

Groundwater Sampling Results

Closed City of Rhinelander Legacy Landfill

Rhinelander, WI

September 2021

Prepared by

University of Wisconsin–Madison Environmental Geotechnics Laboratory

Professor James M. Tinjum, PE, PhD, F.ASCE

Graduate Student Elliot Draxler, Geological Engineering

Full Results in Submitted Data Report

Groundwater Sampling Results
Closed City of Rhinelander Landfill

September 2021

Table of Contents

1. Introduction
 - 1.1. Site Description
 - 1.2. Site History
 - 1.3. Purpose and Scope
2. Environmental Setting
 - 2.1. Regional Geology
 - 2.2. Regional Hydrogeology
 - 2.3. Site Geology
 - 2.4. Site Hydrogeology
3. Methods
 - 3.1. Sampling
 - 3.1.1. Sampling Equipment
 - 3.1.2. Sampling Methods
 - 3.2. Analytical Methods
4. Site Investigation Results
 - 4.1. Environmental Forensics
 - 4.2. Aerial Drone Survey
5. Summary and Conclusion
6. Recommendations
7. References

Tables

Table 1: Well Information

Table 2a: Sampling Results - 10/13/2020

Table 2b: Sampling Results - 1/5/2021

Figures

Figure 1: Site Location Map

Figure 2: Sample Locations and Results

Figure 3a: Potentiometric Surface of "A" Horizon Oct. 2020

Figure 3b: Potentiometric Surface of "A" Horizon Jan. 2021

Figure 3c: Potentiometric Surface of "B" Horizon Jan. 2021

Figure 3d: Potentiometric Surface of "C" Horizon Jan. 2021

Groundwater Sampling Results
Closed City of Rhinelander Landfill

September 2021

Appendices

Appendix A: Field Data Sheets

Appendix B: Analytical Methods

Appendix C: Analytical Results

Appendix D: Field Activity Report

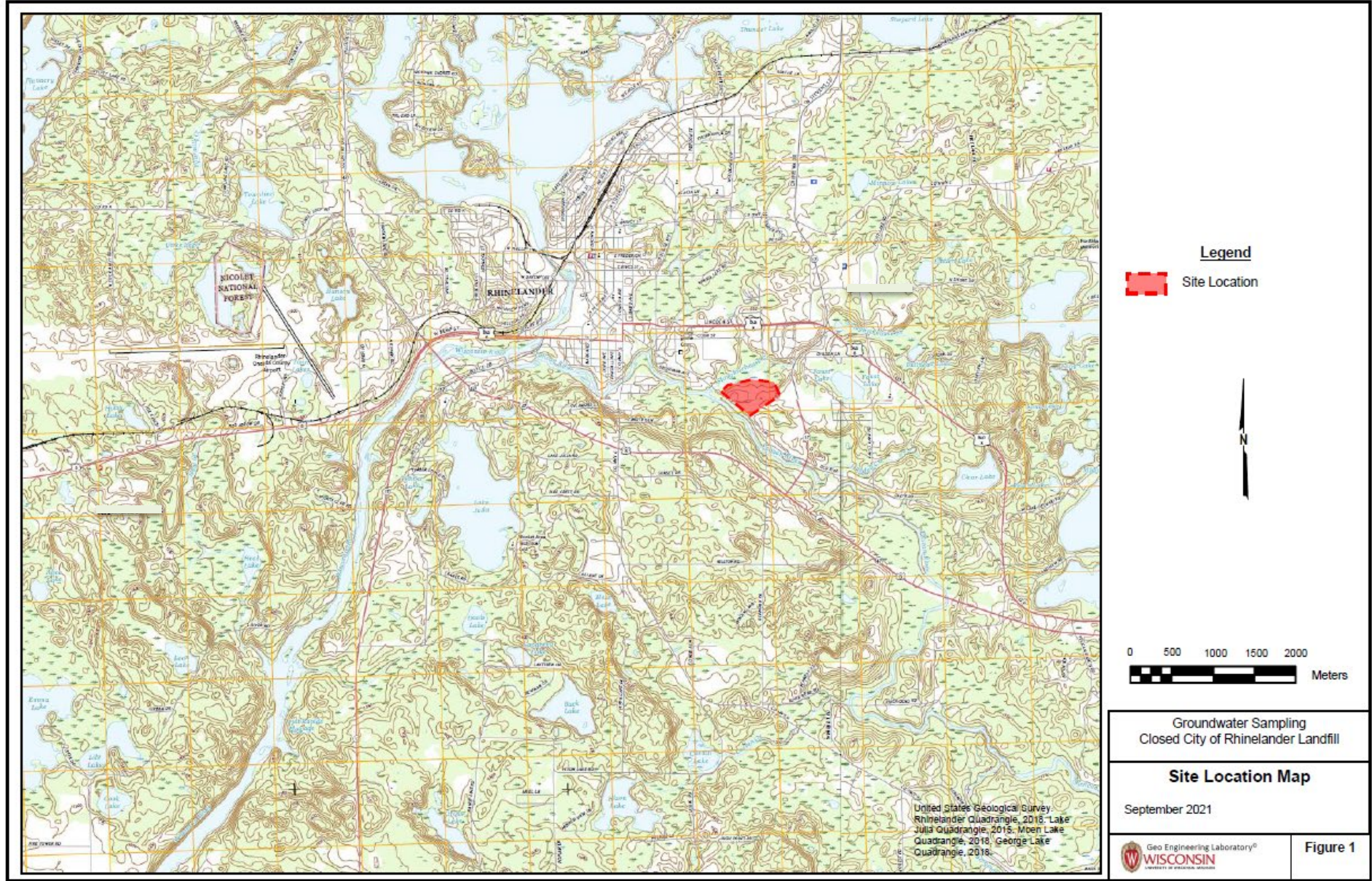
Appendix F: Drone Survey Results

Groundwater Sampling

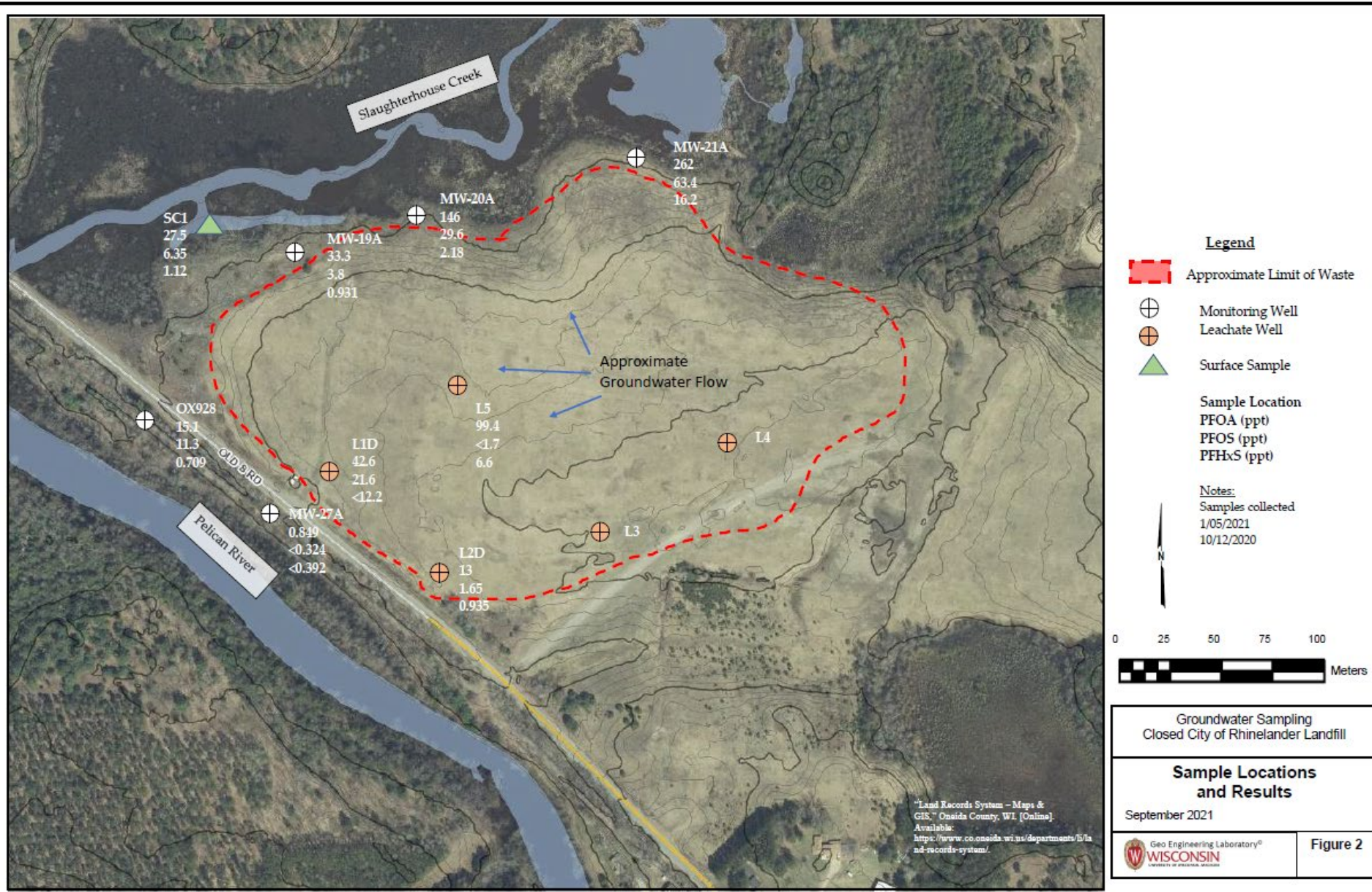
- ❑ **Round 1:** (10/12/20) Collect water samples from 4 leachate wells over the extent of the landfill and one surface water sample from Slaughterhouse Creek
- ❑ **Round 2:** (1/5/21) Collect water samples from five monitoring wells on the perimeter of the landfill
- ❑ Samples analyzed by The Wisconsin Laboratory of Hygiene for 33 PFAS compounds

