Occurrence of microplastics in the Niagara Dolomite Aquifer

UNIVERSITY of WISCONSIN UWMILWAUKEE

Justin Peschman[1], Fuad Shatara[2], Erica Majumder[2], and Charles Paradis[1]

[1]University of Wisconsin at Milwaukee, Department of Geosciences, Milwaukee, WI, USA [2]University of Wisconsin at Madison, Department of Bacteriology, Madison, WI, USA

Introduction

Microplastics are an emerging contaminant of concern in drinking water which are generally defined as plastic fragments less than five millimeters in size. The occurrence of microplastics in surface waters like the Great Lakes has been documented. However, there are relatively few studies that document the occurrence of microplastics in groundwater. The objective of this research is to determine if microplastics occur in the Niagara dolomite aquifer in Milwaukee. This aquifer is comprised of fractured rock at a depth of approximately 300 feet below ground surface and is a drinking water source for Eastern Wisconsin. The aquifer may be susceptible to contamination from near-surface sources of microplastics due to the regional cone of depression from pumping and leakage of untreated sanitary sewer water from the Deep Tunnel Project (Fig. 1).

Methods

Water level and water quality data (pH, conductivity and temperature) were collected during two pumping tests, 6 hours each, in wells screened in the Niagara aquifer located just outside of Lapham Hall (Fig. 2). Water level was collected in 30 second intervals by WellIntel® sensors placed on top of each well.

To determine the occurrence of microplastics, three hundred gallons of the produced groundwater was filtered through a novel microplastics sampling device provided by UW-Madison (Fig. 3). This device contains four stainless steel mesh screens with 1526 µm, 500 µm, 300 µm, and 100 µm pore sizes. After pumping, the material remaining in the sampler was air dried and collected to determine mass. The material was then sent to UW-Madison for type analysis through the use of Fourier transform infrared spectroscopy (FTIR).

Results

- Drawdown v. time and water quality parameters v. time are shown (Fig. 4, 5).

- 0.2105 g of material was recovered from screens (Fig. 6,7)

- No microplastics were found in any samples from FTIR analysis

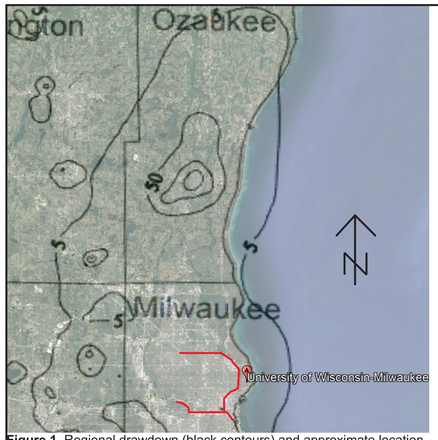

Figure 1. Regional drawdown (black contours) and approximate location of deep tunnel system (red line) relative to UWM.

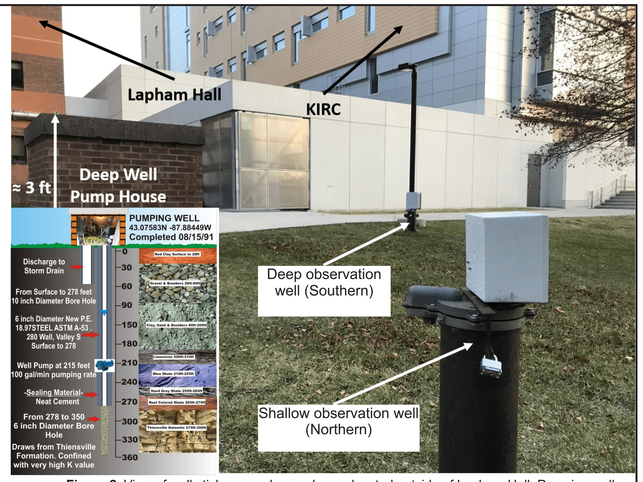

Figure 2. View of well stick-ups and pump house located outside of Lapham Hall. Pumping well construction in insert.

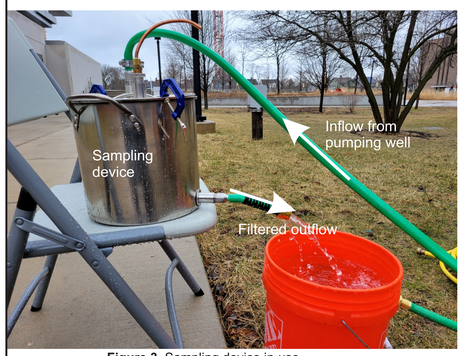

Figure 3. Sampling device in-use.

