MEMORANDUM

DATE:	5 February 2019
TO:	Chris Prucha, Bill McDonough and Jim Forney, Waste Management (WM)
FROM:	François Richard and Madeleine Corriveau (BluMetric)
PROJECT NO:	180150-05
SUBJECT:	PFAS Sampling Summary, Waste Management Richmond Landfill, Town of Greater Napanee

BACKGROUND AND OBJECTIVE

The Ministry of the Environment, Conservation and Parks (MECP) requested sampling of leachate, groundwater and surface water monitoring locations for per- and polyfluoroalkyl substances (PFAS). The monitoring locations were selected based on their position downgradient from the Waste Management (WM) Richmond landfill, and in relation to the previously delineated area where groundwater in the intermediate bedrock flow zone has been impacted by landfill leachate.

PFAS are a large group of man-made chemicals with unique stain and stick-resistant properties that are used to repel oil, water and stains from cloth, carpet, furniture, food packaging and non-stick cookware surfaces. PFAS can also be found in fire-fighting foams, lubricants, waxes, stone and tile finishing, surfactants and many other sources. PFAS chemicals are ubiquitous and have been found at low concentrations in a variety of environments. There are no existing Ontario groundwater or surface water standards for PFAS. However, Health Canada has developed drinking water screening values for a number of PFAS[1]. The guidelines apply to water intended for human consumption and are therefore not applicable for the WM Richmond site.

[1] https://www.canada.ca/en/services/health/publications/healthy-living/water-talk-drinking-water-screening-values-perfluoroalkylated-substances.html

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The objective of the sampling event at the WM Richmond landfill was to collect PFAS chemistry data to characterize leachate with respect to PFAS constituents and assess their potential presence downgradient from the waste mound, including in surface water and within the intermediate bedrock groundwater flow zone, where a contaminant plume has been delineated from recent hydrogeological investigations[2] using 1,4-dioxane as the primary leachate indicator parameter.

SAMPLING

Sampling Summary

One leachate, three surface water and 14 groundwater samples were collected and analyzed for PFAS. Sampling locations are summarized in Table 1 and shown on Figure 1. Samples were collected on December 11 to 13, 2018 and were submitted to Maxxam Analytics for analysis of the PFAS parameters listed in Table 2. Based on initial results (discussed in more detail below), a verification sample was collected from monitoring well M187 on January 21, 2019.

Table 1: Summary of Sampling Locations

Sample Type	Sample ID
Leachate	Composite Sample from North and South Chambers
Surface Water	S3, S8R and S20-Karst
Non-Impacted[2] Intermediate Groundwater Monitoring Wells	M72, M106, M177, M186, M187, M188-1, M190 and OW1
1,4-Dioxane Impacted[2] Intermediate Groundwater Monitoring Wells	M6-3, M110-1, M121, M167, M178R-3 and M192

Table 2: PFAS Parameters Analyzed

Parameter	Acronym	Parameter	Acronym
Perfluorobutanoic acid	PFBA	Perfluoroundecanoic acid	PFUnA
Perfluoropentanoic acid	PFPeA	Perfluorodecanesulfonic acid	PFDS
Perfluorohexanoic acid	PFHxA	Perfluorododecanoic acid	PFDoA
Perfluoroheptanoic acid	PFHpA	Perfluorobutanesulfonic acid	PFBS
Perfluorooctanoic acid	PFOA	Perfluorohexanesulfonic acid	PFHxS
Perfluorononanoic acid	PFNA	Perfluorooctanesulfonic acid	PFOS
Perfluorodecanoic acid	PFDA	Perfluorooctane sulfonamide	PFOSA

[2] *Site Conceptual Model Update and Contaminant Attenuation Zone Delineation, Waste Management Richmond Landfill Site*, prepared by BluMetric Environmental Inc., October 2018

A total of six quality assurance/quality control (QA/QC) samples were also collected, including two field duplicate samples, two equipment blanks, one trip blank and one field blank. PFAS-free de-ionised (DI) water was supplied by the laboratory for blank samples.

Sampling Methodology

Due to the very low analytical method detection limits and the numerous potential sources of trace PFAS concentrations that can lead to false positive results, PFAS sampling programs require additional precautions to reduce the potential for cross-contamination. Sample collection followed current industry standard guidance for aqueous sampling for PFAS.

