terms also can be found in the MOU.

Summary of Report Plans by Section

Human Exposure
by Dr. Schoof, Dr. Lioy

Dr. Schoof:

At this stage, more uncertainty analysis, not collecting more data, in the SLEA might make the report more sufficient for the PCP to judge if the data gaps have been filled.

Dr. Lioy:

More data, especially site-specific data are needed to improve the Screening Level Exposure Assessment (SLEA). Comment for the next round is that: analysis should be done from the back end going forward, for example, more data about bio-accumulation should be collected.

Question from Dr. Small:
Should we discuss how the on-going health exposure studies in the community interface with our study?

Dr. Lioy:
Yes. More data are always better.

Biota
by Dr. Kurunthachalam

There are insufficient data for the biological media available; only <2% of the total samples are biological despite the fact that biota can be an important pathway for human exposure to PFOA. More data need to be collected for biota. Some of the sub-populations are not addressed properly, such as infants.

Breast milk monitoring in the local population is needed to assess PFOA exposure in infants

Question from Dr. Small:
In terms of prioritization, what are the three most important biological media?

Dr. Kurunthachalam:
It is believed that some biota may not provide an important pathway for PFOA exposure in humans. Since biota encompass a wide variety of samples (plants, farm products, animals, fish, milk, etc) it will be helpful to analyze a few samples for those biota samples that are believed not to present a major pathway; this will enable elimination of those biota species as a pathway of exposure. For example, game animals are assumed to be an insignificant route of PFOA exposure (considering the lesser bioaccumulation potential of PFOA). However, it is not possible to rule out this as a possible route of exposure without some preliminary data. Overall, it would be effective to identify pathways that are of least significance (based on the knowledge of PFOA bioaccumulation and proximity to sources), provide some data for those media to support the hypothesis and eliminate that as a pathway from SLEA consideration. Efforts should be made for different species of fish to assess exposures in anglers. The process should be implemented step by step for effective and efficient use of resources.

Multimedia
by Dr. McLachlan and Dr. Baker

This summary is allied with the yesterday's discussion. The transfer of PFOA following air emissions to surface soil was studied and reported and this work is considered sufficient for a screening level assessment. Although information on PFOA emissions to the Ohio River as well as PFOA concentrations in the Ohio River is available, no effort was made to assess whether this information was internally consistent. No empirical evidence was identified to support the understanding on PFOA transport from

surface soil to groundwater and no measurements have been done on pathways leading to food. This is appropriately identified as a future data need in the reports.

Question from Dr. Small:

Is a multimedia modeling framework available that can handle chemicals with properties similar to PFOA? What is the best way to do the mass balance in a multimedia model?

Dr. McLachlan:

A model to handle this problem is available. But some data collection and preparation needs to be done before using this model because some components in the model are really barriers. And this is a multimedia model, not attacking one medium at a time.

Soil and groundwater

by Dr. Lee

Additional data associated with potential contamination of groundwater and migration to off-site streams from the ponds and contaminated layers in or near the water-bearing zones under the former landfills are warranted as well as some post monitoring of the Riverbank Landfill and Anaerobic Digestion ponds that will have an engineered cap system. Additional assessment as to whether or not pumping at LHWA is causing some unexpected hydraulic connection between the water underlying the Anaerobic Digestion ponds is suggested as well. Further details are provided below for the Washington Works Site, the LWHA site, and the Local, Dry Run, and Letart Landfills.

Question from Dr. Small:

Is there anything isotopic that can be done to illuminate what water is coming from where?

Dr. Lee:

First, getting some sediment samples could offer a lot of insights. From there, whether an isotopic analysis would be needed and beneficial can be determined.

Surface water and sediment

Dr. Mabury

Additional sampling was carried out at two dates in each of 2004 and 2005, in the Ohio River at and near the Outfall 005; for reasons unknown the outfall itself was not apparently sampled on those days. Near the outfall, i.e. 5 ft to 20 ft from the bank, PFOA concentrations were generally between 1 and 6 ppb with concentrations dissipating out to "300 ft from the bank". It is unknown what the specific transect, relative to the outfall, was sampled in the river.

Overall, there were 68 samples included in the SLEA, of which 39 were ND or NQ for PFOA. In summary, river water sampling was so intermittent, and lacking in information regarding time of day or week, plant operation, river flow etc, that it is difficult to have a sense of what the river water concentrations mean.

