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February 21, 2018

COMMENTS
ON
DRAFT INTERIM CONCEPTUAL SITE MODEL REPORT
BENNINGTON, VERMONT
PREPARED BY BARR ENGINEERING
FOR SAINT-GOBAIN PERFORMANCE PLASTICS
DECEMBER 2017

Below are the initial comments of the Vermont Agency of Natural Resources (VT ANR) on the "Draft Interim Conceptual Site Model Site Investigation Report; Bennington, Vermont-December 2017," prepared by Barr Engineering (Barr) for Saint-Gobain Performance Plastics. For the remainder of the comments the above-referenced report will be referred to as the SI report. VT ANR is sending you these comments now so that Barr can begin to update the SI Report before receiving VT ANR's final comments. VT ANR may provide more comments once we have reviewed the updated SI Report with the bedrock well information that was submitted on February 15, 2018.

Response to Barr's Conclusions-General Comments

Barr makes the following conclusions in their SI Report:

- hydrogeologic conditions are similar to those used in the conceptual site model (CSM);
- relationship and trends in PFOA concentrations are not indicative of historical releases from the former Chemfab facilities: and.
- the measured soil concentrations across the investigation area are generally consistent with background concentrations and may also be indicative of localized sources of PFAS.

VT ANR's general response to the conclusions are provided below (The response to the last two conclusions are combined given that both conclusions are based on their interpretation of the PFAS and PFOA distribution over the study area, including background locations):

1. *Hydrogeologic conditions are similar to those used in the conceptual site model (CSM) –*

   VT ANR does not agree with this conclusion because the new SI data show that there are sufficient differences in the hydrogeologic conditions that warrant an update to the CSM and the applicable numerical models prepared by Barr Engineering. The specific

comments section provides details about the updates to the CSM and the applicable numerical models that VT ANR believes are warranted.

2. *Relationship and trends in PFOA concentrations are not indicative of historical releases from the former Chemfab facilities and the measured soil concentrations across the investigation area are generally consistent with background concentrations and may also be indicative of localized sources of PFAS-*

   The VT ANR does not agree with these conclusions, primarily for the following reasons:

   a. Air modeling, completed by both Barr and VT ANR, show PFAS depositions throughout CAA II which originated from the former Chemfab facilities. The ANR models shows higher PFAS deposition rates further away from the former Chemfab Water Street facilities than the Barr model. The VT ANR considers the input parameters used in the ANR model to be more representative of actual conditions than those used in the Barr Model. As documented in previous comments on the air model, the VT ANR does not agree with many of the input parameters in the Barr model that effect emissions rates and the distance PFAS travels from the former Chemfab facilities.

   b. The SI report indicates that most of the soil samples collected for the area-wide site investigation were collected from town right-of-way, which consisted primarily of disturbed soil. The concern is that the soil sample results from predominately disturbed areas compromise the ability to evaluate relationships and trends in PFAS distribution and to assess the measured distribution of PFAS in soils and groundwater against the predicted distribution based on modeling of air emissions from the former Chemfab facilities.

   c. The background concentration assessment is flawed, particularity the application of Rankin *et al.* 2016 to support an average PFOA soil" background" concentration of 1.2 ng/kg. For example, the SI report states that long range transport (regional background) appears to be a significant source of PFAS, using Rankin *et al.* 2016 to support this claim, which ignores the influence that the former Chemfab facilities have on "regional background." These facilities emitted many tons of PFAS compounds to the environment, and they are only 8 to 22 miles away from the "four" background sampling locations, which are in the prevailing downwind direction of these facilities. To presume that all of the PFAS in these samples comes from other regional sources that are many more miles away from these sampling locations is not supported by the CSM or SI Report. The VT ANR air deposition model estimates approximately 65% of the PFAS emitted from the Water Street facility leaves the model domain and travels further afield to be deposited in other areas of the state, the nation, and perhaps the world. Some of these PFAS compounds most certainly would be expected to have been deposited in the soils that were sampled as part of the background

study presented in the SI report. Additional comments on why ANR considers the assessment flawed are provided in the specific comments section.

d. Barr's effort to normalize the soil samples to account for background fails to adequately explain significant variability in the data. The TOC-normalized background created by Barr assumes a uniformity throughout background concentrations for the study area that is not reflected by the data. For example, soil results in part of the site have elevated levels in areas where drinking water wells are not impacted (SO1, SO3, SO4, SO5, S44, S48, and D24) whereas other areas of the site have soil results showing no elevated levels of PFASs but have elevated levels of PFOA in drinking water wells (samples south of the Water Street facility, S36, D20, D21 and D23, and areas around the landfill, D12, D16, S30, S10, and areas along Chapel Road, S09, S32, S37, S39, and S42). This variability in data does not support Barr's basis for applying a background adjustment to explain why their model-simulations under-predicted the measured PFOA concentrations found in area-wide groundwater.

