Appendix C – Preliminary Foam Assessment

TABLE OF CONTENTS

1. Background

PFAS-containing foam has been observed in the Project 1007 Corridor and in associated waterbodies (Site) since August 2019. Based on analytical results, the foam samples collected to-date typically contain higher PFAS concentrations than other media sampled, with PFOS and PFOA quantified at several orders of magnitude above drinking water standards. This Preliminary Foam Assessment includes an initial summary and observations of foam sampled from the Site. The Foam Assessment will be further developed as the project progresses to better characterize foam observed at the Site, to evaluate human and ecological risk, and to assess the role that foam plays in the fate and transport of PFAS throughout Project 1007. The objectives of this Preliminary Foam Assessment are to:

- Identify locations where foam has been observed,
- Characterize the types of foam observed,
- Describe the factors that impact foam formation and accumulation, and
- Summarize the concentrations of PFAS compounds found in foam and the foam enrichment factor.

2. Locations of Observed Foam

Foam has been regularly observed on Raleigh Creek, both upstream and downstream of the confluence with Project 1007 (Confluence), and to a lesser extent in select downgradient locations along Project 1007. Areas include:

- Upstream of the Project 1007 confluence with Raleigh Creek near Jamaca Ave N and 34th St N (RC16),
- In the southeastern lobe of Eagle Point Lake (EP18),
- Downstream of Eagle Point Lake (EP19),
- Along the western (EP21A and EP21B) and eastern (near EP14) shores of Lake Elmo,
- Downstream of the Horseshoe Lake outlet (WL6), and
- Inside a catch basin between North and South Ponds in West Lakeland (WL11).

<u>Raleigh Creek and the Confluence</u>

The location of foam generation and accumulation is variable depending on observed flow conditions. Foam has been consistently observed on Raleigh Creek near RC5, RC7, RC21, RC17, and RC18/RC18A regardless of flow conditions. The section of Raleigh Creek between Ideal Avenue and Tablyn Park (RC9 to RC13) is intermittently dry and may occasionally contain foam when water is present.

Isolated foam bubbles have been observed on the surface along other stretches of Raleigh Creek. These foam occurrences were minimal and insufficient quantities prohibited sampling; therefore, these foam bubbles were not evaluated for the presence or absence of PFAS.

Eagle Point Lake

Foam has been observed near the southeastern lobe of Eagle Point Lake. Periodic pumping of surface water from Goose Lake to Eagle Point Lake occurs when the Goose Lake surface elevation encroaches on 10th Street North. Foam observations at this location are likely the result of pumping and turbulence as the water enters Eagle Point Lake, causing foam to actively generate. The mode of generation or extent to which foam forms in other areas of Eagle Point Lake is unclear and has not yet been evaluated due to limited lake access to those locations.

Lake Elmo

Foam has been observed on both the western and eastern banks of Lake Elmo. The frequency and extent to which foam accumulates along different areas of the lake is unknown. Based on observations to-date, foam has often appeared along the downwind shoreline where greater wind speeds and wave action provide favorable conditions for both foam formation and accumulation.

West Lakeland Storage Sites

In both West Lakeland sampling locations where foam has been observed (WL6 and WL11), the foam was likely forming because of turbulence created by a culvert, followed by stream obstructions (e.g. fallen reeds near WL6) or a protected structure (e.g. a catch basin near WL11) that allowed the foam to accumulate.

Foam has not yet been observed on the surface of the West Lakeland storage ponds. Their relatively small sizes limit wind fetch and wave action that typically occurs on larger, more open water bodies. However, observations from site reconnaissance of Sunfish Lake, a nearby small surface water body, suggest that minimal wind and wave action may still enable the formation and accumulation of foam. These environmental conditions suggest the need for ongoing foam reconnaissance of the West Lakeland storage ponds, in particular the east side of South Pond along Neal Ave N (WL16) during future site visits.

Other Locations

Foam has also been observed in sufficient quantities for sampling outside of the primary surface water flow path of Project 1007. These locations on associated water bodies include:

- On the southern shore of Sunfish Lake (EP25) located between the Washington County Landfill and Lake Elmo,
- Along the eastbound 10th Street N roadway adjacent to the southern half of Goose Lake (GL2),
- Downstream of the Farney Creek dam (FC2), and
- Along the north branch of Valley Branch Creek (VB1, VB2, and VB3) south of Interstate-94 (I-94).

Isolated foam bubbles have been observed at other locations not specified above. These foam occurrences were minimal and insufficient quantities prohibited sampling; therefore, these foam bubbles were not confirmed for the presence or absence of PFAS.

Locations of sampled and observed foam are shown on **Figure C-1**. Sampled and observed locations are also provided in **Attachment C-1**.

3. Categories of Foam and Notable Observations

The foam observed along the Project 1007 Corridor and associated water bodies have had several appearances. Variability in flow conditions, weather conditions, presence of debris, and suspended/dissolved matter in different surface water bodies along the Project 1007 Corridor appears to influence the variety of foam types. Foam characteristics are summarized in **Table C-1**.

The following list describes the categories of foam observed to-date:

- Actively generating and accumulating
- Deflated (old)
- Frozen
- Non-frozen, accumulated on ice
- Floating bubbles (isolated and not accumulating)
- Organic/particulate rich
- High turbulence generated (fluffy)
- Wind-generated

Some foam occurrences observed to-date have exhibited one of these characteristics (e.g. floating bubbles that don't accumulate will not be associated with any other characteristic), while some have exhibited one or more of these characteristics (e.g. frozen foam can be deflated or fluffy).

High turbulence generated foam tends to be fluffy, actively regenerates, and does not appear to contain high levels of organic material; while older, deflated foam does not actively regenerate and appears to be rich in organic or non-organic particulates. Foam observed along creeks and streams tend to vary in appearance and can occur with any combination of the above-listed characteristics. Wind-generated foam has only been observed on lakes, has generally been white and fluffy, and has actively accumulated along a downwind shoreline. Both organic-rich foam and unfrozen foam with a wrinkled appearance have been observed to accumulate along ice dams or ice shelves.

Detailed characterization and continued site reconnaissance of foam will generate a more robust evaluation of foam types and the conditions with which they form along the Project 1007 Corridor.

4. PFAS Concentrations in Foam

To date, 20 foam samples have been collected and analyzed (**Table C-2**). In the absence of site-specific foam screening criteria, PFAS concentrations in foam are compared to the Minnesota Department of Health (MDH) Health-Based Values (HBVs) for drinking water when available. HBVs have been established for PFOA (0.035 micrograms per liter (µg/L)), PFOS (0.015 µg/L), PFBA (7.0 µg/L), PFHxS (0.047 µg/L), and PFBS (2.0 µg/L).

PFAS was detected in all analyzed foam samples with exceedances of MDH HBVs for PFOA and PFOS in all samples. The PFHxS HBV was also exceeded in foam samples from RC5, RC21, and VB3. PFOS concentrations were generally the highest of any PFAS compound ranging from 13,800 µg/L (RC7, 8/14/2019) to 2.55 µg/L (VB1, 4/7/2020), followed by PFOA (ranging from 175 µg/L (RC7, 8/14/2019) to 0.0845 µg/L (VB1, 4/7/2020)). RC7 (8/12/2019) was an exception to this as ETFOSAA had a higher concentration than PFOS (94.5 µg/L compared to 40.1 µg/L). PFDA, PFOSA, and ETFOSAA were also detected above laboratory reporting limits in all foam samples analyzed.

Of the 33 compounds analyzed, 24 of the compounds were detected in at least one of the foam samples. Samples collected from RC7 (8/14/2019), RC12 (8/14/2019), RC17 (8/14/2019), and WL6 (2/25/2020) had the greatest overall number of PFAS detections. In general, the short chain perfluorocarboxylic acids (PFCAs), short chain perfluorosulfonic acids (PFSAs), fluorotelomers, and replacement chemistries were not consistently detected in foam and only in low concentrations when detected.

Pending Results

Foam collected from associated water bodies located outside of the primary Project 1007 flow path have been sampled and submitted for analysis. However, analytical results for these samples are pending with the exception of the samples collected from Valley Branch Creek (VB1 and VB2), which have concentrations of PFOS and PFOA above MDH HBVs.

Laboratory Detection Limits

A laboratory non-detection in the foam samples cannot infer a specific compound is not present in the foam. Laboratory detection limits were higher for foam samples analyzed compared to other sampled media because specific constituents (PFOS, PFOA) were present at elevated concentrations and resulted in laboratory dilution of the samples.

5. Seasonal Observations of Foam

Foam reconnaissance was conducted in August 2019, and on a monthly basis from February 2020 through June 2020. Due to the relatively short-lived and elusive nature of foam, foam present in sufficient quantities was typically collected and submitted for analysis in areas where it was previously not observed. General observations of the foam types, occurrences, and other environmental conditions were compared to evaluate seasonal variability in foam along Project 1007.

Winter

In general, stream flow along Project 1007 is lower in the winter than in the spring and summer, which may prevent foam from being washed downstream. When foam was observed, it was typically an orange-brown color, in stark contrast with the bright white color of the surrounding snow, and often appeared as thin, deflated windrows.

In the winter, there were stretches of open channels that were turbulent and unfrozen, followed by calm or stagnant downstream stretches that froze and turned into ice, allowing for the foam to accumulate. In some cases, the foam appeared frozen or partially frozen, and in other cases the foam accumulated on top of a thin sheet of ice.