For monitoring wells where water levels were shallow enough for use of a peristaltic pump:

- New ¼" High Density Polyethylene (HDPE) tubing was installed;
- New pump head tubing (silicone) was used at each location; and,
- Purging and sampling was conducted with a peristaltic pump at low flow to achieve parameter stabilization in flow through cell (temperature, pH and conductivity, dissolved oxygen and Eh).

Where water levels were too deep for a peristaltic pump (M186 and M187):

- Existing HDPE tubing and an electric powered hydrolift pump were used to purge and sample the well.

Where artesian conditions were present (M121, M167 and M178R-3):

- Artesian plugs were opened to allow water flow; and,
- Stainless steel control valves were used to control flow and fill sample bottles.

All purge water was collected and disposed of in the South Chamber leachate collection station.
For collection of the equipment blank associated with the peristaltic pump, the pump head tubing was replaced with new tubing; lab-supplied PFAS-free DI water was run through the pump to rinse the new tubing, and sample bottles were filled using lab-supplied PFAS-free DI water.

For the equipment blank representative of sampling at deep groundwater wells (M187), the dedicated HDPE tubing was removed from the well following sample collection, keeping the tubing end from touching anything, and the bottom 20 cm section of tubing was cut with the foot valve attached and placed in a laboratory supplied bottle filled with PFAS-free DI water; the bottle was then filled by passing PFAS-free DI water through the tubing/foot valve.

RESULTS AND DISCUSSION

A summary of results is presented in Table 3. Laboratory measurement uncertainty values supplied by the laboratory are also provided. Total PFAS concentrations were calculated for each sample by adding individual constituent concentrations (non-detects were treated as zero).

The leachate sample had several compounds detected (PFBS, PFBA, PFDA, PFHpA, PFHxS, PFHxA, PFNA, PFOSA, PFOS, PFOA and PFPeA) at relatively elevated concentrations (up to 830 ng/L of PFHxA), and a total PFAS concentration of 3,235 ng/L.

Typically, locations closer to the landfill (i.e. M6-3 and M110-1) exhibited a higher number of PFAS compounds detected and at relatively higher concentrations, compared to those located farther away from the landfill (Figure 1). Total PFAS concentrations detected in samples from monitoring wells M6-3 and M110-1, located closest to the landfill footprint, were 2,132 ng/L and 93 ng/L, respectively. Total PFAS in all other monitoring wells ranged from non-detect to 36 ng/L.

As expected, groundwater locations previously identified as impacted by landfill leachate based on the presence of the primary leachate indicator 1,4 dioxane had measurable PFAS concentrations (PFBS, PFBA, PFHpA, PFHxS, PFHxA, PFOS, PFOA and/or PFPeA). The exception was M192 which has previously been identified as impacted based on low 1,4-dioxane concentrations recorded in recent sampling events (ranging from 1 to 3.6 ug/L) but did not have any PFAS detections. This suggests that this well is located near the edge of the contaminant plume, as delineated from previous work and depicted on Figure 1. As expected, none of the samples from groundwater monitoring locations downgradient of the previously delineated contaminant plume had detections for PFAS, with the exception of location M187. The sample collected from well M187 in December 2018 had a low-level detection (4.2 ± 2.0 ng/L) of a single PFAS compound (PFBA), very close to the reportable detection limit (RDL) of 2 ng/L. At the suggestion of the Chief Science Advisor at Maxxam Analytics, a verification sample with field duplicate was collected on January 21, 2019. Both the sample and field duplicate results were non-detect for PFAS compounds, indicating the initial result was a false positive.

Surface water sampling location S20-Karst, collected upstream from the karst feature in the central portion of the proposed CAZ, approximately 75 m southwest of monitoring well M187, was below detection for all PFAS parameters. Surface water sampling locations S3 (Marysville Creek, just east of County Road 10) and S8R (Beechwood Ditch just north of Beechwood Road) had low concentrations for some PFAS compounds (PFBS, PFBA, PFHpA, PFHxS, PFHxA, PFOS, PFOA and/or PFPeA). Total PFAS concentrations detected at sampling location S3 were 32 ng/L, while at sampling location S8R total PFAS concentrations detected were 135 ng/L.

An evaluation of QA/QC data (from duplicate and blank samples) is provided in Table 4. A standard margin of error of 20% relative percent difference (RPD) between regular and duplicate samples was deemed acceptable for field duplicates. All parameters for field duplicate samples were less than 5%, well within the 20% margin of error. All parameters were below the RDL in the equipment, field and trip blank samples.