e. No proof is offered to support the premise made throughout the SI report and in Appendix H that the Chemfab facilities only emitted PFOA and if other PFAS compounds, particularly PFOS, are present, then the source of PFAS is not from the Chemfab facilities. With a few exceptions, a majority of the PFOS concentrations in the monitoring wells installed as part of the area-wide SI and in the drinking water wells are at low concentrations, with many of the area-wide SI results having a J qualifier (which the laboratory is estimating a concentration that is below their reporting limit but above their detection limit). Also, if PFOS was an indicator for another source for an area, then why wasn't PFOS found in all the surrounding wells? PFAS compounds were found in groundwater and soils throughout Corrective Action Areas I and II, including near the Water Street facility. In addition, CT Male provided soil data collected at the Water Street Facility. PFOS was detected in soil samples collected at three locations (soil borings from three monitoring wells (MW-2, MW-6, and MW-7) in testing done as part of the Water Street SI. Furthermore, the SI report needs to include a definition for what is meant by PFAS. According to the literature, PFAS are all compounds that contain a CnF2n+1- moiety (Buck et al. 2011). This would include PTFE, which suggests that Barr is claiming no Teflon was emitted from their stacks. The Taconic Plastics 2016 stack tests results also strongly suggest that many different PFAS are emitted from a similar process, including sulfonated PFAS.

f. Appendix H identifies many possible sources of PFOA throughout the area. The wide-spread distribution of PFAS in the groundwater and soil in the Bennington area points supports a localized air-borne source not "countless" point sources as suggested in the SI report. The emissions from the models developed by Barr and VT ANR predicting PFOA deposition from the Water Street facility further support an area-wide distribution of PFAS, including the presence of PFOA found in CAA II. VT ANR reviewed existing files and records, particularly from

the air permitting and engineering services program, and did not find any evidence or records that suggest other businesses or industries emitted PFAS compounds into the atmosphere at the scale of the two Chemfab facilities. VT ANR did identify one Bennington facility, the Eveready Production Facility downtown, that may have had an air-emitting process in the past that used PFAS as a dispersant. VT ANR requested Eveready to perform an initial investigation at the facility as well as at a former facility in Saint Albans. Eveready collected groundwater samples at existing monitoring wells associated with the facilities. Three monitoring wells at and near the Bennington Eveready facility were sampled. The groundwater results showed low levels of PFOA, with PFOA concentration ranging from 2.2 ng/L and 20 ng/L. PFOS was detected at 2.1 ng/L in one monitoring well. At the former Saint Albans Eveready Facility, PFAS was found at low concentrations. The highest PFOA concentrations at that facility was 3 ng/L. The low concentration found in these three monitoring wells at or near the Bennington Eveready facility are consistent with the decreasing concentrations of PFOA in groundwater away from the two former Chemfab facilities. Due to the low concentration found in these monitoring wells and the lack of a concentration trend emitting from the Bennington Eveready facility, VT ANR concluded that this facility is not a substantive source of the PFAS to the local area directly around the site or the hundreds of drinking water wells on the eastside of Bennington that have been shown to be contaminated with PFOA. Lastly, even if the Eveready facility was a source of the low concentrations of the PFOS, the results of the investigations at their two facilities provide clear evidence that they are not the source of the PFOA in CAA II. It is because of the elevated levels of the PFOA in CAA II that site remediation is necessary.

g. The SI report neglects to address the potential impacts of PFAS emissions from the Northside Drive facility on the distribution of PFAS in CAA II.

Specific Comments

Section 2 Background

3. Section 2.1-Either remove the word countless in the phrase... “While it is likely that there are countless sources of PFAS within the investigative area” or substantiate why stating “countless” sources is justified. Appendix H is speculative with respect to other potential sources, whereas the two former Chemfab facilities are known air-borne sources.

4. Section 2.1.-Former Chemfab Facilities-The SI report states that PFOA is understood to be the only PFAS compound in the air emissions from the former Chemfab facilities. There is no reference or statements supporting this statement. Either remove these statements or provide evidence that supports it. In addition, this statement appears inconsistent to the discussion in Section 2.2 Barr Environmental’s draft CSM dated June, 2017 about the presence of another PFAS found near the facility and the soil results reflected in Chart 2 of CT Male’s shallow soil report dated July 20, 2017, which shows total PFCs as well as PFOA decreasing with concentration with distance away from the Water Street facility.

5. Section 2.1.2- Bennington Landfill-Add a phrase or sentence in this section that specifically mentions that an interceptor trench was installed as part of the 1999 capping activities to divert groundwater from entering the landfill.

6. Section 2.2.1- Regional Geology and Hydrogeology-Barr states in the report that, "Runoff in upland areas is focused to seasonal streams that typically lose discharge in areas in which they flow over stratified drift at the margins of the larger valleys." However, the CSM modeling effort showed all streams in the model domain to be gaining streams. How does this statement conform with the modelling effort?

7. Section 2.3- On page 8- Barr states that "In saturated, unconsolidated deposits and fractured rock media, they [PFOA and PFOS] are mobile and migrate as an unattenuated solute in flowing groundwater." This statement seems to be contradicted by the literature (Zareitalabad et al, 2011), which shows that PFOA and PFOS (and other anionic surfactants) exhibit electrostatic interactions between Fe-oxide surfaces. Electrostatic interaction would support a pH dependent retardation factor, further classification of rock types, as well as consideration for other contaminants competing for adsorption sites (especially around the landfill). Barr seems to confirm these interactions are taking place in appendix D1 – Table 6.