Overall, foam was seen at more locations and more frequently during the winter compared to other times of the year. Possible explanations for this are as follows:

- PFAS compounds may be less soluble in water at lower temperatures.
- The foam piles may be stable at lower temperatures (i.e. slower to condense back into the water column).
- There are more channel obstructions such as ice dams on which the generated foam accumulates.
- Seasonal changes in water chemistry such as variations in total dissolved solids (TDS) or chlorides that may encourage foam formation.

Spring and Summer

During baseline conditions in the spring and summer, foam bubbles were often observed in the stream channel but may not have been accumulating into a foam mass. Often the exception to this was the period following a high rain event where there was a short but large increase in surface water runoff that generated turbulence and may have encouraged foam to form and accumulate in small, protected areas of a stream.

In nearly all locations where foam was sampled, there were natural obstructions present in the channel such as reeds, leaves, small boulders, fallen trees, or branches that contributed to the reduction of surface tension which then encouraged the formation of bubbles and/or created an environment for the bubbles to coalescence and temporarily form a foam mass. Rain may also disrupt the integrity of the foam and increase the rate that it condenses.

Overall, the foam seen in the spring and summer appears to be more transient and regularly appears following rain events. Additionally, foam observed in a given location was often no longer present at the same location on the following day or after several hours.

6. Foam Enrichment Factors

Foam enrichment factors are the calculated fold increase (or decrease) of PFAS concentrations in foam compared to the co-located surface water sample. These values are unitless and are determined by dividing the foam concentration of a specific PFAS compound by the concentration of the same compound detected in the surface water sample. The

foam enrichment factor for a given PFAS compound indicates whether that compound is preferentially concentrating into the foam from the bulk water column. Calculated foam enrichment factors are included in **Table C-3**.

Surface water samples used to calculate the foam enrichment factors were collected both upgradient and downgradient of where foam appeared to be generating or accumulating. Foam enrichment factors were not calculated for all foam samples because some surface water samples were not collected concurrently with foam samples from the same location. This was the case for RC16 (4/7/2020), VB1 (4/7/2020), and VB3 (4/7/2020). Additionally, foam enrichment factors were not calculated for all PFAS compounds because of the higher detection limits of the foam samples. In many of the samples where a specific PFAS compound was detected in the surface water sample but not in the foam, the detection limit in the foam was higher than the concentration measured in the water.

Currently, the extent to which the presence of foam may deplete PFAS concentrations in surface water is unclear. A summary of foam enrichment factors of short chain and long chain PFAS compounds is provided below:

Short Chain PFAS Compounds

The short chain PFAS compounds did not tend to enrich into the foam. Often the four, five, and six-carbon length chains were not detected in the foam samples. If they were detected, their concentrations were lower compared to concentrations measured in the surface water sample. An exception to this is foam sampled from RC21 (2/24/2020) which had similar concentrations of PFBA, PFBS, and PFHxA in the surface water and foam samples.

Long Chain PFAS Compounds

Long chain PFAS compounds were found to have relatively higher foam-to-water enrichment factors than short chain PFAS compounds. This is likely because the long chain compounds are less soluble in water and PFAS compounds are surface active compounds that tend to dwell at the air-water interface. As a result, the compounds will preferentially concentrate in the surface microlayer (SML), an approximately 50 micrometers (µm)-thin layer and diffuse into foam. In a majority of the samples, ETFOSAA and PFOSA had the largest foam enrichment, with the exception of RC12 (8/14/2019), RC17 (8/14/2019), and RC17A (8/14/2019) where PFDA was higher than PFOSA, and at RC21 (2/24/2020), RC18A (5/5/2020), EP21 (4/23/2020) and WL11 (5/5/2020) where neither ETFOSAA and PFOSA were detected in the surface water sample.

Summary

The value of PFAS surface water concentrations to foam concentration enrichment factors in the fate and transport of PFAS in surface water, in particular the SML, is not well understood. Future data evaluation will be performed to determine if enrichment factors are useful diagnostic data points for the development of a comprehensive conceptual site model. For reference, foam enrichment factors are provided in **Table C-3**.

7. Conclusion

PFAS-enriched foams have regularly been observed in some stretches of the Project 1007 Corridor while foam occurs more intermittently in other areas. Foam has also been observed in associated water bodies near but not directly in the flow path of Project 1007. The presence of various water bodies and flow conditions in the Project 1007 Corridor may impact the different types of foam and the range of PFAS compounds that are detected. The extent to which the presence of foam may deplete PFAS concentrations in surface water remains unknown.

The foam observed and collected to-date have allowed for preliminary conclusions regarding the extent, types, and range of PFAS concentrations in the foam sampled to-date across the Project 1007 Corridor. Temperature variability appears to have an influence on the visual characteristics of foam but little influence on measured concentrations. Continued foam sampling for PFAS analysis is not planned during the seasonal or high rain sampling events in 2020 unless foam is observed in a new location in the corridor or associated water bodies; however, foam may be collected to support a planned ecological risk assessment.

The MPCA and AECOM plan to collaborate with the Environmental Protection Agency (EPA) Office of Research and Development (ORD) to better understand how to collect foam, the parameters that influence foam formation, and the extent to which the SML affects the fate and transport of PFAS in the Project 1007 Corridor. Work conducted with ORD will contribute to the understanding of how environmental conditions such as water chemistry, flow regime, and wind speed affect the occurrence and types of PFAS compounds present in PFAS-containing foam. Work with ORD will also focus on the formation of SML and the extent that PFAS is concentrated in this layer.

The presence of high PFAS concentrations in foam observed and sampled along the Project 1007 conveyance system and associated water bodies signifies the importance foam plays in the fate and transport of PFAS in the project area.

Figures
Figure C-1 – Sampled and Observed Foam
Figure C-2 – Foam PFAS Analytical Results

Tables
Table C-1 – Foam Characteristics
Table C-2 – Foam PFAS Analytical Results
Table C-3 – Foam Enrichment Factors

Attachments
Attachment C-1 – Sampled and Observed Foam

APPENDIX C
FIGURES

Figure C-1
Sampled and Observed Foam
Six-Month Investigation Progress Report
(November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Project 1007 Structures
- Catch Basin
- Manhole
- Other Structure
- Channel
- Culvert
- Pipe

- Washington County Landfill connection
- MnDOT Pipeline
- Surface Water Body

RC7 Sampled Foam
RC7 Observed Foam

* = Sample results are pending.
** = Foam was collected at both the RC16 and RC16A locations and combined as one composite sample.
*** = A second sample was collected here and submitted for analysis for the solid and liquid fraction. Results are pending.

AECOM

N W E S

0 0.5 1 1.5 2 Miles

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community; Other Sources: MDH, Barr Engineering
AECOM Path: C:\Users\marie.santos\Desktop\Project 1007 OFFLINE\GIS temp\6-Month Investigation Progress Report\Figure C-1 - Foam Sampled and Observed.mxd Revised: 8/4/2020 By MGD

Notes:
Foam concentrations are reported in micrograms per liter (µg/L) or parts per billion (ppb)
<0.0002 = Concentration is less than laboratory reportable limit
Bold = Result is above the laboratory minimum reporting limit
J = Estimated concentration
D = Dilution data
MDH = Minnesota Department of Health
HBV = Health-Based Value

Exceedance of MDH HBVs:
PFBA = 7.0 ppb
PFOA = 0.035 ppb
PFBS = 2.0 ppb
PFHxS = 0.047 ppb
PFOS = 0.015 ppb

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs

RC5	2/24/2020
	Foam
PFBA	0.51
PFOA	1.24
PFBS	0.0205
PFHXS	0.0752
PFOS	30.7

RC7	8/12/2019	8/14/2019
	Foam	Foam
PFBA	< 0.311	< 32
PFOA	0.658	175
PFBS	< 0.0777	< 8
PFHXS	< 0.0777	< 8
PFOS	40.1	13,800

RC7A	2/24/2020
	Foam
PFBA	< 3.180
PFOA	5.21
PFBS	< 0.796
PFHXS	< 0.796
PFOS	531

RC12	8/14/2019	4/28/2020
	Foam	Foam
PFBA	< 32	0.501 J
PFOA	16.2 J	9.11
PFBS	< 8	<0.0703
PFHXS	< 8	0.371
PFOS	10,500	391 D

RC17	8/14/2019
	Foam
PFBA	< 8
PFOA	3.75 J
PFBS	< 2
PFHXS	< 2
PFOS	2,750

RC16**	4/7/2020
	Foam
PFBA	0.0995
PFOA	0.117
PFBS	<0.00584
PFHXS	0.0144 J
PFOS	3.67

RC21	2/24/2020	4/23/2020
	Foam	Foam
PFBA	0.103	0.079
PFOA	6.79	0.212
PFBS	0.00471	<0.00576
PFHXS	1.13	0.0353
PFOS	56.4	1.57

RC18A***	5/5/2020
	Foam
PFBA	0.96
PFOA	0.165
PFBS	< 0.00665
PFHXS	0.026
PFOS	8.22

RC17A	8/14/2019
	Foam
PFBA	< 0.316
PFOA	0.504
PFBS	< 0.0791
PFHXS	< 0.0791
PFOS	595 D

EP25	5/11/2020
	Foam
PFBA	<3.170
PFOA	1.54 J
PFBS	<0.792
PFHXS	<0.792
PFOS	1,630 D

EP21B	5/5/2020	5/5/2020
	Foam	Foam Duplicate
PFBA	0.839 J	0.83
PFOA	1.05	1.07
PFBS	<0.110	<0.0995
PFHXS	<0.110	<0.0995
PFOS	904 D	862 D