Table 3: Per- and Polyfluoroalkyl Substances (PFAS) Sampling Results

			Leachate [1]		Surface Water						Groundwater Monitoring Wells											
Reading Name	Acronym	Units	2018-12-13		S20-Karst 2018-12-11		S3 2018-12-11		S8R 2018-12-11		M6-3 2018-12-13		M110-1 2018-12-13		M121 2018-12-12		M167 2018-12-11		M178R-3 2018-12-12		M192 2018-12-13	
			Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
Total PFAS	-	*ng/L*	*3235*		*0*		*32*		*135*		*2132*		*93*		*36*		*6*		*36.3*		*0*	
Perfluorobutanesulfonic acid	PFBS	ng/L	90	+/- <20	< 2	N/A	2.2	+/- <2.0	2.4	+/- <2.0	69	+/- <20	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorobutanoic acid	PFBA	ng/L	440	+/- 50	< 2	N/A	5.1	+/- <2.0	19	+/- 2.7	580	+/- 66	48	+/- 5.6	24	+/- 3.2	6.3	+/- <2.0	13	+/- 2.3	< 2	N/A
Perfluorodecanesulfonic acid	PFDS	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorodecanoic Acid	PFDA	ng/L	47	+/- 7.5	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorododecanoic Acid	PFDoA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluoroheptanoic Acid	PFHpA	ng/L	260	+/- 36	< 2	N/A	2.5	+/- <2.0	12	+/- 2.0	190	+/- 26	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorohexanesulfonic acid	PFHxS	ng/L	160	+/- 26	< 2	N/A	< 2	N/A	2.4	+/- <2.0	170	+/- 29	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorohexanoic Acid	PFHxA	ng/L	830	+/- 130	< 2	N/A	11	+/- <2.0	42	+/- 6.3	520	+/- 79	3.9	+/- <2.0	< 2	N/A	< 2	N/A	6.3	+/- <2.0	< 2	N/A
Perfluorononanoic Acid	PFNA	ng/L	24	+/- 4.0	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorooctane Sulfonamide	PFOSA	ng/L	4.1	+/- <4	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A
Perfluorooctanesulfonic acid	PFOS	ng/L	190	+/- 30	< 2	N/A	< 2	N/A	4.4	+/- <2.0	2.5	+/- <2.0	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorooctanoic Acid	PFOA	ng/L	690	+/- 110	< 2	N/A	3.4	+/- <2.0	22	+/- 3.8	350	+/- 56	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluoropentanoic Acid	PFPeA	ng/L	500	+/- 54	< 2	N/A	7.8	+/- 2.0	31	+/- 3.8	250	+/- 27	41	+/- 4.7	12	+/- 2.2	< 2	N/A	17	+/- 2.5	< 2	N/A
Perfluoroundecanoic Acid	PFUnA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A

			Groundwater Monitoring Wells (cont'd)																	
Reading Name	Acronym	Units	M72 2018-12-13		M106 2018-12-13		M177 2018-12-12		M186 2018-12-11		M187 2018-12-11		M187 2019-01-21		M188-1 2018-12-12		M190 2018-12-13		OW1 2018-12-12	
			Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
Total PFAS	-	*ng/L*	*0*		*0*		*0*		*0*		*4.2*		*0*		*0*		*0*		*0*	
Perfluorobutanesulfonic acid	PFBS	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorobutanoic acid	PFBA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	4.2	+/- <2.0	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorodecanesulfonic acid	PFDS	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorodecanoic Acid	PFDA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorododecanoic Acid	PFDoA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluoroheptanoic Acid	PFHpA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorohexanesulfonic acid	PFHxS	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorohexanoic Acid	PFHxA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorononanoic Acid	PFNA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorooctane Sulfonamide	PFOSA	ng/L	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A	< 4	N/A
Perfluorooctanesulfonic acid	PFOS	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluorooctanoic Acid	PFOA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluoropentanoic Acid	PFPeA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A
Perfluoroundecanoic Acid	PFUnA	ng/L	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A	< 2	N/A

Notes: [1] Leachate Sample: Composite from North & South Chambers; MU = Measurement Uncertainty; Groundwater Monitoring Locations within 1,4 Dioxane Impacted Area Shown in Red Font