Furthermore, sediment analysis is important for the assessment of pathways of migration of PFOA from the site and the landfills. Sediments are also important pathways of exposure to fish and benthic organisms. Human exposure to sediment can occur as a result of incidental ingestion and dermal absorption.

Question from Dr. Small:

There are a number of measurements that could be made for compounds that are related to PFOA. Can these measurements be used to make inferences about local PFOA vs. global PFOA, and short-term PFOA vs. long-term PFOA, in the site areas?

Dr. Mabury:

It is more difficult in this situation; one cannot simply make such an inference. Nonetheless, methods development is underway for this type of evaluation, and for related compounds that can readily be analyzed, such analysis should be made.

Air

Dr. Watson:

The mass balance calculation is extremely important. The monitoring and modeling cannot be assessed if there is not some attempt to see if all the released material can be accounted for in the environment. Modeled and measured mass balance calculations are necessary to account for all emissions and validate the monitoring, modeling, and exposure assessments.

Air monitoring with diurnal time resolution is necessary to determine daily temperature dependent deposition and detect deposition and re-suspension cycles. Winter and summer air sampling is necessary to determine the temperature dependence of deposition and transport processes.

Wrap up

by Dr. Small

Following further discussion and public input at this meeting, the report will be modified, eventually leading to a Final Report of the PCP (anticipated posting on web site for final public comment by May 15, 2009, with final report submitted to US EPA by July 10, 2009).

Thank you all for participating!

Meeting Adjourned, 11 AM

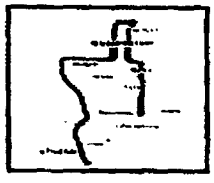
A.2 Public Comments

The following public comments were received during the course of the Peer Consultation Panel review:

1. Comments of Robert L. Griffin, General Manager, Little Hocking Water Association, Inc., submitted March 30, 2009.

2. Comments of Robert L. Griffin, General Manager, Little Hocking Water Association, Inc., submitted June 30, 2009.

1. Comments of Robert L. Griffin, General Manager, Little Hocking Water Association, Inc., submitted March 30, 2009.



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March 30, 2009

DuPont-EPA PFOA Peer Consultation Panel
c/o Dr Mitchell Small, Independent Third Party Administrator

Department of Civil & Environmental Engineering
Porter Hall 119, Frew Street
Carnegie Mellon University
Pittsburgh, PA 15213

Re: Comments on March 16, 2009 Preliminary Report of the Peer Consultation Panel

Dear Dr Small:

On behalf of the Little Hocking Water Association ("LHWA"), I am writing to submit comments on the Peer Consultation Panel's ("PCP") March 16, 2009 Preliminary Report ("Report").

We greatly appreciate the PCP's efforts and insight. During the course of their review PCP panelists discovered significant limitations and omissions in the data collected and the analyses presented. We share the sentiments of the PCP. We also share the opinion of the PCP (as stated in the Report's "Summary of Key Preliminary Findings and Conclusions") that a significantly expanded data collection and analysis program is required With this in mind, these comments

1) provide facts relevant to the Report's conclusion that drinking water is not "currently" (i e "at this moment") the dominant exposure pathway;

2) support and provide facts relevant to the Report's recommendation that DuPont needs to expand its future data collection efforts by testing for other fluorinated chemicals, in addition to PFOA;

3) support the sampling recommendations offered by the PCP that will fill data gaps;

4) provide suggestions with respect to DuPont's groundwater flow model; and,

5) provide information about specific disposal sites not addressed in the Report, which may foster insights into the sources of the PFOA contamination.

LHWA's comments cover the major issues noted in our review of the Report and are not intended to be a comprehensive critique of the Report

Drinking water as the dominant exposure pathway

We believe that drinking water remains the potentially dominant exposure pathway despite the current granular activated carbon filtration ("GAC") of LHWA's water prior to use. When discussing the relative importance of different exposure pathways, the Report states that "[t]he conclusion that drinking water is the dominant exposure pathway is particularly problematic and could be misleading, because that is currently not the case." This opinion, while currently accurate for LHWA, appears to be oversimplified in that:

a. there is a significant threat that DuPont will try to discontinue the GAC filtration under a settlement agreement reached in the West Virginia class action lawsuit, *Leach, et al. v. E.I. DuPont de Nemours and Company*;

b. Because of the high PFOA levels in the blood of many LHWA members, there are scientific and medical uncertainties connected with drinking water with *any* PFOA in it;

c. GAC filtration does not remove all perfluorinated chemicals. We understand that other perfluorinated chemicals, such as PFBA (C4), pass through GAC systems; and,

d. Despite tests showing that the GAC plant is producing finished water that is non-detect for PFOA, detectable levels of PFOA were found in various parts of LHWA's distribution system after GAC operations began. LHWA and other water systems need to be checked to verify that PFOA and related chemicals are not detected in these systems.