EP21A	4/23/2020
	Foam
PFBA	0.897 J
PFOA	0.521
PFBS	< 0.111
PFHXS	< 0.111
PFOS	216 D

WL6	2/25/2020
	Foam
PFBA	< 3.170
PFOA	1.54
PFBS	< 0.792
PFHXS	< 0.792
PFOS	1,630

WL11	5/5/2020
	Foam
PFBA	0.431
PFOA	1.25
PFBS	<0.0097
PFHXS	0.0576
PFOS	1,630 D

VB1	4/7/2020
	Foam
PFBA	0.127
PFOA	0.0845
PFBS	<0.00588
PFHXS	0.0163 J
PFOS	2.55

VB3	4/7/2020
	Foam
PFBA	0.252
PFOA	2.42
PFBS	<0.0108
PFHXS	0.218
PFOS	103 D

Figure C-2
Foam PFAS Analytical Results
Six-Month Investigation Progress Report
(November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Project 1007 Structures
- Catch Basin
- Manhole
- Other Structure
- Channel
- Culvert
- Pipe

- Washington County Landfill connection
- MnDOT Pipeline
- Surface Water Body

RC7 Sampled Foam
RC7 Observed Foam

* = Sample results are pending.
** = Foam was collected at both the RC16 and RC16A locations and combined as one composite sample.
*** = A second sample was collected here and submitted for analysis for the solid and liquid faction. Results are pending.

AECOM

N W E S

0 0.5 1 1.5 2 Miles

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community; Other Sources: MDH, Barr Engineering
AECOM Path: C:\Users\marie.santos\Desktop\Project 1007 OFFLINE\GIS temp\6-Month Investigation Progress Report\Figure C-1 - Foam Sampled and Observed.mxd Revised: 8/4/2020 By MGD

APPENDIX C
TABLES

Table C-1
Foam Characteristics
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

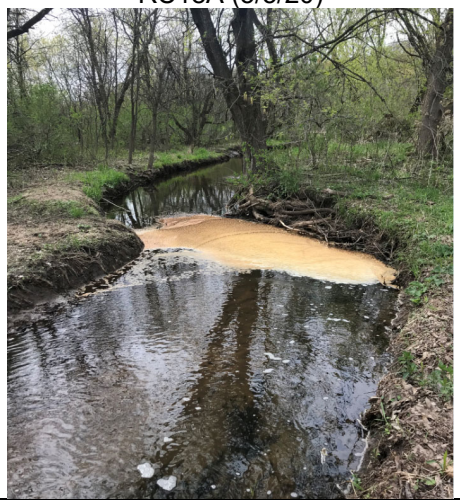
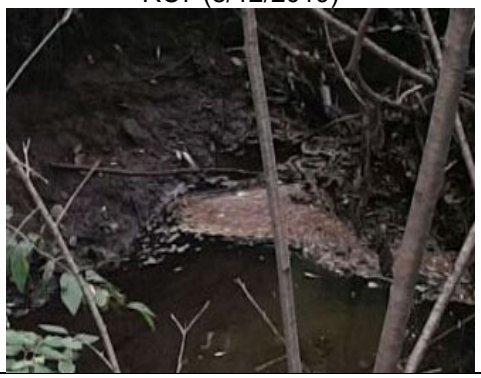
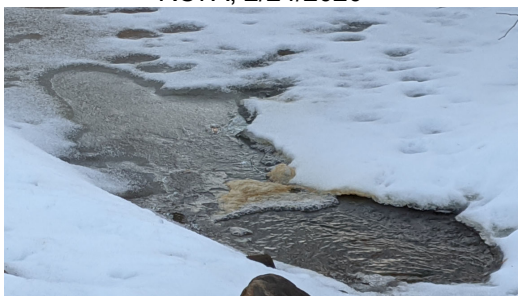
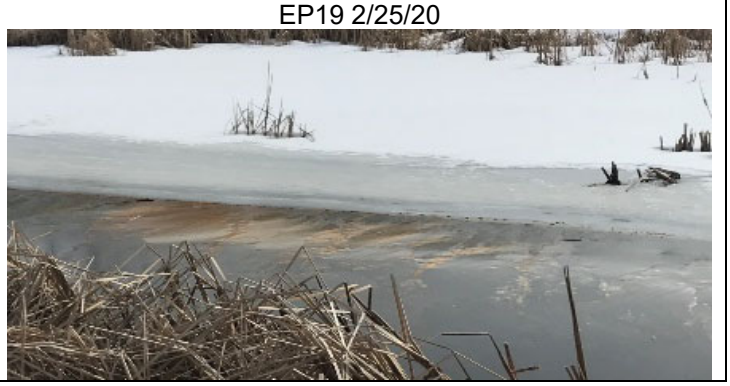
Generic Foam Type	Description	Sampling Location Photo
Actively Generating and Reaccumulating	Foam is observed floating upstream of the accumulation point and continuing to actively accumulate at a location. Frequently source of generation is apparent, and foam will reaccumulate rapidly after sample collection. This foam can either accumulate in large quantities in singular locations or across a wide stretch of creek bank.	RC18A (5/5/20) 
Deflated (old)	Foam is typically thin, in smaller quantities, and discolored with organic matter present. Further, no foam is observed upstream or downstream of point of accumulation, and source of generation is not obvious. This foam is thought to be old because it has never been observed to be actively generating.	RC7 (8/12/2019) 
Frozen	Foam appears frozen, often has a different color and texture from surrounding snow and ice and is usually thin.	RC7A, 2/24/2020  EP19 2/25/20 

Table C-1
Foam Characteristics
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

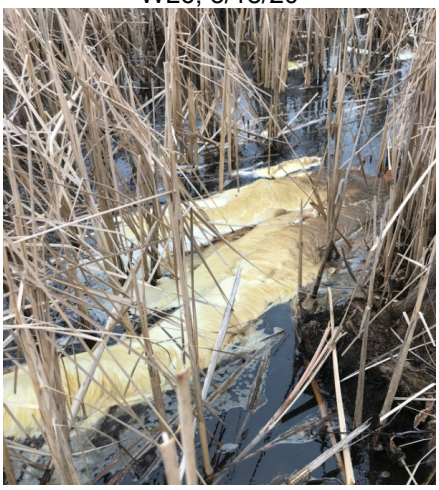
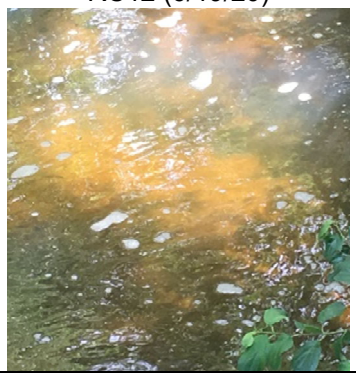
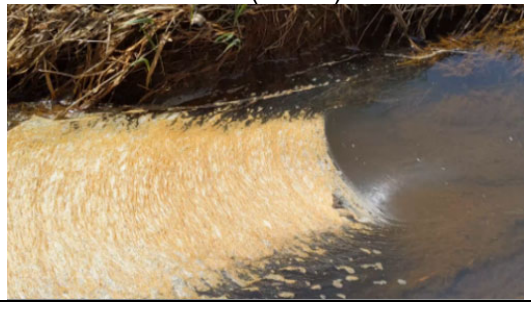
Generic Foam Type	Description	Sampling Location Photo
Accumulation due to Presence of Ice	Foam is not frozen but is able to accumulate on top of thin ice layers. Frequently has a wrinkled appearance.	WL6, 3/18/20 
Floating Bubbles (not accumulating)	Foam bubbles floating down stream but not accumulating either due to rapid re-condensation into water column or an absence of material to accumulate on. Frequently this foam will catch on the bank roots and grasses in small quantities for short periods of time. Due to the sporadic nature and minimal quantities, this type of foam could not be sampled.	RC12 (6/19/20) 
Organic / Particulate Rich	Foam is brown in appearance. This has been observed in both deflated and actively generating foam. For the actively generating foam, the foam may either be colored with dissolved organic matter or it could be accumulating on a biosheen. For the foam that accumulating on a biosheen, the surface of the foam frequently has a wrinkled appearance due	RC16 (4/7/2020)  RC5 (5/5/20) 

Table C-1
Foam Characteristics
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