*Interior Well
at closed
Rhineland
Landfill*





Sample Locations and Results



Summary Table of Results

City of Rhinelander Legacy Landfill Sampling Results - Summary Table									
Sample Type				MW	SW	SE	MW	MW	MW
Sample Date	Recommended	Recommended	Units	10/12/2020	10/13/2020	10/13/2020	10/12/2020	10/13/2020	10/12/2020
Analyte	ES	PAL	Units	L1	SC1	L1D	L2	L2D	L5
PFOA	20 ng/L ⁽ⁱⁱ⁾	2 ng/L ⁽ⁱⁱ⁾	ng/Kg	IV	27.5	42.6F	IV	13	99.4
PFOS	20 ng/L ⁽ⁱⁱ⁾	2 ng/L ⁽ⁱⁱ⁾	ng/Kg	IV	6.35	<21.6	IV	<1.65	<1.7
PFHxS	40 ng/L	4 ng/L	ng/Kg	IV	1.12F	<12.2	IV	<0.935	6.6

First Round

City of Rhinelander Legacy Landfill Sampling Results - Summary Table									
Sample Location			OX928	OX928-DUP	MW-19A	MW-20A	MW-21A	MW-27A	
Sample Date			1/5/2021	1/5/2021	1/5/2021	1/5/2021	1/5/2021	1/5/2021	
Analyte			Units						
PFOA	20 ng/L ⁽ⁱⁱ⁾	2 ng/L ⁽ⁱⁱ⁾	ng/L	15.1	18	33.3	146	262	0.849F
PFOS	20 ng/L ⁽ⁱⁱ⁾	2 ng/L ⁽ⁱⁱ⁾	ng/L	11.3	14.3	3.8	29.6	63.4	<0.324
PFHxS	40 ng/L	4 ng/L	ng/L	0.709F	0.802F	0.931	2.18	16.2	<0.392

Second Round

Analysis method is WSLH PFAS in Wet Solids

Bold = result exceeds LOQ

F next to result = Result is between LOD and LOQ

" < " = results is less than provided number; result does not exceed LOD

MW = Monitoring Well

ns = no sample

EF = Enforcement Standard (updated 11/6/2020)

Result exceeds recommended enforcement standard

Result exceeds recommended preventative action limit

PAL = Preventative Action Limit (updated 11/6/2020)

i The recommendations included in this table are reported as milligrams per liter (mg/L), micrograms per liter (µg/L), or nanogram per liter (ng/L).

ii DHS recommends a combined enforcement standard of 20 ng/L and combined preventive action limit of 2 ng/L for FOSA, NEtFOSE, NEtFOSA, NEtFOSAA, PFOS, and PFOA.

<https://www.dhs.wisconsin.gov/water/gws-cycle11.htm>

Relative Comparison, Michigan Landfill Study

Concentrations and Mass of PFOA AND PFOS Michigan Active Type II Landfills' Leachate

MWRA Participating Landfill Designation	Average Leachate Volume GPD	PFOA (ppt)	PFOS (ppt)
Arbor Hills Landfill	98,400	3200	220
Autumn Hills RDF	54,800	1300	380
Brent Run Landfill	16,400	540	110
C&C Expanded Sanitary Landfill	42,000	1300	450
Carleton Farms Landfill	123,300	1800	250
Central Sanitary Landfill	30,100	2500	470
Citizen's Disposal Inc.	32,900	1100	180
Dafter Sanitary Landfill	16,500	680	130
Eagle Valley RDF	32,900	490	170
Glens Sanitary Landfill	3,800	770	210
Granger Grand River Landfill	64,400	240	160
Granger Wood Street Landfill	19,200	470	110
K&W Landfill	17,500	830	170
Manistee County Landfill	4,700	420	220
McGill Road Landfill	13,700	760	170
Michigan Environs Inc. (Menominee)	13,100	1400	100
Northern Oaks RDF	12,300	1000	220
Oakland Heights Development	17,800	780	230
Orchard Hill Sanitary Landfill	12,500	650	110
Ottawa County Farms Landfill	82,200	1800	530

❑ ENFORCEMENT STANDARD (ES)

- Chapter NR 140 groundwater quality ES recommendations are developed by DHS based on existing "federal numbers," such as public drinking water maximum contaminant levels (MCLs), or through a statutorily prescribed process that incorporates drinking water exposure assumptions, established health based "acceptable daily intake" levels and, for carcinogenic substances, a calculated "one in a million" cancer risk level.
- If an established groundwater ES is exceeded at a regulated facility, practice or activity, a response action is required to achieve compliance with the ES. Chapter NR 140 response actions include operational changes, design or construction modifications and, potentially, prohibition or closure of a facility, practice or activity.