Testing for other perfluorinated chemicals

In addition to PFOA, samples taken by LHWA have confirmed the presence of other perfluorinated chemicals in LHWA's wellfield and in the blood of LHWA members. The chemicals detected include higher chain chemicals (e.g., C9, C10, and C11), which we understand to be even more dangerous to human health than PFOA. As noted above, despite LHWA's urging in recent years, DuPont has not made a commitment to make sure other perfluorinated chemicals are being removed by the GAC plant. LHWA strongly supports the Report's recommendation in section 3.2.7 that future analyses be expanded to include other analytes. We find the Report's comment that other relevant chemicals could have been "co-analyzed at no cost or additional effort" to be accurate and in sharp contrast to DuPont's historic statements that tests could not accurately distinguish between perfluorinated chemicals.

Data gaps

To the greatest extent possible, we request that the PCP formulate specific action items to address data gaps and deficiencies found within the reviewed documents and to be included in the Phase III work items. This will assist both the U.S. EPA and DuPont in knowing the intended scope and breadth of the necessary data and analyses. A review of the MOU reports underscores and amplifies the discussions at the recent PCP meeting – future data needs relating to PFOA migration to the LHWA wellfield include:

a) sampling of sediments in the Ohio River, including, as suggested by a PCP member, a transect from the LHWA well field to the location of the former Anaerobic Digestion Ponds (ADP) on the DuPont Washington Works facility (As was mentioned during the PCP deliberations, the coarser fraction of sediments is not anticipated to contain higher concentrations of PFOA due to the character of the contaminant. Therefore, the samples would be collected primarily from only the finer-grained portion of the sediments.);

b) collection of dry and wet deposition samples in the LHWA well field (and other appropriate locations) to better define the air and deposition pathway;

c) collection of Ohio River water samples, both downstream of major outfalls and in the vicinity of the LHWA well field (collected within a scientifically defensible time period and designed to evaluate concentrations and migration in a complex river setting that is controlled by locks and dams). It is our understanding that the PCP wanted to take into account the effects of barge traffic, flooding, wind direction, and "pool effects" on river flow;

d) collection of samples from the silty zone at the top of the aquifer that one PCP member postulated was the subsurface source of PFOA in the Little Hocking Water Association and the Washington Works Plant;

e) collection of soil/water samples for PFOA isomer fingerprinting in order to evaluate historic concentrations (prior to DuPont manufacture of PFOA) versus recent and current transport and deposition (post 3M stoppage of PFOA manufacture);

f) time series sampling for both air monitoring and deposition monitoring in order to define and evaluate the effects on PFOA emissions reductions from the Washington Works plant, which would logically also include sampling from groundwater to evaluate leaching and concomitant reductions of PFOA in monitoring wells in the aquifer.

g) performance of mass balance to more closely align emissions and presence in environmental media.

h) performance of a surface infiltration study in the LHWA well field to quantify movement of water through surface soils, movement of PFOA through the soils with the infiltration and to further quantify the time for PFOA to be flushed from the unsaturated zone through the aquifer. (This could be used to further refine the estimate presented at the PCP meeting of seven months to remove one-half the PFOA concentration from the first 2.5 cm of surface soil – to see if the PFOA levels seen in the groundwater are supported by the deposition rate – and to estimate PFOA removal rates from the well field);

i) performance of an assessment of the contribution of PFOA from surface runoff to the alluvial aquifer in which the LHWA well field is located This assessment should recognize that runoff from the bedrock hills surrounding the alluvial aquifer may be an important source of contribution of PFOA to both the aquifer and, ultimately, the Ohio River, and

j) identification and sampling of potential seepage zones along the Riverbank Landfill. Samples of soils in identifiable seepage zones of just above the Ohio River level would be collected and analyzed to assess potential migration of PFOA from the Riverbank Landfill to the Ohio River

As noted in the Preliminary Report and discussed during the PCP deliberations, the source(s) of the PFOA in the LHWA well field are not fully understood. The LHWA supports the objectives of the PCP to gather further data to understand pathways of migration of PFOA and related chemicals.