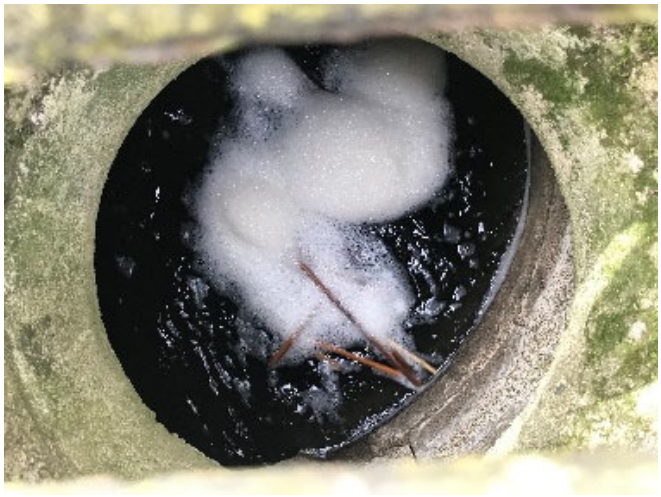
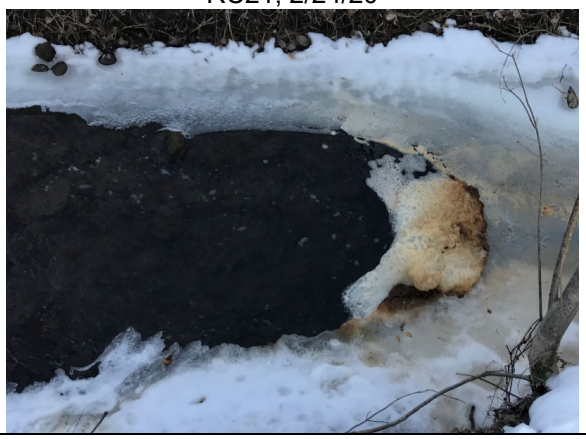
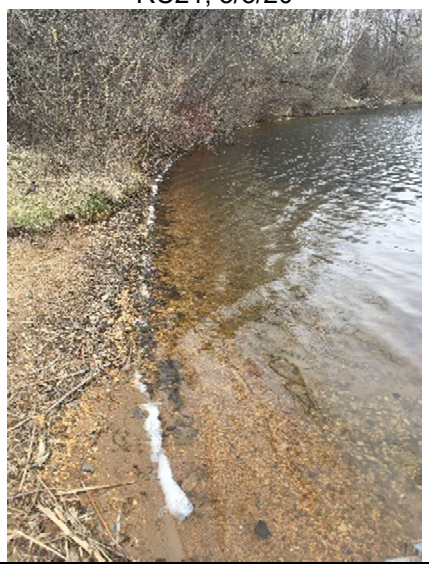
Generic Foam Type	Description	Sampling Location Photo
High Turbulence Generated Fluffy Foam	Foam is typically bright white in color, fluffy, and has been observed as generated from high turbulence factors such as culverts, high flow, and natural eddies and waterfalls. In addition, this foam has been observed when there is a natural dam that allows for consistent accumulation. In winter conditions, ice can act as an effective dam. This foam typically remains stable for longer periods of time and can be discolored but does not appear to be organic.	WL11 5/5/2020  RC21, 2/24/20 
Wind Generated	Energy input to cause foam formation is from waves caused by wind. Foam has been typically observed as white and fluffy.	RC21, 5/5/20 

Table C-2
Foam PFAS Analytical Results
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

CAS Number			375-22-4	2706-90-3	307-24-4	375-85-9	335-67-1	375-95-1	335-76-2	2058-94-8	307-55-1	72629-94-8	376-06-7	375-73-5	2706-91-4	355-46-4	375-92-8	1763-23-1
MDH HBV (µg/L)			7.0	NS	NS	NS	0.035	NS	NS	NS	NS	NS	NS	2.0	NS	0.047	NS	0.015
Location ID	Sample ID	Sample Date	PFBA	PFPEA	PFHXA	PFHPA	PFOA	PFNA	PFDA	PFUNA	PFDOA	PFTRDA	PFTEDA	PFBS	PFPES	PFHxS	PFHPS	PFOS
RC7	RC7-FOAM-081219	8/12/2019	< 0.311	< 0.155	< 0.0777	< 0.0777	0.658	< 0.0777	1.62	1.93	1.17	< 0.0777	< 0.0777	< 0.0777	< 0.0777	< 0.0777	< 0.0777	40.1
RC7	RC7-FOAM-081419	8/14/2019	< 32	< 16	< 8	< 8	175	14.7 J	96.5	< 8	< 8	< 8	< 8	< 8	< 8	< 8	24.9	13,800
RC12	RC12-FOAM-081419	8/14/2019	< 32	< 16	< 8	< 8	16.2 J	11.1 J	72.8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	10,500
RC17	RC17-FOAM-081419	8/14/2019	< 8	< 4	< 2	< 2	3.75 J	< 2	31.5	3.63 J	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2,750
RC17A	RC17A-FOAM-081419	8/14/2019	< 0.316	< 0.158	< 0.0791	< 0.0791	0.504	0.332	5.26	0.401	< 0.0791	< 0.0791	< 0.0791	< 0.0791	< 0.0791	< 0.0791	0.243	595 D
RC5	RC5-FOAM-01-022420	2/24/2020	0.51	0.0438 J	0.0924 J	0.0905	1.24	0.0394	0.378	0.0217 J	< 0.0108	< 0.0108	< 0.0108	0.0205 J	0.0233	0.0752	0.0788	30.7 D
RC7A	RC7A-FOAM-01-022420	2/24/2020	< 3.180	< 1.590	< 0.796	< 0.796	5.21	< 0.796	8.2	1.8	< 0.796	< 0.796	< 0.796	< 0.796	< 0.796	< 0.796	< 0.796	531
RC21	RC21-FOAM-01-022420	2/24/2020	0.103	< 0.00872	0.0174 J	0.0599	6.79	7.31	2.88	0.196	0.0237	0.00653 J	< 0.00436	0.00471 J	< 0.00436	1.13	0.642	56.4 D
WL6	WL6-FOAM-01-022520	2/25/2020	< 3.170	< 1.580	< 0.792	< 0.792	1.54 J	2.73	15.3	0.846 J	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	1.65	1630 D
RC16	RC16-FOAM-01-040720	4/7/2020	0.0995	<0.0117	<0.00584	<0.00584	0.117	0.352	0.475	0.153	0.037	0.00678 J	<0.00584	<0.00584	<0.00584	0.0144 J	0.0164	3.67
VB1	VB1-FOAM-01-040720	4/7/2020	0.127	<0.0128	<0.0135	<0.00588	0.0845	0.0398	0.0687	0.0581	0.0301	<0.00588	0.00595 J	<0.00588	<0.00588	0.0163 J	0.0105 J	2.55
VB3	VB3-FOAM-01-040720	4/7/2020	0.252	<0.0217	0.0108	0.0239 J	2.42	0.317	0.0648	0.0689	0.0141 J	<0.0108	<0.0125	<0.0108	<0.0108	0.218	0.7	103 D
RC21	RC21-FOAM-01-042320	4/23/2020	0.0793	<0.0115	0.00651 J	0.00617 J	0.212	0.184	0.139	0.03	0.00968 J	<0.00576	<0.00576	<0.00576	<0.00576	0.0353	0.00909 J	1.57
EP21A	EP21-FOAM-01-042320	4/23/2020	0.897 J	<0.223	<0.111	<0.111	0.521	0.26	2.11	0.331	<0.111	<0.111	<0.111	<0.111	<0.111	<0.111	0.15 J	216 D
RC12	RC12-FOAM-01-042820	4/28/2020	0.501 J	<0.141	0.124 J	0.155	9.11	0.635	2.52	0.158	0.0748 J	<0.0703	<0.0703	<0.0703	<0.0703	0.371	1.91	391 D
RC18A	RC18A-FOAM-FRESH-01-050520	5/5/2020	0.0963	<0.0133	0.007 J	<0.00665	0.165	0.312	0.697	0.375	0.149	0.0292	0.0128 J	<0.00665	<0.00665	0.026	0.0153	8.22
EP21B	EP21-FOAM-01-050520	5/5/2020	0.839 J	<0.22	<0.11	<0.11	1.05	0.999	10.8	0.952	0.125 J	<0.11	<0.11	<0.11	<0.11	<0.11	0.503	904 D
EP21B	EP21-FOAM-02-050520 (DUP)	5/5/2020	0.83	<0.199	<0.0995	<0.0995	1.07	1	10.4	1.1	0.144 J	<0.0995	<0.0995	<0.0995	<0.0995	<0.0995	0.498	862 D
WL11	WL11-FOAM-01-050520	5/5/2020	0.431	<0.0199	0.0221 J	0.0202 J	1.25	0.169	0.489	0.0323	<0.00997	<0.00997	<0.00997	<0.00997	<0.00997	0.0576	0.257	87.1 D
EP25	EP25-FOAM-01-051120	5/11/2020	4.9	0.0701	0.0586	0.0153	0.481	0.106	0.155	0.084	0.0117 J	<0.00637	<0.00637	<0.00637	<0.00637	<0.00637	<0.00637	1.11

Notes:
MDH - Minnesota Department of Health
HBV - Health-Based Values
NS - No standard
All results are shown in parts per billion (ppb) or µg/L
Result is in exceedance of MDH HBV for drinking water
Bold - Result is above the laboratory minimum reporting limit.
< 0.0002 - Concentration is less than laboratory reportable limit
J - Estimated concentration
D - Dilution data
DUP - Duplicate sample

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs
Fluortelomers
FOSA, FASE, FASAAs
Replacement Chemistries

Table C-2
Foam PFAS Analytical Results
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