8. Section 2.4- PFOA Fate and Transport Conceptual Modeling Approach and Results- the VT ANR does not concur that the modeling approach constituted a conservative model, given that the simulated results are consistently and significantly lower than the measured results.

Section 3 – Work Plan Implementation Activities and Results

9. Section 3.0- The SI report indicates that soil investigations were intended to target areas that have been undisturbed since the 1960s. As stated in the general comments, VT ANR is concerned that soil sample results from the undisturbed areas will not provide insight into the distribution of PFOA is soils from past air emissions from the two facilities. The SI report must include a table, or tables, with a description of each boring location identifying whether it is disturbed or undisturbed and an explanation for its given designation. The SI report must also include an evaluation of disturbed versus undisturbed soil results and determine if the outcome of this evaluation has compromised the ability to evaluate relationships and trends in PFAS distribution and assess the measured distribution of PFAS in soils and groundwater against the predicted distribution based on modeling of air emissions.

10. Section 3.0- Include a figure that shows all the soil borings and monitoring wells (shallow, deep, and bedrock) on one map. An inset is needed for the Water Street facility, such as was done for landfill, to show the locations of nearby monitoring wells, including the 11 wells installed in 2016 by CT Male at and near the facility.

11. Section 3.0-A brief discussion is needed on the modified analytical methods used to collect PFAS samples in soil and groundwater, including assumptions and uncertainties associated with the modified method. Suggest including in the Section 3.5 (QA/QC section).

12. Section 3.1-Unconsolidated Soil Characterization-The SI report did not include shallow soil sampling results from previous sampling efforts by Saint-Gobain's consultant, particularly the shallow soil sample results included in CT Male Final Draft Shallow Soil Sampling Report, dated July 20, 2016, and the shallow soil samples collected as part of the initial site characterization at the Water Street facility in 2016. The SI report must incorporate these results into the narrative, tables, and figures. Also, ANR is not in receipt of the validated data for the shallow soil sampling effort. The SI report must include the validated results of soil samples collected by CT Male in 2016 and a figure showing the shallow soil sampling results from CT Male 2016 shallow soil sampling effort.

13. Section 3.1-Unconsolidated Soil Characterization-To better understand trends in total PFAS concentrations relative to PFOA in soils with distance from the Water Street facility, include figure or figure(s) similar to Chart 2 in the CT Male shallow soil report dated July 20, 2017.

14. Section 3.1.1-Background Soil Borings-This section summarizes the number of samples with detections relative to the number of samples collected, but this does not give the reader the spatial distribution of detections. Revise this narrative in the final SI Report to identify the number of borings where specific PFAS compounds were detected and non-detected.

15. Section 3.1.1-Background Soil Borings-The color-coded ranges in Figures 3.3 and 3.4 appear too broad to provide insight into the spatial distribution in soils of PFOA and PFOS concentrations, respectively. Based on the distribution of PFOA concentrations in Figure 4.6, suggest the following color-coded ranges for the PFOA and PFOS ranges for Background, shallow borings, and deep borings:
    - Less than 0.2 ng/g (or non-detect)
    - Non-detect to 0.75 ng/g
    - 0.751 ng/g to 1.5 ng/g
    - 1.51 ng/g to 5.0 ng/g
    - 5.01 ng/g/ to 10.0 ng/g
    - Greater than 10.0 ng/g

16. Section 3.1.1-Background Soil Borings- There is a color for non-detects (ND) but it is not clear what that value is. Please clarify. If ND varies with a given sample, then clarify this is a note within the respective Figures.

17. Section 3.1.2-Shallow Soil Borings-The same comments as Comments #14, #15, and #16 but for the shallow boring results.

18. Section 3.1.3- Deep Soil Borings-The report does not include deep soil sample results from the Water Street SI completed in 2016. The report must incorporate these results into the narrative, tables, and figures.

19. Section 3.1.3-Deep Soil Borings-PFOS concentrations (16 ng/g) in deep soils greater than PFOA (7.2 ng/g) yet groundwater has much higher PFOA levels. Explain this?

20. Section 3.1.3-Deep Soil Borings- The same comments as Comments #14, #15, and #16, but for the deep boring results.

21. Section 3.1.4-Comparision of Landfill and Non-Landfill Results-This section must be re-named and revised to compare soil sampling results for non-landfill areas to soil samples collected at or near the Water Street facility in 2016. Because of the number of soil samples collected at or around the Water Street facility, provide an inset around the Water Street facility (Figures 3.8 and 3.9) and a separate figure showing the soil sampling results at and in the immediate vicinity of the Water Street facility and how these results compare with the results from the rest of the sampling results from the area-wide SI investigation.

22. Figures 3.13 and 3.14 (Frequency of PFAS detections in soil samples)- Include separate figures for Water Street Area, Landfill and non-landfills/Water Streets area. Also, it would be helpful in reviewing the figure if the compounds on this and similar figures were ordered clockwise from the smallest to the largest. Lastly, provide a way to compare the frequency of occurrence with the sample concentration. This could shed light on the importance not only of occurrence but also on the significance of concentration.

23. Figures 3.14-Clarify whether this figure includes shallow soil data collected from the deep borings or only includes deep samples from these boring. Include all shallow results in one figure and note whether it is from a shallow or deep boring.