Groundwater modeling

In its discussions the PCP recognized that modeling is one methodology useful in evaluating contaminant fate and transport in the environment. However, the PCP also recognized that modeling must be validated and results verified in order to be scientifically defensible. For example, the PCP recognized the need to collect specifically designed and distributed samples to provide necessary validation of the air model Similarly, we recommend that the PCP employ comprehensive validation criteria for the groundwater model.

Such validation will require the collection of additional data, including aquifer infiltration data to quantify the amount of recharge to the well field from the Ohio River and to

further calibrate the groundwater flow model. Such a study will require a sufficient number of wells on the bank of the river (including a new pumping well) and a stilling well in the Ohio River. The study would require water level measurements on both sides of the Ohio River to determine drawdown. Pumping conditions (both sides of the Ohio River) should be verified and as constant as possible. Test holes should be installed into the aquifer under the Ohio River to evaluate stratigraphic variations (or lack thereof) of the deposits and to evaluate whether there is dewatering under the river bed. These studies should be used to perform validation on the presence and position of the groundwater flow divide under the Ohio River that was postulated in the groundwater flow model.

However, modeling cannot replace a more complete understanding of subsurface pathways and sources of contamination.

DuPont's underground injection wells and offsite disposal sites

In an effort to be comprehensive in identification of sources and pathways, we ask that the PCP request that the following potential sources of PFOA be evaluated and either eliminated or addressed in the reports submitted under the MOU:

a. Underground injection wells at the Washington Works Plant. Public records make it clear that two injection wells were used by DuPont for liquid waste disposal and that these wells are no longer in service. Considering that subsurface injection could pose a potential ground-water contamination and migration pathway not addressed in the reports, at a minimum the report should discuss the potential source, types and volumes of waste disposed, injection pressures, depth of well and completion/operational information that may have resulted in overpressurization and/or well integrity concerns for shallow migration; and,

b. Waste disposal sites on both sides of the Ohio River. For example, we understand that a facility now known as the Little Hocking Service Center accepted extruder dies (containing PFOA) from the DuPont manufacturing facility at Circleville Ohio for incineration. This facility is reportedly a DuPont operation and is located approximately one mile west of the LHWA well field. At a minimum, air emissions should be evaluated from this facility. A comprehensive survey of such facilities needs to be completed.

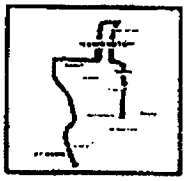
We have been looking forward to the collection, submission, and analysis of the data collected, as well as, the independent review that the PCP is now undertaking. At the first Enforceable Consent Agreement ("ECA") public meeting in Washington D.C. in June of 2003, LHWA submitted comments and asked the U.S. EPA, "Please give us data and information that we can have confidence in." The LHWA actively participated in the ECA process until the Memorandum of Understanding ("MOU") was signed by DuPont and the U.S. EPA in November 2005. Since that time we have closely followed the MOU process. We appreciate the PCP's independent evaluation of the data contained

in the reports generated in the MOU and are happy to provide any additional information that the PCP may need.

Sincerely,
LITTLE HOCKING WATER ASSOCIATION, INC.

Robert L. Griffin, P.E.
General Manager

2. Comments of Robert L. Griffin, General Manager, Little Hocking Water Association, Inc., submitted June 30, 2009.



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June 30, 2009

DuPont-EPA PFOA Peer Consultation Panel
c/o Dr Mitchell Small, Independent Third Party Administrator

Department of Civil & Environmental Engineering
Porter Hall 119, Frew Street
Carnegie Mellon University
Pittsburgh, PA 15213

Re. Comments on June 4, 2009 Draft Final Report of the Peer Consultation Panel

Dear Dr. Small

On behalf of the Little Hocking Water Association ("LHWA"), I am writing to submit comments on the Peer Consultation Panel's ("PCP") June 4, 2009 Draft Final Report ("Report")

We appreciate the PCP's consideration of the earlier LHWA comments on the March 16, 2009 Preliminary Report of the PCP (The LHWA comment letter of March 30, 2009 is included in Appendix A of the Draft Final Report of the PCP.)

