Movement and Quantification of *E. coli* in a Managed Aquifer Recharge (MAR) Site

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Research Questions

1. What is the risk of *E. coli* and fecal contamination in groundwater below a wastewater recharge pond at a MAR site?
2. How do *E. coli* concentrations in the pond vary over time due to weather patterns and various management practices?

Background

Managed Aquifer Recharge (MAR) Site

- Stores non-potable water to ease drinking water demand
- Supports desert riparian wildlife [1]
- The MAR study site is at the Gilbert Riparian Preserve (GRP)
- The GRP stores treated wastewater in recharge ponds
- GRP management practices: tillage, water distribution to ponds

E. coli

- Fecal indicator bacteria – indicates fecal pollution in water
- Fecal pollution is in the GRP recharge ponds due to animal activity
- Pathogenic *E. coli* can cause gastrointestinal illness in humans
- About 73,480 illnesses occur each year in the United States [2]

Methodology

Quantification of *E. coli*

- Sample water from Pond 7 at the GRP
- Count *E. coli* using culture-based quantification methods

E. coli Movement Through Soil

- Sample soil from Pond 7 at the GRP (Vecont clay)
- Soil column experiment – track transport of *E. coli* as it moves through Pond 7 soil and determine *E. coli's* maximum vertical travel distance through the soil

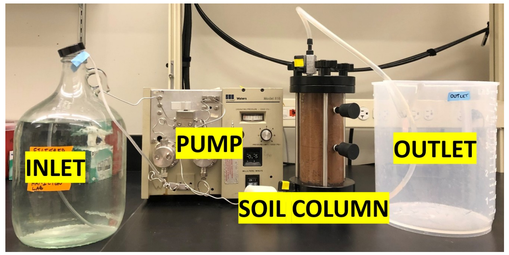

Figure 1: Soil Column Experiment Setup

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Co	Contine clay loam	3.0	34.6%
Ve	Vecont clay	5.6	65.4%
Totals for Area of Interest		**8.6**	**100.0%**

Figure 2: Pond 7 at the Gilbert Riparian Preserve

The soil column experiment graph in Figure 3 below can help determine how deep below the surface *E. coli* can travel in soil. *E. coli* was injected for 2 pore volumes, then a bacteria-free solution was injected for 4 pore volumes (after the orange line).

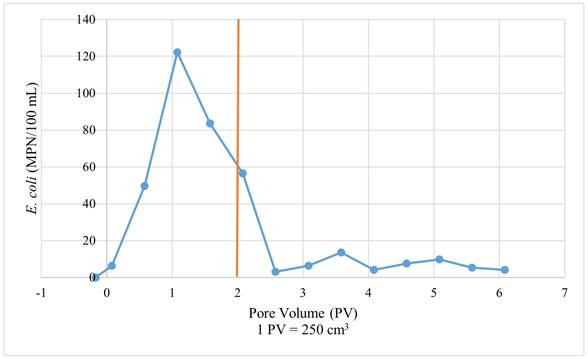

Figure 3: *E. coli* Breakthrough Curve

Results

Sampling water from Pond 7 over time has so far yielded the following results:

Table 1: Pond 7 *E. coli* Concentrations

Sample Date	Average Result	Result Units	Quantification Method	Water Temperature (°C)	Pond 7 Volume	Tillage	Precipitation (in)
6/29/2021	2600	CFU/100 mL of sample	mTEC	29.0	Low	No	0
3/4/2022	110			18.9	High	No	0
7/6/2022	0	MPN/100 mL of sample	IDEXX Colilert	33.8	High	No	0
7/12/2022	81			28.1	Low	No	0
7/26/2022	220,295			28.6	Low	No	0
8/9/2022	71			28.9	Low	No	0.04
8/26/2022	2,116			30.8	High	Yes	0
9/9/2022	207			28.2	High	No	0.08
10/11/2022	241			24.2	High	No	0

Conclusions and Future Work

- More data is needed to analyze variance of *E. coli* concentrations
- Bacteria concentrations in Pond 7 vary over time → risk of exposure varies over time
- More soil column experiments will be done to determine *E. coli* transport variance due to different management practices (bulk densities before and after tillage occurs at the GRP)
- 1st hypothesis: *E. coli* will be retained inside soil column because of
  - Attachment to soil particles (high surface area)
  - Bacterial die-off inside the column (cannot survive without a host)
  - Barrier formed by clay at the GRP
- 2nd hypothesis: higher soil bulk density → less bacterial movement/recovery

References

[1] "Town of Gilbert, Arizona." https://www.gilbertaz.gov/departments/public-works/water/water-resources/reclaimed-water.
[2] Rangel, Josefa M, et al. "Epidemiology of Escherichia Coli O157:H7 Outbreaks, Volume 11, Number 4-April 2005.

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