Table 4: QA/QC Results from Per- and Polyfluoroalkyl Substances (PFAS) Sampling

Field Duplicate Samples

Reading Name	Acronym	Units	M110-1 2018-12-13 Regular Sample	M110-1 2018-12-13 Field Duplicate	RPD %	M187 2019-01-21 Regular Sample	M187 2019-01-21 Field Duplicate	RPD %
Perfluorobutanesulfonic acid	PFBS	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorobutanoic acid	PFBA	ng/L	48	46	-4.2%	< 2	< 2	0%
Perfluorodecanesulfonic acid	PFDS	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorodecanoic Acid	PFDA	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorododecanoic Acid	PFDoA	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluoroheptanoic Acid	PFHpA	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorohexanesulfonic acid	PFHxS	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorohexanoic Acid	PFHxA	ng/L	3.9	4	2.6%	< 2	< 2	0%
Perfluorononanoic Acid	PFNA	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorooctane Sulfonamide	PFOSA	ng/L	< 4	< 4	0%	< 4	< 4	0%
Perfluorooctanesulfonic acid	PFOS	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluorooctanoic Acid	PFOA	ng/L	< 2	< 2	0%	< 2	< 2	0%
Perfluoropentanoic Acid	PFPeA	ng/L	41	43	4.9%	< 2	< 2	0%
Perfluoroundecanoic Acid	PFUnA	ng/L	< 2	< 2	0%	< 2	< 2	0%

Table 4: QA/QC Results from Per- and Polyfluoroalkyl Substances (PFAS) Sampling – Cont'd

Blank Samples

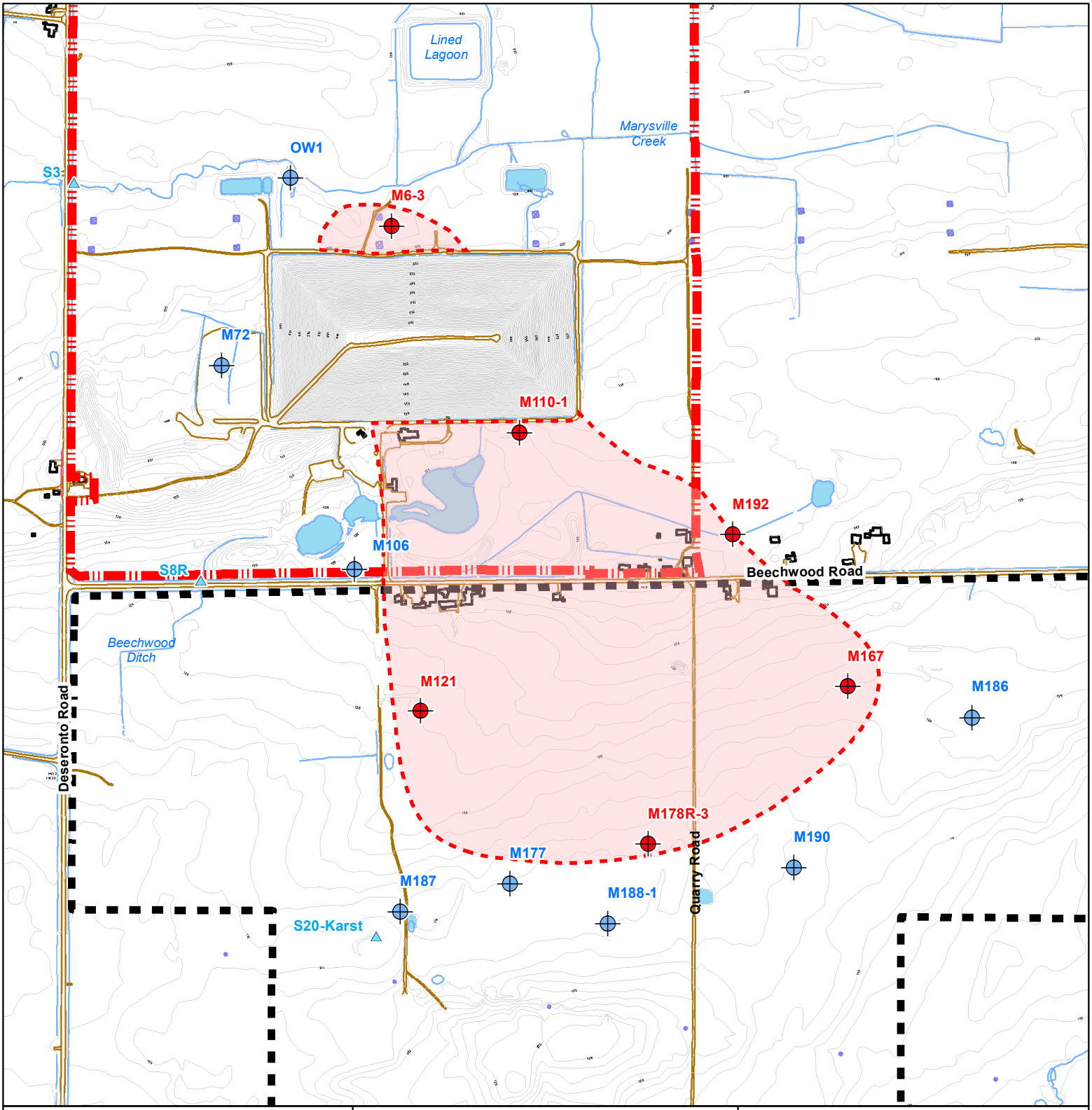
Reading Name	Acronym	Units	Blank - Equipment 2018-12-13	Blank - Equipment 2019-01-21	Blank - Field 2018-12-12	Blank - Trip 2018-12-11
Perfluorobutanesulfonic acid	PFBS	ng/L	< 2	< 2	< 2	< 2
Perfluorobutanoic acid	PFBA	ng/L	< 2	< 2	< 2	< 2
Perfluorodecanesulfonic acid (PFDS)	PFDS	ng/L	< 2	< 2	< 2	< 2
Perfluorodecanoic Acid	PFDA	ng/L	< 2	< 2	< 2	< 2
Perfluorododecanoic Acid	PFDoA	ng/L	< 2	< 2	< 2	< 2
Perfluoroheptanoic Acid	PFHpA	ng/L	< 2	< 2	< 2	< 2
Perfluorohexanesulfonic acid	PFHxS	ng/L	< 2	< 2	< 2	< 2
Perfluorohexanoic Acid	PFHxA	ng/L	< 2	< 2	< 2	< 2
Perfluorononanoic Acid	PFNA	ng/L	< 2	< 2	< 2	< 2
Perfluorooctane Sulfonamide	PFOSA	ng/L	< 4	< 4	< 4	< 4
Perfluorooctanesulfonic acid	PFOS	ng/L	< 2	< 2	< 2	< 2
Perfluorooctanoic Acid (PFOA)	PFOA	ng/L	< 2	< 2	< 2	< 2
Perfluoropentanoic Acid	PFPeA	ng/L	< 2	< 2	< 2	< 2
Perfluoroundecanoic Acid	PFUnA	ng/L	< 2	< 2	< 2	< 2