□ PREVENTIVE ACTION LIMIT (PAL)

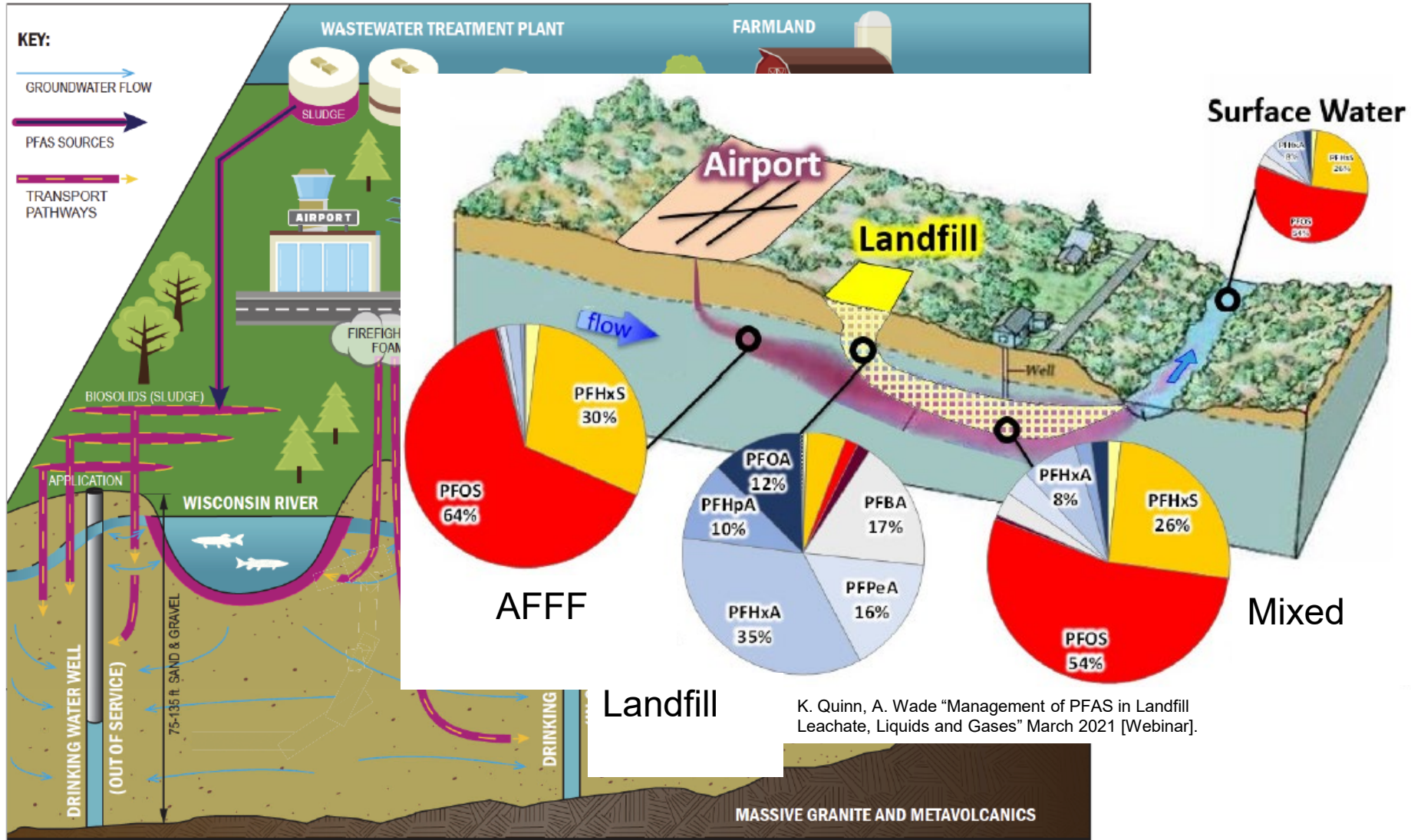
- A ch. NR 140 PAL, in accordance with ch. 160, Wis. Stats., is set at a percentage of an established ES concentration. PAL groundwater quality standards are used as design standards for facilities, practices and activities regulated by the state that can affect groundwater. They are also the level at which a regulatory agency may investigate the source of a substance in groundwater and require response actions to minimize the substance concentration and prevent exceedance of an ES.

Environmental Forensics – “Fingerprinting”

- ❑ Aid in understanding the source of PFAS constituents in the Rhinelander region
- ❑ Comparing the relative percent of individual PFAS compounds
- ❑ Each source area has a specific “fingerprint” based on the type of PFAS release (AFFF¹, landfill, industrial)
- ❑ This study utilized groundwater data from municipal well testing, private well testing, and testing from this study
- ❑ Two zones of distinctly different “fingerprints” are identified