24. Section 3.3- Groundwater Characterization-CT Male indicated that the validated groundwater and soil sample result collected at the Water Street Facility in 2016 would be included in this report. Include validated analytical results and all applicable figures and tables to present these results.

Section 4 - Analysis

Section 4.2 - Hydrogeologic Conditions
Slug Tests

25. Saturated thicknesses are set to the difference between the water table to the bottom of screen rather than the actual aquifer thickness. For overburden, the difference between the water table and the top of rock may be more appropriate.

26. Double straight line (rapid sand pack drainage for situations where the water table lies within the screened interval) invokes need to input sand pack porosity. For SG3-MW17-03 porosity was set to zero.

27. Compare results for SG3-MW17-04 using double straight line (sand pack drainage) option.

28. For SG3-MW17-02, the K is high enough to suspect or expect inertial effects. The data may not be dense enough to show damped oscillations. Please provide the AQTESOLVE files.

    Grain Size K estimates

29. Provide equations used for three methods (Barr, Kozeny-Carmen, Hazen) in the final SI Report.

30. Hazen was designed to be used with uniform, coarser materials, not soils with high proportions of clays and silts which seem to be the dominant soil types here. Hazen is usually better for low coefficient of uniformity as well (some references suggest CU < 5). For the samples subjected to grain size analysis, the CU is generally much greater than 10 and often > 100. Include narrative in the report that discusses these limitations and how the Hazen method was used in determining the K values selected in the SI report.

31. An assumption of porosity of 0.3 for the Barr and Kozeny-Carmen methods may not be appropriate (i.e., too low) for the range of soil types sampled and analyzed. Substantiate why this assumption was used for porosity.

Section 4.3 – Relationships and Trends in PFAS Concentration

33. Section 4.3-The SI report lacks analysis of PFOA data in relation to the releases from the former Chemfab Northside Drive facility. The Northside Drive facility is located towards the southeast corner of CAA II. The failure to include an assessment of soils from the Chemfab facility to other soil sample results is a serious flaw in the CSM given that one of the primary wind directions is from the south. Barr's air modeled annual deposition results in CAA II are similar to those of CAA I, and soil and private wells north of the plant have elevated concentrations of PFOA. Compare soil results from around the Water Street facility with other soil results around Bennington as a part of the revised CSM report.

34. Section 4.3-The SI report states the chemical signature from air emissions from Chemfab is no longer distinguishable in soil data. What is the chemical signature that represents the Chemfab release? What has changed such that it is no longer apparent in soils?

35. Section 4.3- The SI report states a preliminary multivariate analysis (MVA) did not yield results from which distinct signatures of other potential sources could be readily identified. This statement seems to contradict Barr's assertion that other sources are a possible cause of contamination. Discuss this discrepancy in the final SI Report.

36. Section 4.3-The box-and-whisker plots on Figure 4.7 must include a separate plot for the Water Street Facility and immediate vicinity, using CT Male 2016 data (soil and groundwater data) so that a more meaningful examination can be made between results at and near the Water Street facility to other results.

37. Section 4.3-Although addressed in Appendix D, please include in this section what data was used for the statistical analysis. Was the soil data from the Water Street initial SI (2016) used in the statistical analysis? It was not clear from the narrative in Appendix D. If not, include this soil data in the analysis.

38. Section 4.4.1-Background PFOA Soil Concentration-The report states PFOA concentrations are not significantly different between the background soils and non-landfill soils. Barr's derivation of background has serious shortcomings as described in Comment 2 and in comments below.

39. Section 4.4.1-Background PFOA Soil Concentration-VT ANR disagrees with Barr's premise suggested in this section that the two Bennington Chemfab facilities plants did not

contribute to PFAS found in the background samples. As stated in Comment 2c, their premise ignores the fact that these facilities emitted many tons of PFOA and are located between 8 and 22 miles from the background locations and are in the prevailing downwind direction of the two facilities. This premise also implies that all PFAS at these background locations came from potential sources that are much further away that the two former Chemfab facilities. The VT ANR air modeling indicates that 65 percent of the PFOA emitted from the Water Street facility left the model domain. It seems more plausible to believe that at least some of the PFOA found in the "background" samples have come from the 65% of the PFOA emissions from the Water Street facility that have left the model domain than from "ubiquitous" sources.

40. Synthetic Precipitation Leaching Procedure (SPLP) results from soil samples collected as part of the split samples that ANR's contractors collected, showed that soils with non-detect for PFOA had detectable levels of PFOA in the SPLP leachate. This could explain why some areas of Bennington that have low levels of PFOA or non-detect levels of PFOA in soils have detectable levels of PFOA in groundwater.

41. Section 4.3.1.3 Presence of Sulfonated PFAS Compounds- The report states that presence of sulfonated PFAS are not a result of the emissions for the Chemfab Plants and are indicative of other PFAS sources. Barr has not presented evidence that Chemfab emissions only produced PFOA or that other potential sources of sulfonated PFAS also released PFOA. In addition, the sporadic presence of PFOS at very low concentrations in soils and groundwater does not mean that the PFOA in CAA II is not from the former Chemfab facilities. In addition, the Taconic Plastics 2016 stack tests results also strongly suggest that many different PFAS are emitted from a similar process, including sulfonated PFAS.