The following two non-substantive, factual changes need to be made in the interest of accuracy

First, in the interest of accuracy and consistency we ask that references to our organization be made as either "the Little Hocking Water Association" or "the LHWA".

Second, Figure 2 of the Report provides a clearer understanding of the LHWA wellfield data However, LHWA noted the following errors in the transfer of some data:

1) TW-13S – the "soil PFOA" value for the 0.5 foot depth should be 43, not 3 (reference Appendix 5.8, Table 4.7).

2) TW-13D – the "soil PFOA" value for the 6 foot depth should be 16, not 6 (reference Appendix 5.8, Table 4.7);

3) Sample 5A the soil value for PFOA at the 0 to 1 inch depth should be 14.4, not 1.4 (reference Table 5.24) ; and

4) TW-14D – all "soil PFOA" values from 0 inches to 22 feet are incorrectly stated (it appears as though the values are for TW-15D) and should be placed opposite the quoted depths in the table, starting from the surface, as follows: 51, 38, 29, 9.3, 18, 11, 9.3, 9, 14, 11, 16, and 6.5 (reference Appendix 5.8, Table 4.7).

In addition, LHWA offers a limited comment on one other issue. On page 32 of the Report (Section 3.3.2.2) the statement is made that "*Although questions arise as to whether or not the groundwater flow model described in the report has been validated and if any tracer studies were employed to confirm groundwater movement, a United States Geological Survey (USGS) report (#2004-5088) that summarizes the Survey's geohydrology assessment and simulation of groundwater flow in the Ohio River alluvial aquifers, including the Parkersburg area, supports this claim*". It is unclear to LHWA how the USGS study, conducted in the vicinity of Parkersburg, West Virginia (located about seven miles upstream from the LHWA wellfield) validates DuPont's groundwater model

The USGS report did not specifically model either the pumping conditions or the geological conditions in the LHWA wellfield. These conditions are extremely complicated due to confounding factors such as multiple pumping centers and pooling of the Ohio River in a series of locks and dams. Consequently, there are many questions about the groundwater model

LHWA supports the Report's recommendation that pump and tracer tests should be carried out to further explore hydraulic connections between the Ohio River waters near the Washington Works Site and groundwaters on both sides of the Ohio River.

Summary

Once again, we appreciate the PCP's independent assessment of the data and the recommendations for the Phase III work. If the PCP has any questions about our comments or needs further information, please do not hesitate to contact us.

Sincerely,
LITTLE HOCKING WATER ASSOCIATION, INC.

Robert L. Griffin

Robert L. Griffin, P.E.
General Manager

Reply To: **DAVID W BOOTHE**
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March 19, 2009

VIA ELECTRONIC MAIL

Dr. Mitchell J. Small
H. John Heinz III Professor of Environmental Engineering
Carnegie Mellon University Civil & Environmental Engineering and Engineering & Public Policy
Porter Hall 119
Frew Street
Pittsburgh PA 15213

RE: EPA-DuPont Memorandum of Understanding

Dear Dr. Small,

During the March 11, 2009 teleconferences of the EPA-DuPont Memorandum of Understanding (MOU) Peer Consultation Panel, you invited DuPont to provide any feedback that might clarify information in the Panel's Draft Preliminary Report dated March 9, 2009. We appreciate the opportunity to do so and offer the comments included in the Attachment to this letter. The comments are based upon the Preliminary Report that was issued subsequent to the March 9th teleconference and that is dated March 16, 2009.

Please note that the comments submitted with this letter are provided for the purpose of improving the accuracy of certain statements in the Preliminary Report. DuPont respects the independent nature of the Panel and the procedures set forth in the MOU for review of the Assessments. Accordingly, DuPont has limited its comments in this letter to those that DuPont believes are strictly factual, that are intended to improve accuracy, and that DuPont believes can be addressed prior to the March 23rd-24th public meeting. As a result, the comments are focused on Preliminary Report sections 3.1.2 through 3.1.4 pertaining to air monitoring and dispersion modeling.

As you are aware, and as set forth in the MOU, DuPont will present its Assessments at the aforementioned public meeting and answer questions from the Panel at that time. Additional comments will be provided at that time also. We look forward to the public meeting and to a purposeful discussion of the work that has been done and to the opinions of the Panel with respect to future work that addresses the specific Charge set forth in the MOU.