¹ AFFF – Aqueous Film Forming Foam

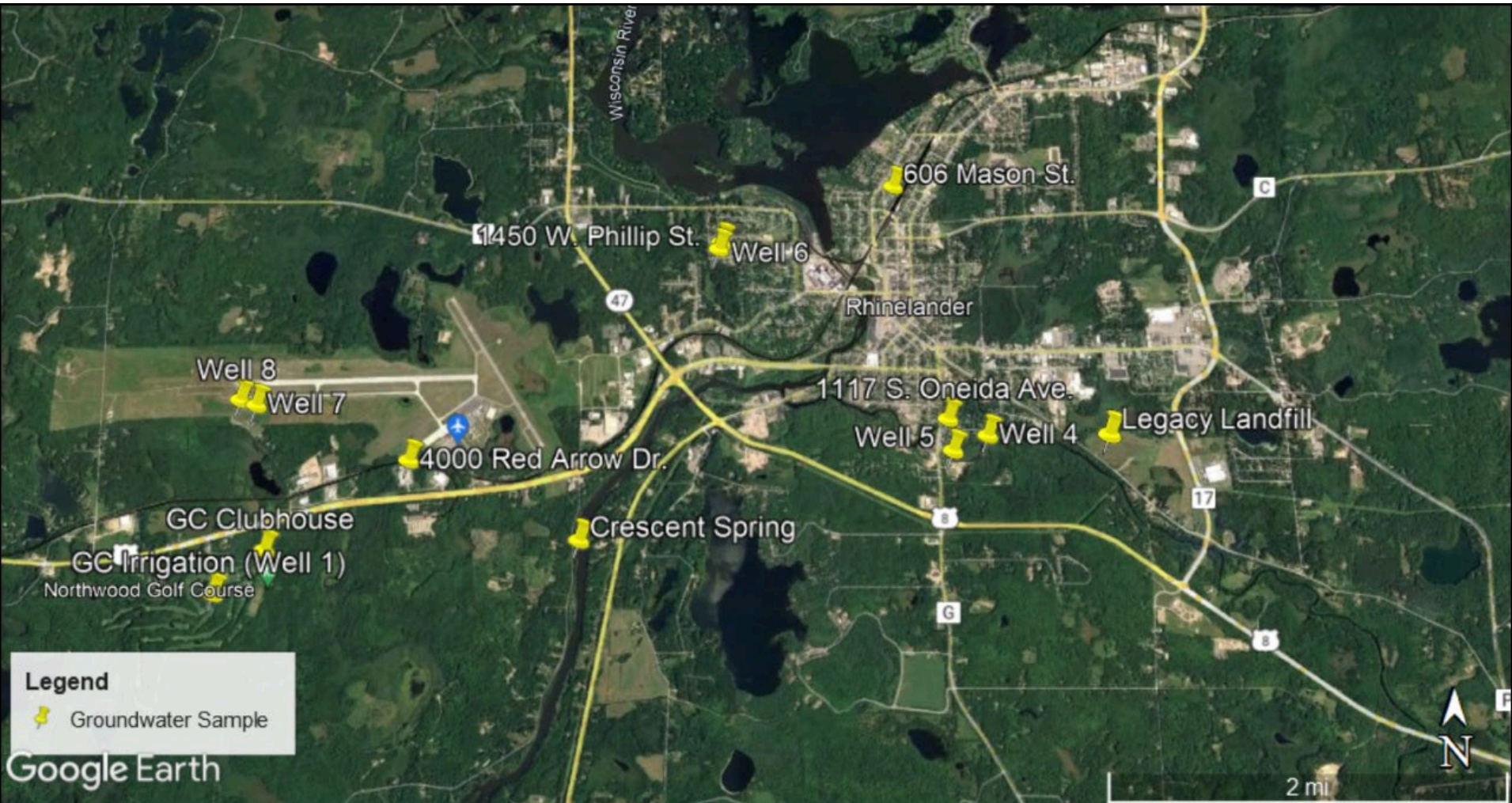
Environmental Forensics – “Fingerprinting”