42. Section 4.3.2.1 Multivariate Analysis (MVA) of Groundwater Data- The report states that a groundwater MVA cluster analysis was conducted and suggests that it demonstrates a variety of other PFAS sources within the investigation area. While there may be other sources of PFASs in the area, no link of combined PFOA and sulfonated PFAS sources has been provided in the report. This section references Figure 4.10 to support it claims. Review of Figure 4.10 indicates the majority of wells in CAA II have a PFAS profile similar to those in CAA I, including those closest to the Chemfab plants (PFOA/PFHpA with no or low sulfonated PFAS).

43. Section 4.3.2.1 Multivariate Analysis of Groundwater Data-Figure 4.10 color-codes of three statistical groups:
    - Groundwater with PFOA or PFOA/PFHpA low or no sulfonated PFAS compounds;
    - Groundwater with widespread sulfonated compounds; and
    - Groundwater with high proportions of sulfonated compounds.

    Please define your groups. What is considered low or no sulfonated PFAS compounds; what is considered widespread sulfonated compounds; and what is considered high proportions of sulfonated compounds?

44. Section 4.3.2.2 Groundwater Type Classification. The ANR does not agree that the use of major elements (ions) alone can be used to reliably discriminate groundwater chemical groups (or sources) in the unconsolidated aquifer. Given the heterogeneity of surficial deposits and the underlying bedrock formations from which these deposits were derived, accurate discrimination of groundwater chemical groups (or sources) in the unconsolidated aquifer needs to be more robust and include trace elements and stable (H and O) isotopes.

Section 4.4 - Evaluation of PFAS Sources

45. Barr has introduced the possibility of a regional background presence of PFOA as a reason why the modeling performed to date has resulted in consistent under-prediction of observed PFOA concentrations at monitoring locations. Barr details this approach in a Technical Memorandum contained in Appendix D.2. Barr has used the data from four selected background locations identified for the SI investigation in conjunction with inferences from the 2016 Rankin, *et al*., study to posit what it terms 'a representative background perfluorooctanoic acid (PFOA) soil concentration'. While in the introduction's first paragraph Barr acknowledges that "A regionally constant background PFOA soil concentration should not be expected," Barr appears to do exactly that. This exercise is flawed on several counts. First, the use of a global survey to establish probable background PFOA to total organic carbon ratios; second, the treatment of these data; third, the use and analysis of the background data set for the SI report, and lastly the omission of other SI data that suggest alternate possible background PFOA concentrations or impacts.

    a. Use of the Global Survey- Barr uses as a guide, data from a 2016 study (Rankin, *et al*.; A North American and global survey of perfluoroalkyl substances in surface soils: Distribution patterns and mode of occurrence). Barr cites that Rankin, et al sampled 33 locations in North America for background PFOA concentrations in surficial soils. However, the Rankin *et al.* study does not claim to be more than a survey of distributions for the perfluoroalkyl compounds (PFOA included). The Rankin *et al.* study, while attempting to obtain samples from perceived undisturbed locations noted that "The PFCA and PFSA congener profiles were similar amongst most locations, with a few principal-component statistical anomalies suggesting impact from nearby urban and point sources." In the Rankin, *et al.* study, a single surficial soil sample was taken which was then analyzed in triplicate. Multiple samples were not taken at each location to provide a true assessment of background concentrations at these selected locations. Field sampling and analytical error were assessed by the use of field and process blanks. The study reported data corrected for process blanks, but was unclear if the data were adjusted for the field blank results. When considering the data as presented on Tables S2, S13 and S14 in the supporting information to the Rankin, *et a*l paper, two additional features of the North American (NA) data set should be noted: 1) it includes a wide band of environmental conditions (an aim of the study) from Puerto Rico to Canada to Mexico to Alaska, which would not be similar to the Bennington setting; and 2) the supporting study information notes that these data are influenced by "Several factors such as the proximity to emission sources, precipitate and other soil properties that differ significantly amongst sampling locations, which may preclude any direct comparison

with TOC."; and "Lastly, there are inherent differences in soil properties, such as pH and cation exchange capacity (CEC) because of the geographical differences between sampling locations, which could suppress the sorption of PFCAs and PFSAs to TOC."

b. Treatment of Data-Barr's treatment of the Rankin *et al*. study data is to accept them as truly representative of a range of regional background concentrations or, and more importantly ratios of PFOA to TOC, despite the above warnings and the more general Rankin, *et al* study goal (as a survey for world-wide distribution of PFAS) and uses all 33 North American (NA) sample results in justifying a site-specific PFOA/TOC ratio from SI background samples. Boxplots were prepared that show the Rankin *et al*. NA data set contains several outliers. In deleting these outliers in three successive steps, the resulting data (27 remaining samples) are still skewed (not normally distributed), but more likely log-normally distributed, and the mean and median PFOA/TOC values have decreased significantly, suggesting that the Bennington site-specific PFOA/TOC value (discussed next) may be subject to outlier bias as well. In successively removing the outliers, the respective means and medians for the NA data set of PFOA/TOC ratios become: 0.03 and 0.00726 ng/g soil (contrary to a median value of 0.0113 ng PFOA/mg TOC cited by Barr on page 2 of their internal memorandum (Appendix D.2) for all 33 values; 0.01863 and 0.00581 ng/g soil for 30 values; and 0.01245 and 0.00545 ng/g soil for 27 values. The skewness and kurtosis for the three data sets are 2.10 and 4.3 for all 33 values, 1.71 and 2.43 for 30 values, and 1.48 and 0.96 for 27 values. For the ln-transformed data set (27 values), the skewness was 0.29 and the kurtosis -0.63. Thus the use of the 95 percentile on the entire NA data set as a guide for an acceptable PFOA/TOC ratio likely produces an excessively high value for the ratio. Barr also cites the PFOA/TOC ratio for the Rankin *et al*. study sample NA17 at Holderness, NH, as further support while still acknowledging that "There is no indication whether the NA17 site was located near a cross-country skiing area. Use of fluorinated cross-country ski wax can result in locally elevated soil PFOA concentrations along ski trails." However, there also is no indication that it is not, and as the Rankin *et al*. study and data show, there are numerous other factors why this PFOA/TOC ratio could be elevated, and that the study samples were not meant to be, nor should they be considered, as representative of local background.