CAS Number			68259-12-1	335-77-3	79780-39-5	757124-72-4	27619-97-2	39108-34-4	754-91-6	31506-32-8	4151-50-2	2355-31-9	2991-50-6	24448-09-7	1691-99-2	13252-13-6	919005-14-4	756426-58-1	763051-92-9
MDH HBV (µg/L)			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Location ID	Sample ID	Sample Date	PFNS	PFDS	PFDOS	4:2 FTS	6:2 FTS	8:2 FTS	PFOSA	N-MEFOSA	N-ETFOSA	MEFOSAA	ETFOSAA	N-MEFOSE	N-ETFOSE	HFPO-DA	ADONA	9CL-PF3ONS	11CL-PF3OUDS
RC7	RC7-FOAM-081219	8/12/2019	**1.1**	**3.1**	< 0.0777	< 0.311	< 0.28	< 0.311	**18.8**	**2.12**	**5.5**	**1.18**	**94.5**	< 0.777	< 0.583	< 0.311	< 0.311	< 0.311	< 0.311
RC7	RC7-FOAM-081419	8/14/2019	**12.6 J**	**< 8**	< 8	< 32	**592**	< 32	**270**	< 9.2	< 20	< 8	**263**	< 80	< 60	< 32	< 32	< 32	< 32
RC12	RC12-FOAM-081419	8/14/2019	< 8	< 8	< 8	< 32	**361 J**	< 32	**71.1**	< 9.2	< 20	< 8	**168**	< 80	< 60	< 32	< 32	< 32	< 32
RC17	RC17-FOAM-081419	8/14/2019	**3.17 J**	< 2	< 2	< 8	< 7.2	< 8	**51**	< 2.3	< 5	**2.1 J**	**92.5**	< 20	< 15	< 8	< 8	< 8	< 8
RC17A	RC17A-FOAM-081419	8/14/2019	**0.582**	**0.147 J**	< 0.0791	< 0.316	< 0.285	< 0.316	**8.78**	< 0.0909	**0.211 J**	**0.216**	**10.6**	< 0.791	< 0.593	< 0.316	< 0.316	< 0.316	< 0.316
RC5	RC5-FOAM-01-022420	2/24/2020	**0.0416 R**	**0.0155 J**	< 0.0108	< 0.0432	< 0.0389	< 0.0432	**2.96**	**0.0131 J**	**0.204**	**0.0274**	**4.01**	< 0.108	< 0.0811	< 0.0411	< 0.0432	< 0.0432	< 0.0432
RC7A	RC7A-FOAM-01-022420	2/24/2020	**2.950 R**	**3.16**	< 0.796	< 3.180	< 2.870	< 3.180	**103**	**5.31**	**54.1**	**1.320 J**	**96.4**	< 7.960	< 5.970	< 3.020	< 3.180	< 3.180	< 3.180
RC21	RC21-FOAM-01-022420	2/24/2020	< 0.00436	< 0.00436	< 0.00436	< 0.0174	< 0.0157	< 0.0174	**0.214**	< 0.00501	< 0.0109	**0.0315**	**0.136**	< 0.0436	< 0.0327	< 0.0166	< 0.0174	< 0.0174	< 0.0174
WL6	WL6-FOAM-01-022520	2/25/2020	< 0.792	< 0.792	< 0.792	< 3.170	< 2.850	< 3.170	**8.57**	< 0.911	< 1.980	< 0.792	**8.4**	< 7.920	< 5.940	< 3.010	< 3.170	< 3.170	< 3.170
RC16	RC16-FOAM-01-040720	4/7/2020	<0.00584	<0.00584	<0.00584	<0.0234	**<0.021**	<0.0234	**0.521**	<0.00672	<0.0146	**0.0511**	**0.0727**	<0.0584	<0.0438	<0.0222	<0.0234	<0.0234	<0.0234
VB1	VB1-FOAM-01-040720	4/7/2020	**<0.00588**	**0.0194**	<0.00588	<0.0235	<0.0212	<0.0235	**0.123**	**0.0175**	<0.0147	**0.415**	**0.287**	**0.119 J**	<0.0441	<0.0224	<0.0235	<0.235	<0.235
VB3	VB3-FOAM-01-040720	4/7/2020	**<0.0108**	**<0.0108**	<0.0108	<0.0433	<0.039	<0.0433	**0.0113 J**	<0.0125	<0.0271	**0.0168 J**	**0.0205 J**	<0.108	<0.0812	<0.0411	<0.0433	<0.0433	<0.0433
RC21	RC21-FOAM-01-042320	4/23/2020	<0.00576	<0.00576	<0.00576	<0.0231	**0.0561 J**	<0.0231	**0.0143**	<0.00663	<0.0144	**0.0147**	**0.0259**	<0.0576	<0.0432	<0.0219	<0.0231	<0.0231	<0.0231
EP21A	EP21-FOAM-01-042320	4/23/2020	<0.111	<0.111	<0.111	<0.445	<0.401	<0.445	**0.463**	<0.128	<0.278	<0.111	**1.3**	<1.11	<0.835	<0.423	<0.445	<0.445	<0.445
RC12	RC12-FOAM-01-042820	4/28/2020	**0.364**	**0.221 J**	<0.0703	<0.281	<0.253	**0.28**	**3.79**	<0.0808	<0.176	<0.0703	**7.7**	<0.703	<0.527	<0.267	<0.281	<0.281	<0.281
RC18A	RC18A-FOAM-FRESH-01-050520	5/5/2020	**0.0211 J**	**0.0452**	<0.00665	<0.0266	<0.024	<0.0266	**0.0946**	<0.00765	<0.0166	**0.0814**	**0.324**	<0.0665	<0.0499	<0.0253	<0.0266	<0.0266	<0.0266
EP21B	EP21-FOAM-01-050520	5/5/2020	<0.11	<0.11	<0.11	<0.44	<0.396	<0.44	**0.737**	<0.127	<0.275	**0.365**	**3.12**	<1.1	<0.825	<0.418	<0.44	<0.44	<0.44
EP21B	EP21-FOAM-02-050520 (DUP)	5/5/2020	<0.0995	<0.0995	<0.0995	<0.398	<0.358	<0.398	**0.692**	<0.114	<0.249	**0.358**	**2.81 D**	<0.995	<0.747	<0.378	<0.398	<0.398	<0.398
WL11	WL11-FOAM-01-050520	5/5/2020	**0.0288 J**	<0.00997	<0.00997	<0.0399	<0.0359	<0.0399	**0.225**	<0.0115	<0.0249	**0.0131 J**	**0.553**	<0.0997	<0.0747	<0.0379	<0.0399	<0.0399	<0.0399
EP25	EP25-FOAM-01-051120	5/11/2020	<0.00637	<0.00637	<0.00637	<0.0255	<0.0229	<0.0255	**0.00793 J**	<0.00732	<0.0159	**0.0153**	**0.0235**	<0.0637	<0.0477	<0.0242	<0.0255	<0.0255	<0.0255

Notes:
MDH - Minnesota Department of Health
HBV - Health-Based Values
NS - No standard
All results are shown in parts per billion (ppb) or µg/L
Result is in exceedance of MDH HBV for drinking water
Bold - Result is above the laboratory minimum reporting limit.
< 0.0002 - Concentration is less than laboratory reportable limit
J - Estimated concentration
D - Dilution data
DUP - Duplicate sample

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs
Fluortelomers
FOSA, FASE, FASAAs
Replacement Chemistries

Table C-3
Foam Enrichment Factors
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