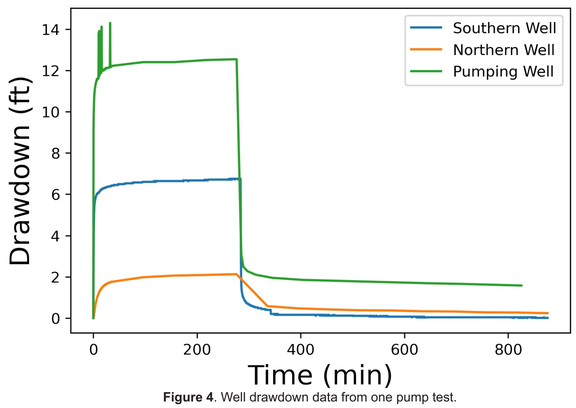

Figure 4. Well drawdown data from one pump test.

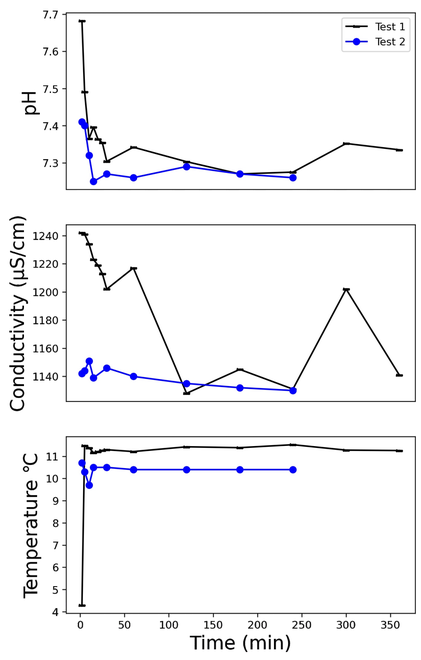

Figure 5. Water quality data from 2 separate pumping tests.

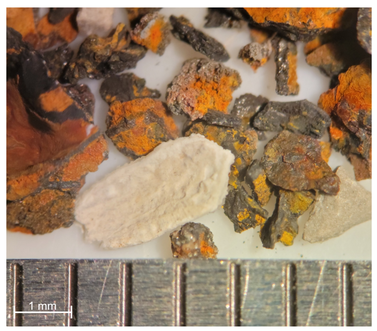

Figure 6. 10x view of material recovered from 500µm screen. Scale in 1mm increments.

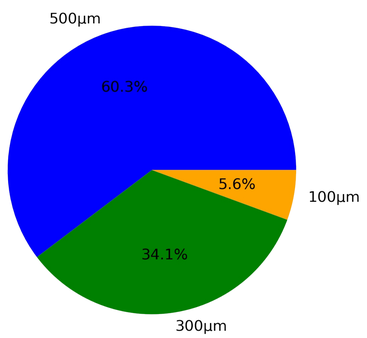

Figure 7. Percent of total mass recovered from each screen. No material was recovered on 1526µm screen.

Discussion

From the drawdown vs time data, hydraulic conductivity was calculated to be 20-30 ft/day. Using this, it was determined that pumping the Lapham well would influence groundwater flow in a 250 to 900ft radius (Fig. 8) which is not large enough to directly influence water in Lake Michigan or the deep tunnel which are, respectively, 4500ft and 2150ft away from the pumping well.

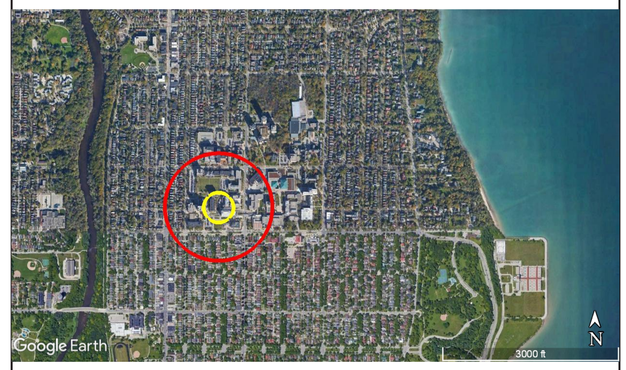

Figure 8. Calculated radius of influence created by pumping. Red = 900ft, Yellow = 250ft

From the water quality data, it is apparent that no changes to this data, besides the initial change, indicates that water is coming from the same lithologic unit.

While no microplastics were detected, only a small fraction (≈1%) of the total water pumped was able to be sampled due to the 1.2 GPM max flow rate of the device. Additionally, material less than 100µm in size was not able to be collected by the device.

In future tests, a more robust sampling device would allow for more material to be collected and allow for a better representation of the type of material in the water of the Niagara aquifer. Also, sub 100µm material should be examined to fully determine the occurance of microplastics.

References

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