c. The site-specific regional background sampling at just four locations is a very limited basis upon which to base Barr's main conclusion that the assumed regional background deposition is enough to correct the apparent under-prediction of the modeling versus observed concentrations. If truly regional, then more recent surficial deposits might be expected to exhibit a more uniform composition, e.g., PFOA/PFOS ratios, but apparently they do not (PFOS is quite variable across the study area).

d. The SI sampling plan selected four locations considered unlikely to be affected by site-related releases and ranging from 8 to 22 miles from the former Water Street Chemfab facility. Samples were obtained from 0-0.5, 0.5 to 1.0, 1.0 to 1.5 and 3 to 4 feet below ground surface from each of the four locations. Analysis of these samples included PFOA and TOC and these data were used to calculate PFOA/TOC ratios. Although the objective was to establish 'background' for individual depths (corresponding to unsaturated zone modeling layers (0-10 cm, 10-30 cm, and >30

cm), the samples for 0-1.5 ft were lumped for the analysis. This probably reflects the limited background data set. Based on comparison with the Rankin *et al*. study data and 95th percentile ratio, the location BG1 was eliminated from calculation of acceptable PFOA/TOC ratios. Even so, a single average PFOA/TOC ratio was calculated for each location and then the resulting three values averaged to produce a projected average 'background' ratio of 0.0586 ng PFOA/mg TOC for the site (as opposed to an average of 0.01245 and median of 0.00545 ng PFOA/mg TOC for the reduced Rankin *et al*. NA data set). This was then multiplied by the assumed TOC content (25,000 mg/kg) of the top 10 cm used in the unsaturated zone model, expressed as fraction organic carbon (foc of 0.025), rather than the site-specific actual determined TOC average of 16,000 mg/kg (foc of 0.016) as summarized on Table 4.1 (page 37 of the Draft SI report). The resulting computation produces a proposed 1.46 ng/g "background" concentration for the Bennington area. This result is then applied to the results of the transport modeling to potentially account for the model's general under-prediction of impacts to groundwater.

e. While the background data set of four samples was specifically selected for comparison, there is no guarantee that these locations would not provide anomalous results. Further, with the elimination of one location and the non-detect of one of the three remaining samples, the statistical analysis of such a small data set leaves considerable doubt as to its representativeness. While other shallow and deep soil borings were placed relatively randomly across the SI study domain, and some were targeted for specific suspected impacted locations (e.g., the Bennington Landfill), nonetheless many samples, despite the suggestion of a widespread "background" surficial soil concentration of 1.46 ng/g soil and a representative PFOA/TOC ratio of 0.0586 ng/mg TOC, many of the samples analyzed at these boring locations provided cleaner samples than the proposed background levels. Of the approximately 70 soil sampling locations, 9 had a surficial sample PFOA concentration less than 1.46 ng/g but greater at a deeper depth, 46 had all samples with shallow depths analyzed as less than 1.46 ng/g, and only 15 locations had surficial soil concentrations greater than the 1.46 ng/g PFOA. Further, 45 of the samples had a PFOA/TOC ratio less than the proposed value of 0.0586 ng PFOA/mg TOC with a mean of 0.021 and a median of 0.015 ng PFOA/mg TOC. The lack of widely spread proposed "background" concentrations across the study area suggests the proposed number of 1.46 ng/g is excessively high to use as a background concentration.

f. In summary, the analysis misapplied the Rankin *et al*. data set as representative of background, does not examine the Rankin *et al*. data set for apparent sampling location outliers or other environmental factors differentiating them from Bennington (thereby needing adjusted guidance according to the changed statistics), considers only the four-sample background data set locations combining depths and PFOA/TOC ratios for 0-1.5 ft rather than upper 6-inches (understandable given the few data points), and applies assumed foc values rather than those resulting from the SI data.

Section 4.5.2 - Evaluation of Expected Distribution of PFAS Concentrations

46. Figure 4.14 presents measured versus simulated PFOA in soil under two conditions (a) all data in previous and the current investigations and (b) measured versus simulated PFOA in soil for model layers 1, 2, and 3. Figure 4.14 (a) shows poor correlation between measured versus simulated concentrations; with measured concentrations being much higher than simulated (roughly 2 orders of magnitude). Figure 4.14(b) adds a "background" mass to the simulated results for each model layer, which improves the overall correlation, but the fit is still poor (biased high in measured concentrations). The basis for the background adjustment, as discussed previously, has serious shortcomings and does not explain the poor correlation between modeled and observed result.

