**Inquiry Labs Information Sheet**

**1. Name of Lab:**

**Groundwater - Why it’s important, how it flows & what’s in your water?**

**2. Authors:**

Jeffrey Lockridge - jlockridge@ncmich.edu - North Central Michigan College

Matt Heller - hellermj@jmu.edu James Madison University

**3. Delivery Format** (e.g. In-Person, Online Synchronous, Online Asynchronous)

* In person

**4. Audience:**

* Introductory Geology. Earth Science, and Environmental Geology lab courses

**5. Learning Objectives:**

* Understand that groundwater is an important resource for everyone.
* Apply terminology and concepts for groundwater movement/migration within the subsurface. Understand connection b/w GW and surface water
* Describe potential sources of groundwater contamination and understand how water quality data is accessed, analyzed and used to find/remediate contamination sources.

**6. Intended levels of Inquiry included (per Buck et al., 2008)**

Activity 1: Structured and guided inquiry in activity (problem, background, design provided). Could be left open ended for what info is important to collect about student sample.

Activity 2: 2a) Open inquiry - experimenting with materials

 2b) Guided or open inquiry (depends on structure provided by instructor)

* Materials best for flow, best for absorption/remediation, best for isolating/confining?

Activity 3: Guided (or open) inquiry (for open, students would have to figure out what to do with provided well data).

Activity 4: Guided inquiry

**7. Expected Prior Knowledge (e.g. previous lab activities)**

-Complete readings related to groundwater flow and storage terminology (aquifer, aquitard, groundwater access (wells/springs), etc.)

- Basic understanding of water cycle

- Source of water at each student’s tap

- groundwater or surface water source?

- Basic info on home water setup (filtration: refrigerator, pitcher, RO system?; Softener in use?, etc.)

- Students sample tap water and bring it with them at start of lab.

**8. Expected Time for Lab (or for modifications)**

Full 3 hours for all 4 Activities

**9. Materials Required:**

*Part 2a*

* Silt, Sand, gravel (such as pea-sized or aquarium gravel)
* Modeling clay or plumber’s putty
* Well screening materials, such as nylon hose, cotton, coffee filters, aquarium charcoal, sponges
* Aluminum foil and/or plastic wrap or sheeting (as a protective liner)
* A clear funnel (or top ½ of 2-liter bottle) with fine-mesh screen to experiment with
* Container for each group’s aquifer model (can be shoe-box sized tupperware, large, clear cups/beakers, cut 2-liter bottles, etc.)
* Materials for wells and pumps (soap bottle pumps; aquarium tubing & syringe; clear straws)
* Food coloring (blue if desired for increased visibility of water, dark color if introducing a contaminant)
* Dry erase markers to label features on the aquifer container
* Beakers/containers for water and to mix dye and to collect waste “well water” Larger tubs beneath each container to catch spills/overflow
* Large beakers/buckets of water
* 5 gallon waste buckets for disposal of wet sediments (one for each group would be best).

*Part 4*

* *Sterile water sampling bottles (order new or sanitize and reuse). Must be sterile or bacteria results could be impacted!*
* *First Alert (or similar) water quality kit (*[*https://www.amazon.com/First-Alert-WT1-Drinking-Water/dp/B000FBMAVQ/ref=sr\_1\_3?crid=1MZ4LT6463Q9F&keywords=first+alert+water+test+kit&qid=1547840582&sprefix=first+alert+water%2Caps%2C196&sr=8-3*](https://www.amazon.com/First-Alert-WT1-Drinking-Water/dp/B000FBMAVQ/ref%3Dsr_1_3?crid=1MZ4LT6463Q9F&keywords=first+alert+water+test+kit&qid=1547840582&sprefix=first+alert+water%2Caps%2C196&sr=8-3) *)*
	+ *Tests to EPA Drinking Water standards for Tests for bacteria, lead, pesticides, nitrates/nitrites, and chlorine*
	+ *Checks the hardness and pH of water*
* *Local water quality report*
* *Optional: Conductivity/ Total Dissolved Solids (TDS) meter; pH meters*

**10. Materials Provided**

**a. Student Handout**

**b. Instructor Copy (Teaching Notes & Answer Key):**

**11. References**

Activity 2 - Inspired by and adapted from Awesome Aquifers activity produced by The Groundwater Foundation (<https://www.groundwater.org/kids/getinvolved/so/aa.html>) for the Science Olympiad.