Yours truly,

David W. Boothe

Attachment
CC: Cathy Fehrenbacher, EPA (via e-mail)

DuPont Clarifications on Sections 3.1.2 – 3.1.4. (Air)
Preliminary Panel Report dated March 16, 2009

1. **Page 12, Section 3.1.2 Source Characterization**
   "There was no direct monitoring of atmospheric emissions during monitoring studies."

While the reviewer is technically correct that simultaneously stack testing of three separate scrubbers was not performed during each of the nine days of air monitoring, emissions were continuously monitored through indirect methods. The basis for calculating emissions to air is a mass balance that starts with the amount of APFO used for production and accounts for losses to water and the amount removed by air scrubbing systems. The Site tracks use of APFO by recording hourly production data for each process line. Losses to water are calibrated through direct measurements. Validation of scrubber efficiency is verified with prior stack testing in accordance with regulatory requirements. Parametric monitoring for pressure, temperature and flow rate is conducted during the stack test events and these values are used as the basis for establishing operational ranges and permit limits. Scrubber efficiency during normal operation is continuously demonstrated via process control instrumentation: pressure, temperature and flow rate gauges. If any of these parameters strays out of specification, warning alarms sound and ultimately, interlocks are in place to shut the production line down. During all monitoring events, hourly production data were collected to evaluate the amount of APFO used in a given hour and instrumentation showed scrubbers were operating within specifications and that efficiency was consistent with measured performance.

2. **Page 13, Section 3.1.3, Table 1**

Corrected limits of detection (LOD) and limits of quantitation (LOQ) for Phase 2 sampling are shown in the table below. Because LOD and LOQ values were re-determined for each sampling batch, there is not a single LOD and LOQ for each method, but a range of values over the entire sampling period. For simplicity, the table below shows the lowest LOD and LOQ achieved during the sampling period for the OVS and HVS methods.

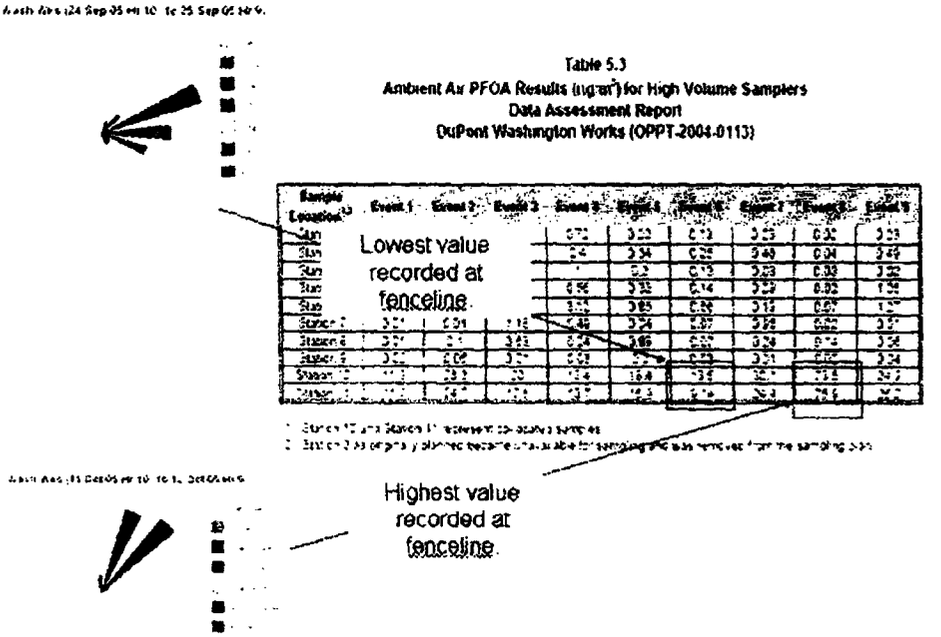
Sampler	Nominal flowrate, L/min	Approximate volume, liters	Approximate volume, m^3	Analytical LOD, ng per tube fraction or filter paper	Analytical LOQ, ng per tube fraction or filter paper	Calculated sampling LOD, ng/m^3	Calculated sampling LOQ, ng/m^3
OVS	1	1,440	1.44	0.09	0.43	0.06	0.3
HVS	1132	1.6E6	1631	0.05	0.26	3E-05	1.6E-04

3. **Page 14, Section 3.1.3, paragraph 3**
   "Concentrations seen in HVS samples ranged from non-detect, less than the LOD of $4x10^{-4}$ ngm^{-3}, to 75.9 ngm^{-3}."