47. Text describing aspects of the data evaluation indicates sampling for TOC/foc was biased by preferential selection of soil with visible organic content. The text has confusing statements such as "the method detection limit exceeded the minimum detected values", and "therefore non-detect values were not accounted for in the geometric mean calculation". Interpreted literally this means that the MDL was greater than the minimum detected values for TOC. If so, how could the minimum detected values be detected if they were below the MDL? For statistical purposes, it also common to us ½ the MDL for non-detects. There is no discussion of the data distribution, so it is not clear if the geometric mean is a better measurement than an arithmetic mean for this particular data set. It is understood that geometric mean calculations cannot contain zero values. Table 4.1 lacks units for foc but it is understood to be the decimal equivalent of percent.

48. Please add units to Table 4.1. The minimum and maximum values at each depth vary by a small factor (3 - 3.5) yet the geometric means vary by more than an order of magnitude, and the foc values selected as model inputs vary by two orders of magnitude. Use of the selected foc values for the model input is not supported by the data statistics as presented in Table 4.1. Provide the data set used to calculate Table 4.1 summary statistics and review that data against available site data.

49. The full soil data set had not been compiled at the time of this review and will need to be evaluated for foc, with a focus on vertical distribution in soil. Data from Bennington College, soil investigations around the former Water Street facility, and available SI data indicate considerably higher foc values at depth than were used by Barr in their model. The use of artificially low foc in the soil leaching model results in rapid leaching and loss of PFOA in soil, thereby yielding an overly optimistic timeframe for clean-up of both soil and groundwater. The applicable model(s) must be revised to reflect the results of the SI data that shows higher foc values at depth than the assumed values used in the Barr models.

Section 4.5.3 - Comparison to the Conceptual Model
Unsaturated zone modeling

50. The geometric mean of 0.0032 for observed foc in the >36 cm below the ground surface zone is 6 times that used in the unsaturated zone model (Table 4.1). While Figure 4.15 suggests foc may generally be < 0.005 in the very deep zones, the model needs refinement to account for the fact that one foc value does not appear to be representative for the vadose

zone below a depth of 36 cm.. One approach is to use a gradation of foc values over layers 3-16 within the unsaturated zone model.

51. Figure 4.16 shows a typical delay curve for the rise of surface zone concentrations over the period of Chemfab operation and fall after emissions ceased, and the resultant soil concentration at the water table as they rose to a maximum and then fell, but including a delay dependent on the assumed recharge, vertical K, and retardation factor (different for the three vertical soil zones). The foc is a major factor in determining the retardation given assumptions for bulk density, porosity and organic carbon partition coefficient. If the foc in the lower soil column is greater than assumed (0.005), then there may be more PFOA mass in the unsaturated zone and delay patterns may be different than shown. For comparison, even using the unsaturated zone assumed foc values (using bulk density of 1.86 g/cc and a porosity 0.3), the retardation factors are 86.25, 18.05, and 2.705 for the 0-10, 10-36, and >36 cm depth intervals, respectively. If the > 36 cm foc value were the geometric mean of the observed values (0.0032), the retardation factor would be 11.9. However, as pointed out above, a more realistic approach would be to provide a gradation of foc over the lower unsaturated zone model layers. This refinement to the model would make the retardation factor for this unit even greater than the ones listed above.

Appendix D: Statistical Analyses

52. D1a. Soils: This section provides basic descriptive statistics and many comparisons, mainly between Bennington Landfill and non-landfill areas, but the results of this effort are relatively unsurprising given the wide variety of soils over such a large study area. This seems to weaken possible correlations or differences, especially with respect to elemental analyses. Spatial trends (distance and depth) exist for PFOA and TOC and would be more relevant to the CSM (higher near the former Chemfab facility and higher in shallower soils) then might be expected from the aerial deposition at ground surface, the mechanism of migration, and the gradation of foc decreasing with depth, coupled with the moderate Koc for the PFOA (550 cc/g). The analysis suggests and uses a relatively strong relationship between TOC and PFOA to normalize these into a PFOA/TOC ratio that generates somewhat stronger correlations. The analysis shows a correlation between PFOA and silver, but that may just be coincidental, and a negative one with pH, which Barr suggests may be due to a lower sorptive capacity for more acidic soils.

53. D1b. Groundwater: This evaluation uses many of the same statistical tests as for soils, but adds Piper and STIFF diagrams for looking mainly at differences between Landfill and non-landfill groundwater sample sets. Only one background groundwater sample was taken so statistical comparisons with background were not possible. The STIFF and Piper diagrams show similar general water quality composition for major anions and cations with a few exceptions, e.g., S24, S28, B-2-2, and the vault sample for the landfill, and D03, S08, and S49 for the non-landfill samples. A narrow hexagon shape seems dominant in both groups (see D1b, Figure 2). The main focus of this effort was on PFOA and PFOS concentrations between landfill and non-landfill samples. The D1b appendix concludes that distributions of

PFOS and PFOA were similar between the Bennington landfill and non-landfill samples despite relatively large differences in individual PFOA concentrations. The lack of statistical distinction may be due in part to large standard deviations resulting in overlap of confidence intervals. Perform a similar comparison in the final SI report for localized Chemfab facility results and non-Chemfab facility results to show the similarities and/or differences between these two exercises.