SUMMARY AND CONCLUSION

Samples were collected and submitted for PFAS analysis in leachate, surface water, and within the intermediate bedrock groundwater flow zone where a contaminant plume has been previously delineated from previous investigations, using the primary leachate indicator 1,4 dioxane.

The results confirm that PFAS compounds are present at relatively high concentrations in leachate. PFAS were also detected at groundwater locations previously identified as impacted by landfill leachate, consistent with plume delineation from recent hydrogeological investigations. As expected, groundwater monitoring locations hydraulically downgradient from the previously delineated contaminant plume did not have detections of PFAS.

PFAS compounds were detected as low concentrations at two surface water sampling locations (S3 and S8R), while they were not detected at surface water location S20-Karst.



LEGEND

- Topographic Contour Lines
- Surface Water
- Property Boundary
- Proposed CAZ Boundary
- 1,4 Dioxane Impacted Area
- M9-2 Non-Impacted Intermediate Monitoring Wells
- M9-2 1,4-Dioxane Impacted Intermediate Monitoring Wells
- S3 Surface Water Sampling Locations

REFERENCES

THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.
-UNITS: METERS
-PROJECTION: UTM NAD83 ZONE 18
-DATA SOURCE: WM CANADA, BLUMETRIC, MNRO, NRCAN

0 200 400 Metres

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CLIENT: WM WASTE MANAGEMENT

PROJECT
WASTE MANAGEMENT RICHMOND LANDFILL
PFAS SAMPLING SUMMARY

TITLE
PFAS SAMPLING LOCATIONS

PROJECT #	DATE
180150-05	February 04, 2019

DRAWN	CHECKED	FIG NO.	REV
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