PFAS Compound	CAS Number	Number of Carbons	RC5 (2/24/2020)				RC7A (2/24/2020)				RC7 (8/12/2019)				RC7 (8/14/2019)			
			Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor
PFBA	375-22-4	4	**0.51**	**0.764**	**0.314**	0.67	< 3.180	**0.659**	NS		< 0.311	**0.349**	**0.53**		< 32	**0.158 J**	**0.53**	
PFPEA	2706-90-3	5	**0.0438**	**0.0662**	< 0.132	0.66	< 1.590	**0.0584**	NS		< 0.155	**0.0218**	< 0.149		< 16	**0.0125**	< 0.149	
PFHXA	307-24-4	6	**0.0924**	**0.141**	< 0.0662	0.66	< 0.796	**0.135**	NS		< 0.0777	**0.0463**	**0.092**		< 8	**0.0223**	**0.092**	
PFHPA	375-85-9	7	**0.0905**	**0.107**	< 0.0662	0.85	< 0.796	**0.0979**	NS		< 0.0777	**0.0338**	< 0.0746		< 8	**0.015**	< 0.0746	
PFOA	335-67-1	8	**1.24**	**0.949**	**0.634**	1.31	**5.21**	**0.88**	NS	5.92	**0.658**	**0.347**	**0.684**	1.90	**175**	**0.184**	**0.684**	951.09
PFNA	375-95-1	9	**0.0394**	**0.00615**	< 0.0662	6.41	< 0.796	**0.00533**	NS		< 0.0777	**0.00402**	< 0.0746		**14.7**	**0.00252**	< 0.0746	5833.33
PFDA	335-76-2	10	**0.378**	**0.00624**	**0.175**	60.58	**8.2**	**0.00512**	NS	1601.56	**1.62**	**0.00793**	**0.139**	204.29	**96.5**	**0.00666**	**0.139**	14489.49
PFUNA	2058-94-8	11	**0.0217**	< 0.00074	< 0.0662		**1.8**	< 0.000737	NS		**1.93**	< 0.000737	< 0.0746		< 8	< 0.000783	< 0.0746	
PFDOA	307-55-1	12	< 0.0108	< 0.00074	**0.127**		< 0.796	< 0.000737	NS		**1.17**	< 0.000737	< 0.0746		< 8	< 0.000783	< 0.0746	
PFTRDA	72629-94-8	13	< 0.0108	< 0.00074	< 0.0662		< 0.796	< 0.000737	NS		< 0.0777	< 0.000737	< 0.0746		< 8	< 0.000783	< 0.0746	
PFTEDA	376-06-7	14	< 0.0108	< 0.00074	< 0.0662		< 0.796	< 0.000737	NS		< 0.0777	< 0.000737	< 0.0746		< 8	< 0.000783	< 0.0746	
PFBS	375-73-5	4	**0.0205**	**0.034**	< 0.0662	0.60	< 0.796	**0.0329**	NS		< 0.0777	**0.0145**	< 0.0746		< 8	**0.00569**	< 0.0746	
PFPES	2706-91-4	5	**0.0233**	**0.0352**	< 0.0662	0.66	< 0.796	**0.0356**	NS		< 0.0777	**0.0137**	< 0.0746		< 8	**0.00623**	< 0.0746	
PFHxS	355-46-4	6	**0.0752**	**0.0933**	**0.081**	0.81	< 0.796	**0.0845**	NS		< 0.0777	**0.0367**	< 0.0746		< 8	**0.0183**	< 0.0746	
PFHPS	375-92-8	7	**0.0788**	**0.0258**	< 0.0662	3.05	< 0.796	**0.0221**	NS		< 0.0777	**0.0157**	< 0.0746		**24.9**	**0.00915**	< 0.0746	2721.31
PFOS	1763-23-1	8	**30.7**	**1.4**	**27.5**	21.93	**531**	**1.37**	NS	387.59	**40.1**	**1.91**	**11.5**	20.99	**13,800**	**1.54**	**11.5**	8961.04
PFNS	68259-12-1	9	**0.0416**	< 0.00074	**0.118**		**2.95**	< 0.000737	NS		**1.1**	< 0.000737	< 0.0746		**12.6**	< 0.000783	< 0.0746	
PFDS	335-77-3	10	**0.0155**	< 0.00074	**0.316**		**3.16**	< 0.000737	NS		**3.1**	< 0.000737	**0.135**		< 8	< 0.000783	**0.135**	
PFDOS	79780-39-5	12	< 0.0108	< 0.00074	< 0.0662		< 0.796	< 0.000737	NS		< 0.0777	< 0.000737	< 0.0746		< 8	< 0.000783	< 0.0746	
4:2 FTS	757124-72-4	4	< 0.0432	< 0.00296	< 0.265		< 3.180	< 0.00295	NS		< 0.311	< 0.00295	< 0.298		< 32	< 0.00313	< 0.298	
6:2 FTS	27619-97-2	6	< 0.0389	< 0.00266	< 0.238		< 2.870	< 0.00265	NS		< 0.28	< 0.00265	< 0.268		**592**	< 0.00282	< 0.268	
8:2 FTS	39108-34-4	8	< 0.0432	< 0.00.96	< 0.265		< 3.180	< 0.00295	NS		< 0.311	< 0.00295	< 0.298		< 32	< 0.00313	< 0.298	
PFOSA	754-91-6	8	**2.96**	**0.0188**	**1.2**	157.45	**103**	**0.0168**	NS	6130.95	**18.8**	**0.0247**	**1.38**	761.13	**270**	**0.0172**	**1.38**	15697.67
N-MEFOSA	31506-32-8	8	**0.0131**	< 0.000851	**0.107**		**5.31**	< 0.000847	NS		**2.12**	< 0.000848	< 0.0858		< 9.2	< 0.0009	< 0.0858	
N-ETFOSA	4151-50-2	8	**0.204**	< 0.00185	**0.193**		**54.1**	< 0.00184	NS		**5.5**	< 0.00184	< 0.186		< 20	< 0.00196	< 0.186	
MEFOSAA	2355-31-9	8	**0.0274**	< 0.00074	< 0.0662		**1.32**	< 0.000737	NS		**1.18**	< 0.000737	< 0.0746		< 8	< 0.000783	< 0.0746	
ETFOSAA	2991-50-6	8	**4.01**	**0.0268**	**2.84**	149.63	**96.4**	**0.0161**	NS	5987.58	**94.5**	**0.0115**	**0.617**	8217.39	**263**	**0.0118**	**0.617**	22288.14
N-MEFOSE	24448-09-7	8	< 0.108	< 0.0074	< 0.662		< 7.960	< 0.00737	NS		< 0.777	< 0.00737	< 0.746		< 80	< 0.00783	< 0.746	
N-ETFOSE	1691-99-2	8	< 0.0811	< 0.00555	< 0.497		< 5.970	< 0.00553	NS		< 0.583	< 0.00553	< 0.559		< 60	< 0.00587	< 0.559	
HFPO-DA	13252-13-6	5	< 0.0411	< 0.00281	< 0.265		< 3.020	< 0.0028	NS		< 0.311	< 0.00295	< 0.298		< 32	< 0.00313	< 0.298	
ADONA	919005-14-4	7	< 0.0432	< 0.00296	< 0.265		< 3.180	< 0.00295	NS		< 0.311	< 0.00295	< 0.298		< 32	< 0.00313	< 0.298	
9CL-PF3ONS	756426-58-1	8	< 0.0432	< 0.00296	< 0.265		< 3.180	< 0.00295	NS		< 0.311	< 0.00295	< 0.298		< 32	< 0.00313	< 0.298	
11CL-PF3OUDS	763051-92-9	10	< 0.0432	< 0.00296	< 0.265		< 3.180	< 0.00295	NS		< 0.311	< 0.00295	< 0.298		< 32	< 0.00313	< 0.298	

Notes:
Surface water and foam PFAS results are shown in micrograms per liter (µg/L) or ppb.
Sediment PFAS results are shown in micrograms per kilogram (µg/kg) or ppb.
ppb - parts per billion
Bold - Result is above the laboratory minimum reporting limit.
< 0.0002 - Concentration is less than laboratory reportable limit
NS - No Sample Collected
DUP - duplicate sample

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs
Fluortelomers
FOSA, FASE, FASAAs
Replacement Chemistries

Table C-3
Foam Enrichment Factors
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