Vermont Geological Survey (VGS) Comments on Appendix E.1: Bedrock Desktop Review and Outcrop Study Report (Golder and Associates, December 14, 2017)

Section 2.2.1 OC-1

54. The locations of fracture domains 6 and 7 were not transposed on the map by Kim (2017b), as suggested by Golder. The rose diagrams and equal area nets for domains 6 and 7 were not transposed either. Only the photos for domains 6 and 7 were reversed and this was remedied on the 11-21-17 version of Kim (2017b) that was uploaded to the VGS website on November 27, 2017. November 22, 2017 and December 1, 2017 emails to Jonathon Carter of Barr Engineering described these issues.

55. The location of OC-1 on Figure 1 of Golder corresponds directly with domain 7 of Kim (2017b) and not domain 6.

56. Golder states that "The stereonet plot for Domain 6 indicates the VT ANR data have slightly steeper bedding dips to the northwest……". Because the bedding planes at this outcrop strike to the northeast and dip to the southeast, VT ANR suspects that Golder meant southeast.

57. Golder states that "These (VT ANR) joint sets do not correspond to the two predominant joint sets (J1 and J2) measured by Golder at this location". The VT ANR does not concur. The rose diagrams for domain 7 show statistical peaks at 263.3 degrees (standard deviation of +/- 14.7 degrees) and 177.4 degrees (standard deviation of +/-8.1 degrees) for full ranges, including standard deviations, of 248.6-278 degrees (peak 1) and 169.3 -185.5 degrees (peak 2), respectively. The Golder petals (Figure 2) that span the bins from 250-280 degrees match the 248.6-278 peak of Kim (2017b). The Golder petal with an azimuth bin of 170-180 degrees matches the second most dominant 169.3-185.5 degree peak of Kim (2017b). Although not shown on the rose plots of Kim (2017b) as a statistical peak, the equal area net for domain 7 shows a 2% contour zone in the southwest quadrant for poles to fracture planes that strike in the 150-160 range and dip moderately to the southwest, the second major Golder petal.

Section 2.2.2 OC-2

58. Golder states that "The stereonet plot for Domain 8 indicates the VT ANR data have slightly steeper bedding dips to the northwest…". Because the bedding planes at this outcrop strike to the northeast and dip to the southeast, VT ANR suspects that Golder meant southeast.

Section 2.2.3 OC-3

59. This outcrop corresponds directly to domain 6 of Kim (2017b). The locations of fracture domains 6 and 7 were not transposed on the map by Kim (2017b), as suggested by Golder. The rose diagrams and equal area nets for domains 6 and 7 were not transposed either. Only the photos for domains 6 and 7 were reversed and this was remedied on the 11-21-17 version of Kim (2017b) that was uploaded to the VGS website on November 27, 2017. November 22, 2017 and December 1, 2017 emails to Jonathon Carter of Barr Engineering described these issues.

60. Golder states that "The stereonet plot for Domain 7 indicates the VT ANR data have similar orientations as the Golder bedding data set (both dipping gently to the northwest)…". Because the bedding planes at this outcrop strike to the northeast and dip to the southeast, VT ANR suspects that Golder meant southeast.

Section 2.2.5 OC-5 and OC-5A

61. These OC-6 and OC-6A outcrops correspond directly to domain 2 of Kim (2017b). Golder noted that poles to bedding planes were not plotted on the earlier version of Kim (2017b); however, these poles are included on the most updated version (11-21-17) that was uploaded to our website on 11-27-17.

Section 2.2.8 OC-9 and OC-9A and Section 2.2.9 OC-10 and OC-10A

62. Because of overlapping stations and labels, it is difficult to tell exactly where these outcrops plot on Figure 1. The locations of these outcrops appear to roughly correspond to those of domain 4 on the Figure 1 map of Golder and the Kim (2017b) map. The fact that the Golder bedding dips to the west means that these outcrops are likely on the west limb/side of the south-plunging anticline hinge shown on cross section C – C' of Kim (2017a). The domain 4 outcrops are located east of the anticline hinge because of their eastward dips. Outcrops OC-11 and OC-12 more closely match the location and structural position of domain 4.

Appendix E-2: Private well logs

63. Well yield tests for these seven wells suggest good yields for wells completed in bedrock. Yields ranged from 4 to 50 gpm, although the duration of the yield test was short in some installations. This data along with the presence of soft, weathered/fractured rock, suggest that a second bedrock layer in the saturated zone model is warranted. The VT ANR will provide more comments about the need to include a second bedrock layer after completing the review of updated SI report that was submitted on February 15, 2018, which provides additional bedrock data.

Appendix H-Preliminary Evaluation of Other Potential PFAS Sources

64. Chemfab did not manufacture high-performance plastic products. They coated fiberglass cloth using PTFE and PFOA as a dispersant.

65. As stated in previous comments, VT ANR disagrees with the comment that PFOA was the only PFAS compound emitted from the Chemfab facilities, given the soil data near the Water Street facility and the absence of product sampling or documentation supporting this claim.