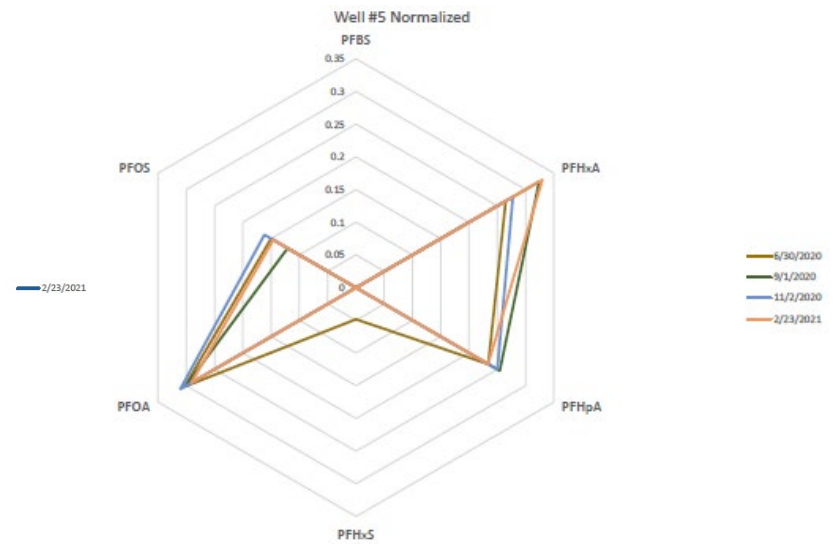
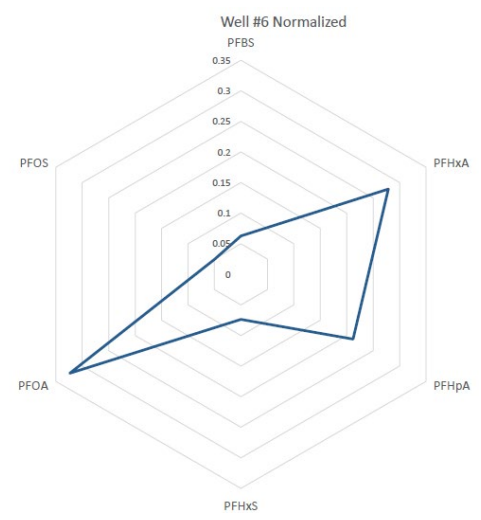
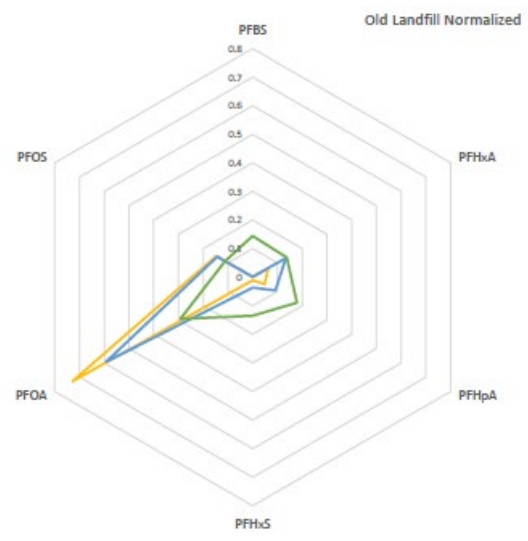
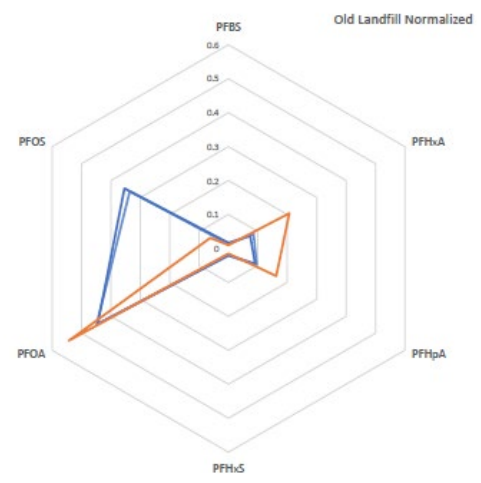
Initial *Conceptual Site Model* of the potential sources, nature, and fate of PFAS in a geo setting similar to that of Rhinelander. Graphic created by Jenny Bonardelli of Nicolet College.

K. Quinn, A. Wade “Management of PFAS in Landfill Leachate, Liquids and Gases” March 2021 [Webinar].

Review of Publicly Available GW Results



Environmental Forensics – Results



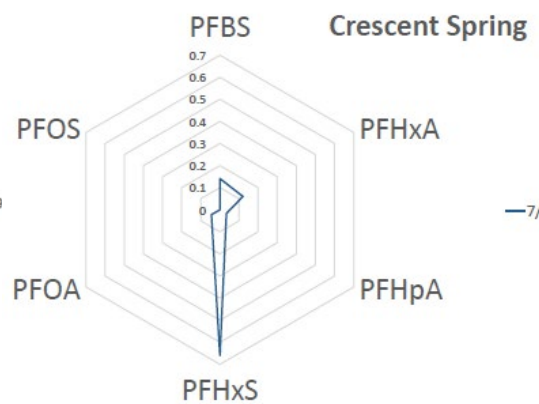
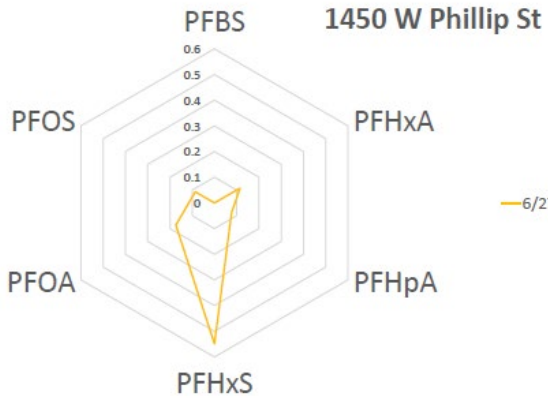
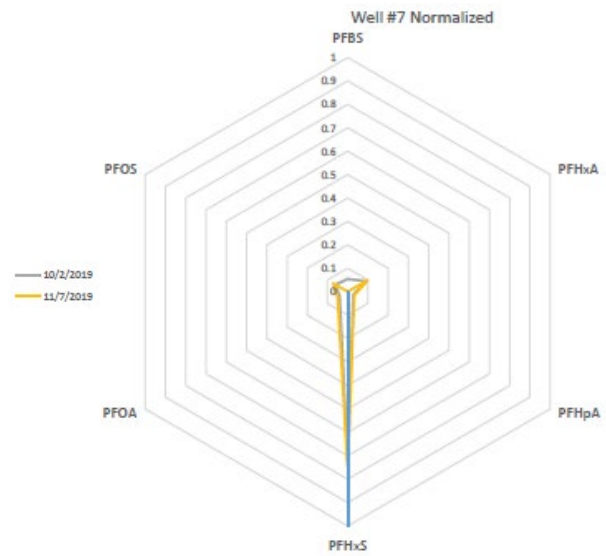
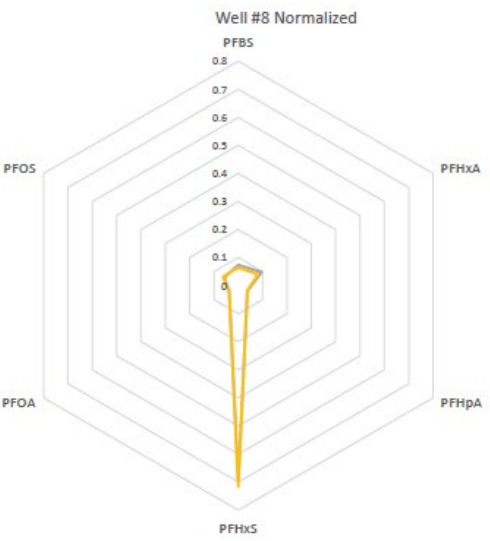
Zone 1:

- ❑ Legacy Landfill
- ❑ Well #5, #6
- ❑ 606 Mason St.
- ❑ 1117 S Oneida

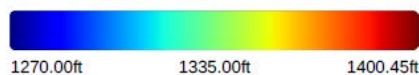
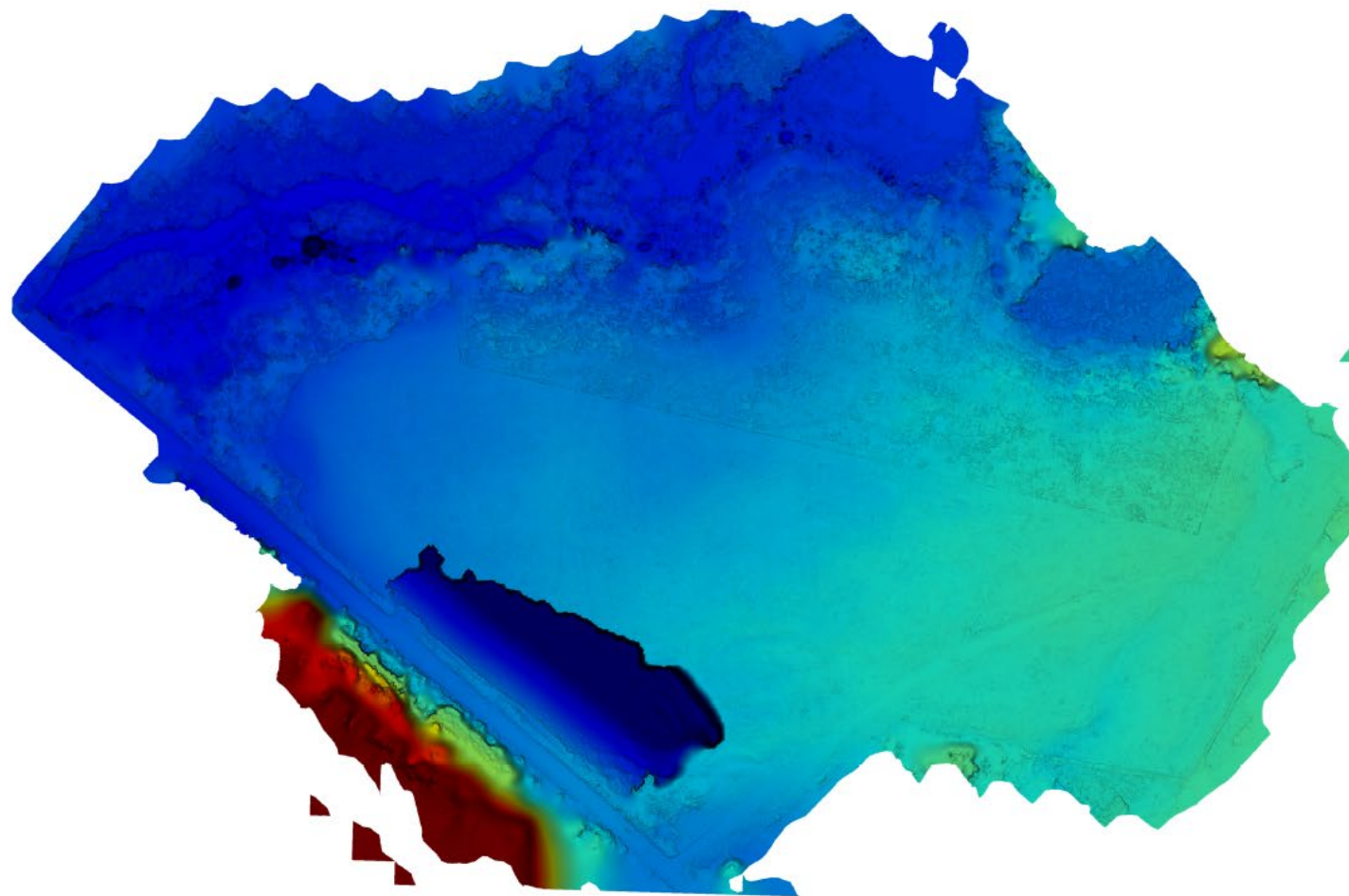
Environmental Forensics – Results