   Concentrations seen in HVS samples are reported in Table 5.3 of the Data Assessment report. There are no non-detect values reported. Non-detects were only reported for OVS tubes (Table 5.2) which sampled substantially less air and therefore had an associated LOQ of approximately 0.3 ng/m^3. Only HVS concentrations were used to assess exposure.

4. **Page 14, Section 3.1.3, paragraph 4 and paragraph 5**
"The maximum concentration seen in Phase 2 was in the samples collected on October 11 and 12 during event 8 at location 10/11." ...
"The reason that the maximum concentration was seen when the winds were coming from a direction where there was no known PFOA source is not explained.

To be complete, it should be noted that the lowest concentrations measured at the fence line location also occurred when winds were from a similar direction, as shown below. It should also be noted that the highest and lowest concentrations measured at the fence line were not significantly different. Concentrations measured at the fence line ranged from 9 to 76 ng/m^3. These values are within the same order of magnitude (differ by less than 10X).



5. **Page 15, Section 3.1.3, paragraph 2**
"Limiting monitoring to 3.6 feet above the surface and within a 2 mile radius from the known air emissions sources is unlikely to account for all the material released from the site."

The Phase 2 Work Plan was not intended to delineate the extent of PFOA in all media until non-detect was recorded. A monitoring height of 3.6 feet was set forth in the Phase 2 Work Plan and selected to reflect the inhalation area of a human receptor.

6. **Page 15, Section 3.1.3, paragraph 3**
"These [published] PFOA Levels are an order of magnitude above the LOQ for the HVS sampling method. It is surprising that there were samples with PFOA levels reported that were below the detection limit when the LOD should be sufficient to see background levels."

No HVS concentrations were reported below the detection limit. See Table 5.3. Levels as low as 0.01 ng/m^3 were reported. Non-detects were only reported for OVS tubes (Table 5.2) which sampled substantially less air and are therefore less reliable for quantification of PFOA. Only HVS concentrations were used to assess exposure.

7. **Page 17, Section 3.1.4, paragraph 1**
"The site emission factors were developed from production correlation factors that apply empirically derived formulas to determine emissions from production history. There was no attempt made to verify the production factors from direct emissions measurement during either of the air monitoring phases."

See comment 1.

8. **Page 17, Section 3.1.4, final paragraph**
"Measurements in the vertical dimension are necessary to ... provide data for model validation."

A model validation was not conducted by DuPont and was not required under the Phase 2 Work Plan. The agreed upon Work Plan included a comparison study to understand how modeling predictions related to measured air concentrations of PFOA at the potential point of inhalation for a receptor. As stated in the Comparison Study report: "The Air Modeling/Monitoring Comparison Study was not intended as a validation of either ISC or AERMOD, which would be a far more involved study requiring substantially more data. Rather, this study was a less formal comparison between measured and modeled data."

Note that modeled concentrations were not used to assess exposure in the SLEA.

9. **Page 18, Section 3.1.4, paragraph 2**
"The behavior of PFOA in the environment is likely to be temperature dependent and therefore both diurnal and seasonal. It is also possible that there may be daily or seasonal cycles of surface deposition and reemission to the atmosphere of PFOA, particularly in summer."

The behavior of PFOA in air is not driven by temperature. PFOA is found as a particle/aerosol and is not present as a vapor. This statement is based on the absence of vapor phase material in any OVS tube during two phases of monitoring, in addition to laboratory tests conducted that show the ammonium salt of PFOA used at the Site has a vapor pressure of 0.003 Pa (3E-08 atm). This low vapor pressure is indicative of a material that is present in particulate and not vapor phase in the environment.

Phase II sampling began in late August and continued through the end of October, with temperatures ranging from 46 to 87 degrees and relative humidity from 25 to 100%. There is no correlation between concentrations and temperature, and there was no vapor detected, even at 87 degree temperatures. Thus, there is neither field evidence nor property data that show deposited material would undergo a phase change and enter the atmosphere as a gas.