Quantifying Groundwater and Surface Water Interaction in the Four Mile Creek Buried Valley Aquifer

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Introduction

Four Mile Creek buried valley aquifer is an alluvial aquifer that was formed as a result of glacier deposits. The deposits that make up the aquifer consist of alternating layers of sand-and-gravel outwash, glacial till, and lake sediment. An aquifer is present due to the layering of the sediments of the high permeability of the sand-and-gravel outwash and relatively low permeability glacial till and lake sediments.

The Four Mile Creek buried valley aquifer supplies water to the City of Oxford by means of three pumping wells. One well (PW1) is directly east of Yager Stadium, north of Bonham Rd. The second (PW2) is located at a service drive off of Oxford-Trenton Rd, between Four Mile Creek and the Water Treatment Plant. The third well (PW3) is between PW1 and PW2, east of Four Mile Creek, within agricultural fields owned by Miami University.

Purpose

The primary goal of this project was to determine the extent of groundwater and surface water interaction taking place in the Four Mile Creek Buried Valley Aquifer when Oxford's pumping wells are active. This was to be done by analyzing O^{18} levels, abundance of E. coli, and hydraulic gradient in Four Mile Creek and Miami's observation well field, followed by developing a pumping-state model. The development of a transient model meaning, a model in which the recharge and discharge are not equal, would give a much more accurate depiction of our aquifer. .

Methods

- Transducers are installed in order to record changes in pressure. The difference is calculated between pressure in the creek and the aquifer to determine the hydraulic gradient. Two transducers are installed at one site, one inside the well and the other in the creek. A total of six transducers are used at three locations.
- Samples are taken from shallow and deep monitoring wells and from Four Mile Creek to determine if E. Coli is present. Samples of 1 mL or 100 mL are tested using petrifilm or a filter pump and petri dish, respectively, and are incubated for 24 hours. The colonies are then counted and compared.
- Samples are taken from Four Mile Creek and surrounding observations wells for isotopic analysis of δO^{18}. Samples from production wells were provided by Oxford Water Treatment Plant. All samples are then analyzed and compared.

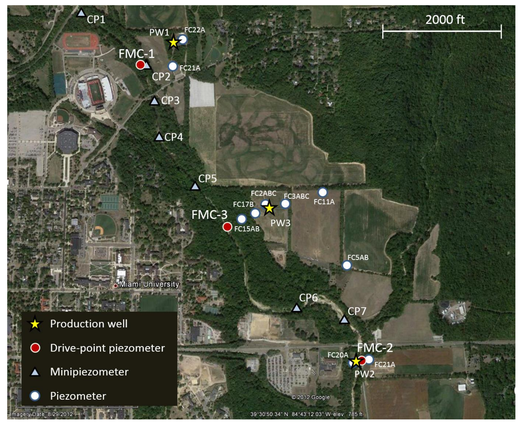
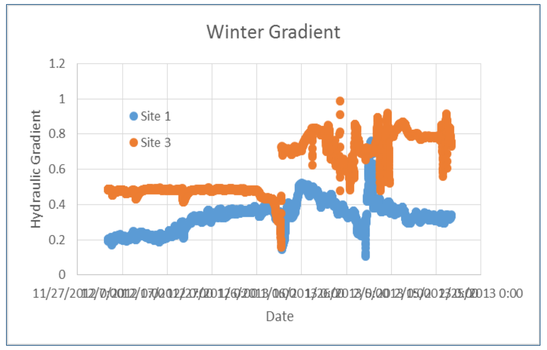
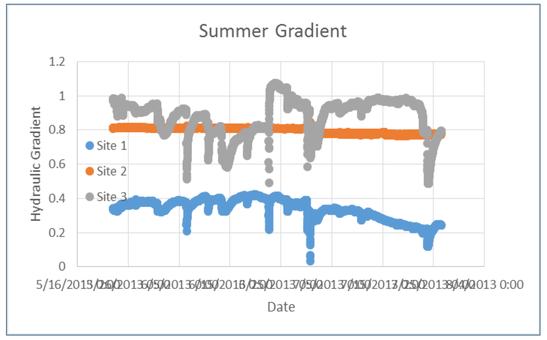


Figure 1. Four Mile Buried Valley Aquifer well field.

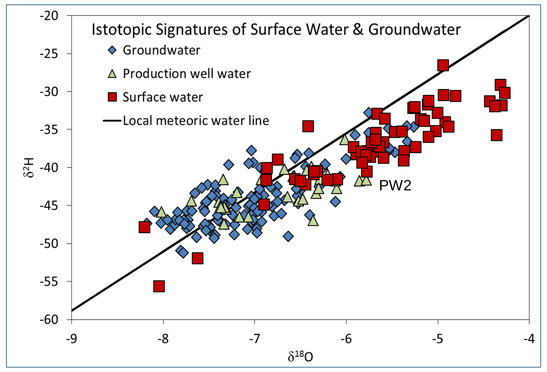
Results



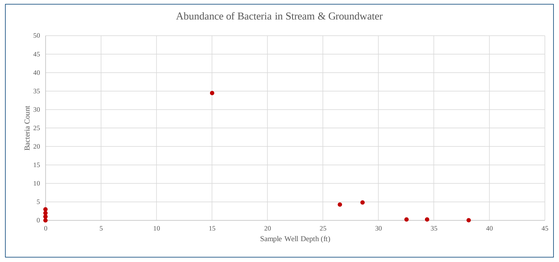
Graph 1.



Graph 2.



Graph 3. Analysis of isotope samples from observation and production wells.



Graph 4. There appears to be an inverse relationship between the depth of the well and the amount of bacteria present.

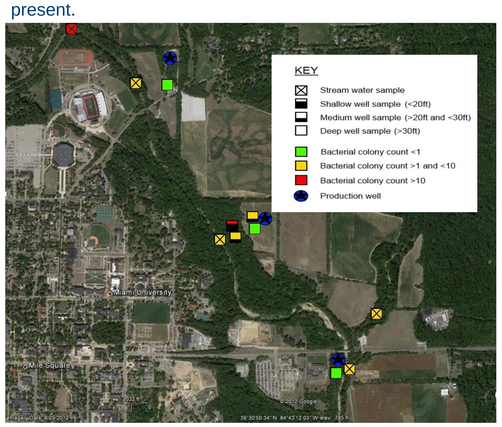


Figure 2. Map of sample location, approximate well depth and presence of E. Coli.

Conclusions

- gradient and pumping conclusion/analysis (Graph 1. & 2.)
- Production wells are predominately groundwater but surface water presence is variable. (Graph 3.) Production well 2 is mostly composed of surface water.
- Graph 4. and Figure 2. show that shallow wells have a higher abundance of E. Coli present than deep wells. It can be inferred that less E. Coli is present as a result of natural filtration.