Zone 2:

- ❑ Well #7, #8
- ❑ Crescent Spring
- ❑ 4000 Red Arrow Dr.
- ❑ 1450 W Phillip St.



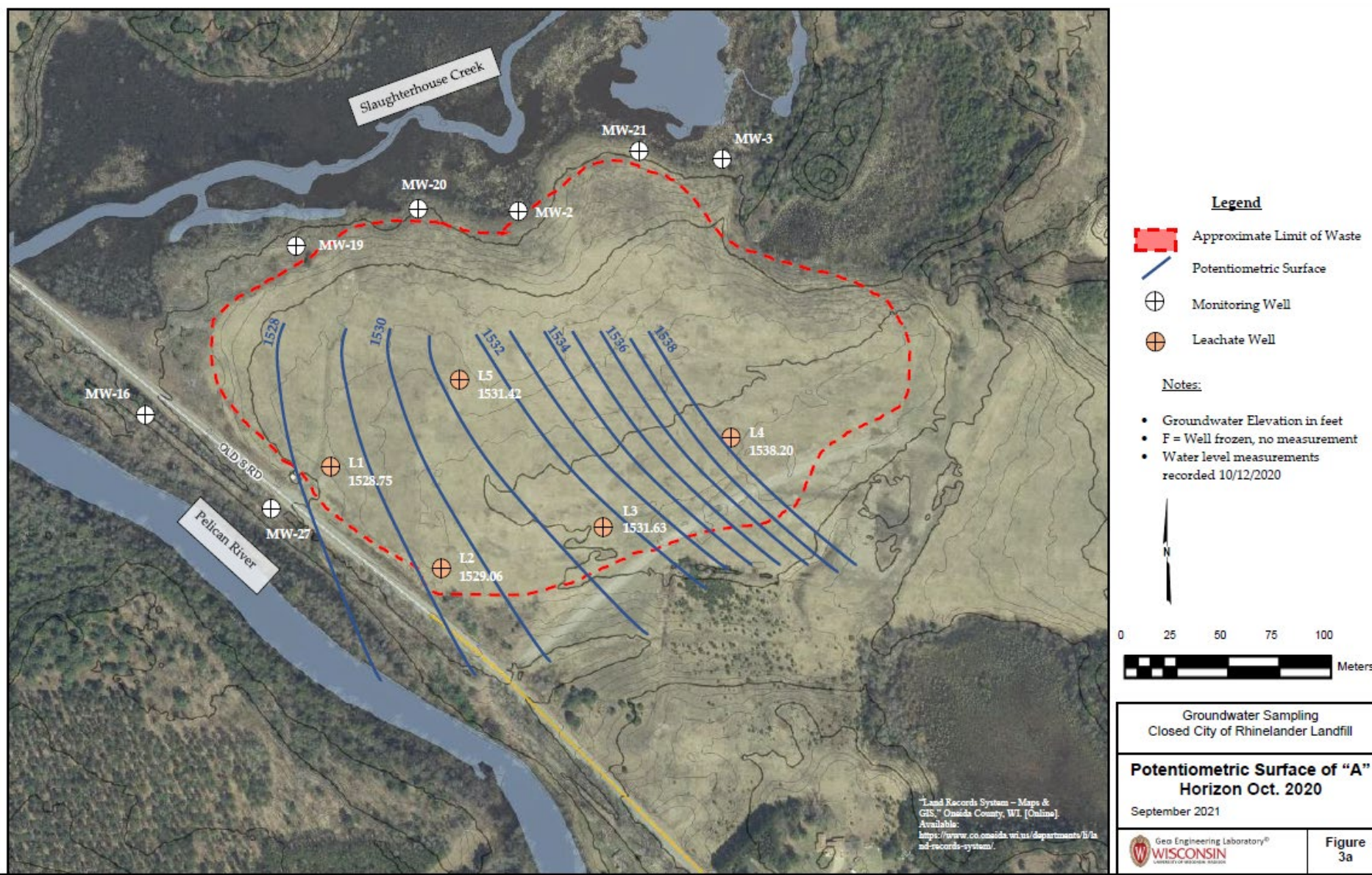
Drone Survey Results: Digital Topography Map



Drone Survey Results: Orthomosaic Map



Groundwater Flow Results Oct. 2020: Shallow



Groundwater Flow Results Jan. 2021: Shallow