PFAS Compound	CAS Number	Number of Carbons	RC12 (8/14/2019)				RC21 (2/24/2020)				RC17 (8/14/2019)				RC17A (8/14/2019)			
			Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor
PFBA	375-22-4	4	< 32	**0.214 J**	**0.52**		**0.103**	**0.0884**	**0.425 J**	1.17	< 8	**0.194**	< 0.302		< 0.316	**0.194**	< 0.302	
PFPEA	2706-90-3	5	< 16	**0.0136**	< 0.146		< 0.00872	**0.00623**	<0.154		< 4	**0.00988**	< 0.151		< 0.158	**0.00988**	< 0.151	
PFHXA	307-24-4	6	< 8	**0.0222**	**0.115**		**0.0174**	**0.00458**	<0.0772	3.80	< 2	**0.0142**	< 0.0755		< 0.0791	**0.0142**	< 0.0755	
PFHPA	375-85-9	7	< 8	**0.0145**	< 0.0729		**0.0599**	**0.00239**	<0.0772	25.06	< 2	**0.00878**	< 0.0755		< 0.0791	**0.00878**	< 0.0755	
PFOA	335-67-1	8	**16.2**	**0.164**	**0.948**	98.78	**6.79**	**0.00748**	**0.344**	907.75	**3.75**	**0.095**	< 0.0755	39.47	**0.504**	**0.095**	< 0.0755	5.31
PFNA	375-95-1	9	**11.1**	**0.00217**	< 0.0729	5115.21	**7.31**	**0.000826**	<0.0772	8849.88	< 2	**0.00139**	< 0.0755		**0.332**	**0.00139**	< 0.0755	238.85
PFDA	335-76-2	10	**72.8**	**0.00441**	**0.459**	16507.94	**2.88**	< 0.00082	**0.103 J**		**31.5**	**0.00191**	< 0.0755	16492.15	**5.26**	**0.00191**	< 0.0755	2753.93
PFUNA	2058-94-8	11	< 8	< 0.000727	< 0.0729		**0.196**	< 0.00082	<0.0772		**3.63**	< 0.000722	< 0.0755		**0.401**	< 0.000722	< 0.0755	
PFDOA	307-55-1	12	< 8	< 0.000727	< 0.0729		**0.0237**	< 0.00082	<0.0772		< 2	< 0.000722	< 0.0755		< 0.0791	< 0.000722	< 0.0755	
PFTRDA	72629-94-8	13	< 8	< 0.000727	< 0.0729		**0.00653**	< 0.00082	<0.0772		< 2	< 0.000722	< 0.0755		< 0.0791	< 0.000722	< 0.0755	
PFTEDA	376-06-7	14	< 8	< 0.000727	< 0.0729		< 0.00436	< 0.00082	<0.0772		< 2	< 0.000722	< 0.0755		< 0.0791	< 0.000722	< 0.0755	
PFBS	375-73-5	4	< 8	**0.00636**	< 0.0729		**0.00471**	**0.00267**	<0.0772	1.76	< 2	**0.00524**	< 0.0755		< 0.0791	**0.00524**	< 0.0755	
PFPES	2706-91-4	5	< 8	**0.00549**	< 0.0729		< 0.00436	< 0.00082	<0.0772		< 2	**0.00342**	< 0.0755		< 0.0791	**0.00342**	< 0.0755	
PFHxS	355-46-4	6	< 8	**0.0194**	< 0.0729		**1.13**	**0.00329**	<0.0772	343.47	< 2	**0.0121**	< 0.0755		< 0.0791	**0.0121**	< 0.0755	
PFHPS	375-92-8	7	< 8	**0.00734**	< 0.0729		**0.642**	< 0.00082	<0.0772		< 2	**0.0042**	< 0.0755		**0.243**	**0.0042**	< 0.0755	57.86
PFOS	1763-23-1	8	**10,500**	**1.22**	**19.6**	8606.56	**56.4**	**0.00215**	**4.2**	26232.56	**2,750**	**0.702**	**1.29**	3917.38	**595**	**0.702**	**1.29**	847.58
PFNS	68259-12-1	9	< 8	< 0.000727	< 0.0729		< 0.00436	< 0.00082	<0.0772		**3.17**	< 0.000722	< 0.0755		**0.582**	< 0.000722	< 0.0755	
PFDS	335-77-3	10	< 8	< 0.000727	< 0.0729		< 0.00436	< 0.00082	<0.0772		< 2	< 0.000722	< 0.0755		**0.147**	< 0.000722	< 0.0755	
PFDOS	79780-39-5	12	< 8	< 0.000727	< 0.0729		< 0.00436	< 0.00082	<0.0772		< 2	< 0.000722	< 0.0755		< 0.0791	< 0.000722	< 0.0755	
4:2 FTS	757124-72-4	4	< 32	< 0.00291	< 0.292		< 0.0174	< 0.00328	<0.309		< 8	< 0.00289	< 0.302		< 0.316	< 0.00289	< 0.302	
6:2 FTS	27619-97-2	6	**361**	< 0.00262	< 0.262		< 0.0157	< 0.00295	<0.278		< 7.2	**0.0137**	< 0.272		< 0.285	**0.0137**	< 0.272	
8:2 FTS	39108-34-4	8	< 32	< 0.00291	< 0.292		< 0.0174	< 0.00328	<0.309		< 8	< 0.00289	< 0.302		< 0.316	< 0.00289	< 0.302	
PFOSA	754-91-6	8	**71.1**	**0.0104**	**1.02**	6836.54	**0.214**	< 0.00082	**0.203 J**		**51**	**0.0057**	< 0.0755	8947.37	**8.78**	**0.0057**	< 0.0755	1540.35
N-MEFOSA	31506-32-8	8	< 9.2	< 0.000836	< 0.0838		< 0.00501	< 0.000943	<0.0888		< 2.3	< 0.00083	< 0.0869		< 0.0909	< 0.00083	< 0.0869	
N-ETFOSA	4151-50-2	8	< 20	< 0.00182	< 0.182		< 0.0109	< 0.00205	<0.193		< 5	< 0.0018	< 0.189		**0.211**	< 0.0018	< 0.189	
MEFOSAA	2355-31-9	8	< 8	< 0.000727	< 0.0729		**0.0315**	< 0.00082	<0.0772		**2.1**	< 0.000722	< 0.0755		**0.216**	< 0.000722	< 0.0755	
ETFOSAA	2991-50-6	8	**168**	**0.00516**	**0.178**	32558.14	**0.136**	< 0.00082	<0.0772		**92.5**	**0.00296**	< 0.0755	31250.00	**10.6**	**0.00296**	< 0.0755	3581.08
N-MEFOSE	24448-09-7	8	< 80	< 0.00727	< 0.729		< 0.0436	< 0.0082	<0.772		< 20	< 0.00722	< 0.755		< 0.791	< 0.00722	< 0.755	
N-ETFOSE	1691-99-2	8	< 60	< 0.00545	< 0.547		< 0.0327	< 0.00615	<0.579		< 15	< 0.00541	< 0.566		< 0.593	< 0.00541	< 0.566	
HFPO-DA	13252-13-6	5	< 32	< 0.00291	< 0.292		< 0.0166	< 0.00312	<0.293		< 8	< 0.00289	< 0.302		< 0.316	< 0.00289	< 0.302	
ADONA	919005-14-4	7	< 32	< 0.00291	< 0.292		< 0.0174	< 0.00328	<0.309		< 8	< 0.00289	< 0.302		< 0.316	< 0.00289	< 0.302	
9CL-PF3ONS	756426-58-1	8	< 32	< 0.00291	< 0.292		< 0.0174	< 0.00328	<0.309		< 8	< 0.00289	< 0.302		< 0.316	< 0.00289	< 0.302	
11CL-PF3OUDS	763051-92-9	10	< 32	< 0.00291	< 0.292		< 0.0174	< 0.00328	<0.309		< 8	< 0.00289	< 0.302		< 0.316	< 0.00289	< 0.302	

Notes:
Surface water and foam PFAS results are shown in micrograms per liter (µg/L) or ppb.
Sediment PFAS results are shown in micrograms per kilogram (µg/kg) or ppb.
ppb - parts per billion
Bold - Result is above the laboratory minimum reporting limit.
< 0.0002 - Concentration is less than laboratory reportable limit
NS - No Sample Collected
DUP - duplicate sample

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs
Fluortelomers
FOSA, FASE, FASAAs
Replacement Chemistries

Table C-3
Foam Enrichment Factors
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

			RC18A (5/5/2020)				EP21A (4/23/2020)				EP21B (5/5/2020)					
PFAS Compound	CAS Number	Number of Carbons	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor	Foam (ug/L)	Foam (ug/L) DUP	Foam (ug/L) Mean	Water (ug/L)	Sediment (ug/kg)	Foam/Water Enrichment Factor
PFBA	375-22-4	4	**0.0963**	**0.0744**	NS	1.29	**0.897**	**0.814**	**0.464**	1.10	**0.839**	**0.83**	**0.8345**	**0.814**	<0.389	1.03
PFPEA	2706-90-3	5	< 0.0133	**0.00558**	NS		< 0.223	**0.0164**	<0.159		<0.22	<0.199		**0.0164**	<0.195	
PFHXA	307-24-4	6	**0.007**	**0.00413**	NS	1.69	< 0.111	**0.0161**	<0.0795		<0.11	<0.0995		**0.0161**	<0.0973	
PFHPA	375-85-9	7	< 0.00665	**0.00196**	NS		< 0.111	**0.00566**	<0.0795		<0.11	<0.0995		**0.00566**	<0.0973	
PFOA	335-67-1	8	**0.165**	**0.00693**	NS	23.81	**0.521**	**0.065**	**0.095**	8.02	**1.05**	**1.07**	**1.06**	**0.065**	**0.117**	16.31
PFNA	375-95-1	9	**0.312**	< 0.000755	NS		**0.26**	< 0.000776	<0.0795		**0.999**	**1**	**0.9995**	< 0.000776	<0.0973	
PFDA	335-76-2	10	**0.697**	< 0.000755	NS		**2.11**	< 0.000776	<0.0795		**10.8**	**10.4**	**10.6**	< 0.000776	<0.0973	
PFUNA	2058-94-8	11	**0.375**	< 0.000755	NS		**0.331**	< 0.000776	<0.0795		**0.952**	**1.1**	**1.026**	< 0.000776	<0.0973	
PFDOA	307-55-1	12	**0.149**	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		**0.125**	**0.144**	**0.1345**	< 0.000776	<0.0973	
PFTRDA	72629-94-8	13	**0.0292**	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		<0.11	<0.0995		< 0.000776	<0.0973	
PFTEDA	376-06-7	14	**0.0128**	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		<0.11	<0.0995		< 0.000776	<0.0973	
PFBS	375-73-5	4	< 0.00665	**0.00221**	NS		< 0.111	**0.00314**	<0.0795		<0.11	<0.0995		**0.00314**	<0.0973	
PFPES	2706-91-4	5	< 0.00665	< 0.000755	NS		< 0.111	**0.00219**	<0.0795		<0.11	<0.0995		**0.00219**	<0.0973	
PFHxS	355-46-4	6	**0.026**	**0.00324**	NS	8.02	< 0.111	**0.00685**	<0.0795		<0.11	<0.0995		**0.00685**	<0.0973	
PFHPS	375-92-8	7	**0.0153**	< 0.000755	NS		**0.15**	**0.00084**	<0.0795	178.57	**0.503**	**0.498**	**0.5005**	**0.00084**	<0.0973	595.83
PFOS	1763-23-1	8	**8.22**	**0.00589**	NS	1395.59	**216**	< 0.000776	**0.619**		**904**	**862**	**883**	**0.0777**	**2.45**	11364.22
PFNS	68259-12-1	9	**0.0211**	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		<0.11	<0.0995		< 0.000776	<0.0973	
PFDS	335-77-3	10	**0.0452**	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		<0.11	<0.0995		< 0.000776	<0.0973	
PFDOS	79780-39-5	12	< 0.00665	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		<0.11	<0.0995		< 0.000776	<0.0973	
4:2 FTS	757124-72-4	4	< 0.0266	< 0.00302	NS		< 0.445	< 0.00311	<0.318		<0.44	<0.398		< 0.00311	<0.389	
6:2 FTS	27619-97-2	6	< 0.024	< 0.00272	NS		< 0.401	< 0.0028	<0.312		<0.396	<0.358		< 0.0028	<0.375	
8:2 FTS	39108-34-4	8	< 0.0266	< 0.00302	NS		< 0.445	< 0.00311	<0.318		<0.44	<0.398		< 0.00311	<0.389	
PFOSA	754-91-6	8	**0.0946**	< 0.000755	NS		**0.463**	< 0.000776	<0.0795		**0.737**	**0.692**	**0.7145**	< 0.000776	<0.0973	
N-MEFOSA	31506-32-8	8	< 0.00765	< 0.000868	NS		< 0.128	< 0.000893	<0.0914		<0.127	<0.114		< 0.000893	<0.112	
N-ETFOSA	4151-50-2	8	< 0.0166	< 0.00189	NS		< 0.278	< 0.00194	<0.199		<0.275	<0.249		< 0.00194	<0.243	
MEFOSAA	2355-31-9	8	**0.0814**	< 0.000755	NS		< 0.111	< 0.000776	<0.0795		**0.365**	**0.358**	**0.3615**	< 0.000776	<0.0973	
ETFOSAA	2991-50-6	8	**0.324**	< 0.000755	NS		**1.3**	< 0.000776	<0.0795		**3.12**	**2.81**	**2.965**	< 0.000776	<0.0973	
N-MEFOSE	24448-09-7	8	< 0.0665	< 0.00755	NS		< 1.11	< 0.00776	<0.795		<1.1	<0.995		< 0.00776	<0.973	
N-ETFOSE	1691-99-2	8	< 0.0499	< 0.00566	NS		< 0.835	< 0.00582	<0.596		<0.825	<0.747		< 0.00582	<0.73	
HFPO-DA	13252-13-6	5	< 0.0253	< 0.00287	NS		< 0.423	< 0.00295	<0.302		<0.418	<0.378		< 0.00295	<0.37	
ADONA	919005-14-4	7	< 0.0266	< 0.00302	NS		< 0.445	< 0.00311	<0.318		<0.44	<0.398		< 0.00311	<0.389	
9CL-PF3ONS	756426-58-1	8	< 0.0266	< 0.00302	NS		< 0.445	< 0.00311	<0.318		<0.44	<0.398		< 0.00311	<0.389	
11CL-PF3OUDS	763051-92-9	10	< 0.0266	< 0.00302	NS		< 0.445	< 0.00311	<0.318		<0.44	<0.398		< 0.00311	<0.389	

Notes:
Surface water and foam PFAS results are shown in micrograms per liter (µg/L) or ppb.
Sediment PFAS results are shown in micrograms per kilogram (µg/kg) or ppb.
ppb - parts per billion
Bold - Result is above the laboratory minimum reporting limit.
< 0.0002 - Concentration is less than laboratory reportable limit
NS - No Sample Collected
DUP - duplicate sample

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs
Fluortelomers
FOSA, FASE, FASAAs
Replacement Chemistries

Table C-3
Foam Enrichment Factors
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

PFAS Compound	CAS Number	Number of Carbons	WL6 (2/25/2020) Foam (ug/L)	WL6 (2/25/2020) Water (ug/L)	WL6 (2/25/2020) Sediment (ug/kg)	WL6 (2/25/2020) Foam/Water Enrichment Factor	WL11 (5/5/2020) Foam (ug/L)	WL11 (5/5/2020) Water (ug/L)	WL11 (5/5/2020) Sediment (ug/kg)	WL11 (5/5/2020) Foam/Water Enrichment Factor
PFBA	375-22-4	4	< 3.170	**0.455**	**0.361**		**0.431**	**0.388**	NS	1.11
PFPEA	2706-90-3	5	< 1.580	**0.0129**	< 0.152		< 0.0199	**0.0127**	NS	
PFHXA	307-24-4	6	< 0.792	**0.0127**	< 0.0762		**0.0221**	**0.0158**	NS	1.40
PFHPA	375-85-9	7	< 0.792	**0.00614**	< 0.0762		**0.0202**	**0.01**	NS	2.02
PFOA	335-67-1	8	**1.54**	**0.0513**	**0.221**	30.02	**1.25**	**0.0846**	NS	14.78
PFNA	375-95-1	9	**2.73**	< 0.00077	< 0.0762		**0.169**	**0.000806**	NS	209.68
PFDA	335-76-2	10	**15.3**	< 0.00077	< 0.0762		**0.489**	< 0.000755	NS	
PFUNA	2058-94-8	11	**0.846**	< 0.00077	< 0.0762		**0.0323**	< 0.000755	NS	
PFDOA	307-55-1	12	< 0.792	< 0.00077	< 0.0762		< 0.00997	< 0.000755	NS	
PFTRDA	72629-94-8	13	< 0.792	< 0.00077	< 0.0762		< 0.00997	< 0.000755	NS	
PFTEDA	376-06-7	14	< 0.792	< 0.00077	< 0.0762		< 0.00997	< 0.000755	NS	
PFBS	375-73-5	4	< 0.792	**0.0037**	< 0.0762		< 0.00997	**0.00467**	NS	
PFPES	2706-91-4	5	< 0.792	**0.00216**	< 0.0762		< 0.00997	**0.00359**	NS	
PFHxS	355-46-4	6	< 0.792	**0.0077**	< 0.0762		**0.0576**	**0.0109**	NS	5.28
PFHPS	375-92-8	7	**1.65**	**0.00102**	< 0.0762	1617.65	**0.257**	**0.00183**	NS	140.44
PFOS	1763-23-1	8	**1630**	**0.0808**	**4.81**	20173.27	**87.1**	**0.136**	NS	640.44
PFNS	68259-12-1	9	< 0.792	< 0.00077	< 0.0762		**0.0288**	< 0.000755	NS	
PFDS	335-77-3	10	< 0.792	< 0.00077	< 0.0762		< 0.00997	< 0.000755	NS	
PFDOS	79780-39-5	12	< 0.792	< 0.00077	< 0.0762		< 0.00997	< 0.000755	NS	
4:2 FTS	757124-72-4	4	< 3.170	< 0.00308	< 0.305		< 0.0399	< 0.00302	NS	
6:2 FTS	27619-97-2	6	< 2.850	< 0.00277	< 0.274		< 0.0359	< 0.00272	NS	
8:2 FTS	39108-34-4	8	< 3.170	< 0.00308	< 0.305		< 0.0399	< 0.00302	NS	
PFOSA	754-91-6	8	**8.57**	< 0.00077	< 0.0762		**0.225**	< 0.000755	NS	
N-MEFOSA	31506-32-8	8	< 0.911	< 0.000885	< 0.0877		< 0.0115	< 0.000869	NS	
N-ETFOSA	4151-50-2	8	< 1.980	< 0.00192	< 0.191		< 0.0249	< 0.00189	NS	
MEFOSAA	2355-31-9	8	< 0.792	< 0.00077	< 0.0762		**0.0131**	< 0.000755	NS	
ETFOSAA	2991-50-6	8	**8.4**	< 0.00077	< 0.0762		**0.553**	< 0.000755	NS	
N-MEFOSE	24448-09-7	8	< 7.920	< 0.0077	< 0.762		< 0.0997	< 0.00755	NS	
N-ETFOSE	1691-99-2	8	< 5.940	< 0.00577	< 0.572		< 0.0747	< 0.00567	NS	
HFPO-DA	13252-13-6	5	< 3.010	< 0.00292	< 0.305		< 0.0379	< 0.00287	NS	
ADONA	919005-14-4	7	< 3.170	< 0.00308	< 0.305		< 0.0399	< 0.00302	NS	
9CL-PF3ONS	756426-58-1	8	< 3.170	< 0.00308	< 0.305		< 0.0399	< 0.00302	NS	
11CL-PF3OUDS	763051-92-9	10	< 3.170	< 0.00308	< 0.305		< 0.0399	< 0.00302	NS	

Notes:
Surface water and foam PFAS results are shown in micrograms per liter (µg/L) or ppb.
Sediment PFAS results are shown in micrograms per kilogram (µg/kg) or ppb.
ppb - parts per billion
Bold - Result is above the laboratory minimum reporting limit.
< 0.0002 - Concentration is less than laboratory reportable limit
NS - No Sample Collected
DUP - duplicate sample

Short-chain PFCAs
Long-chain PFCAs
Short-chain PFSAs
Long-chain PFSAs
Fluortelomers
FOSA, FASE, FASAAs
Replacement Chemistries

APPENDIX C
ATTACHMENT

Attachment C-3
Sampled and Observed Foam
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Sampling Location	7/31/2019	8/12/2019	8/14/2019	2/3/2020	2/18/2020	2/24/2020-25/2020	3/5/2020	3/18/2020	3/20/2020	4/7/2020	4/23/2020	4/24/2020	4/25/2020	4/27/2020	4/28/2020	4/29/2020	4/30/2020	5/4/2020	5/5/2020	5/7/2020	5/8/2020	5/11/2020	5/18/2020	6/29/2020	6/30/2020	7/6/2020
RC3						O		O					O		O	O							O			
RC4						O																				
RC5	O			O		X	O	O				O						O								
RC6								O																		
RC7A						X					O															
RC7	O	X	X					O			O				O						O		O			
RC9								O		O																
RC10								O																		
RC11			O																							
RC12			X					O							X	O							O			
RC16A																	O									
RC16								O		X																
RC14															O	O				O			O			
RC21				O	O	X	O				X				O	O				O			O			
RC17			X								O								O							
RC17A			X	O				O																		
RC18A								O			O								X							
RC18								O											O							
FC1																							X	O	O	
EP18																									X	
EP21A											X															
EP21B																			X							
EP14																										
EP19						O																				
EP25																						X				
WL6						X	O	O	O	O									X	O			O			
GL1																							X			
VB1								O	O	X				O		O		O								
VB2										O								O								
VB3										X				O				O					O			

Notes:

X Samples were collected for PFAS analysis

O Foam was observed but not collected

Empty cells represent sites not visited on that date or no foam was observed. An empty cell should not be interpreted as an absence of foam at a location.

The location of the foam sampled or observed may be offset slightly, either upgradient or downgradient, from the primary sampling location.

Analytical results of foam collected after 5/11/2020 are still pending.