Instructor Notes for Go with the Flow: A Virtual Field Experience on Groundwater Flow:

This module is intended to provide a virtual field experience of collecting water level data from wells/piezometers. The module includes the analysis following the field work including estimating groundwater flow direction using 3-point problems and creating water level contour maps. In addition, students will learn how to use a water level contour map to determine hydraulic gradient and specific discharge of an area.

Module progression:

1. Review of hydraulic head (if necessary)
	1. Larry Murdoch Hydraulic Head Gradient and Groundwater Flow Video (captioned): <https://www.youtube.com/watch?v=8eunHzLVltk>
2. Introduction to water level measurements via videos about the methods and a video of data collection at Glenn Sebastian Nature Trail, Mobile, Alabama; Guiding Questions are included in three-point problem (#3).
	1. USGS Videos include videos on measuring water levels in wells using steel tape and electric tape (water level meter) (captioned): <https://water.usgs.gov/ogw/video/gwpd.html>
	2. Glenn Sebastian Nature Trail water level measurements overview and collection; data from this video will be used in the final assessment activity (captioned) <https://www.youtube.com/watch?v=ZSxgdrpAQMQ>
3. Three point problems
	1. This activity outlines best practices for collecting water level measurements and uses data from wells on California State University, Sacramento campus. The activity teaches students to use 3-point problems to determine groundwater flow direction. The maps are included in the word document and as tiff files. The image file can be opened in a drawing software like Paint when printing capabilities are not available. Video guiding questions are included in this activitiy.
	2. Foldable Aquifer three point problem: <http://aquifer.geology.buffalo.edu/index.php/2019/11/27/three-point-problem/> (This is a possibility to increase the 3D visualization for students. This is included only as a reference for expanding the module.)
4. Introduction to creating water level contour maps and determining flow direction
	1. Video from Larry Murdoch at Clemson on basics of contouring and calculating hydraulic gradient from a contour map (captioned): <https://www.youtube.com/watch?v=IrETS-gBU_o>
5. Practice creating water level contour maps
	1. This activity has the students create a water level contour map using plotted water table elevations. The map is included in the Word document and as an image file. The image file can be opened in a drawing software like Paint when printing capabilities are not available.
6. Using water level contour maps to determine gradient and specific discharge
	1. This activity is already available on SERC and is intended to assess student’s ability to create contour maps from water level data and determine groundwater flow. In addition, this activity teaches students to use the water level contour maps they create to calculate hydraulic gradient and average groundwater velocity (specific discharge). The activity and all necessary documents are available on the SERC website via the following link: <https://serc.carleton.edu/NAGTWorkshops/hydrogeo/HSG2013/activities/71330.html>
7. Water levels and groundwater flow assessment
	1. In this activity, students will use the data collected in the video on water level collection in Glenn Sebastian Nature Trail (GSNT) to create a contour map of water level elevations, determine flow directions, and calculate average groundwater velocity (specific discharge). In addition, students will use a portion of the data to calculate flow direction using the 3-point problem method. The map and graph paper are included in the Word document and as image files. The image files can be opened in a drawing software like Paint when printing capabilities are not available.

# COURSE SCHEDULE CHECKLIST:

# Groundwater level and flow direction Module Schedule (3 days, Pts #)

**Dates: Month Day 1 - Day 3. All activities/assignments due by (instructor choice)**

|  |  |  |  |
| --- | --- | --- | --- |
| Check when complete | Activity/Assignment | Due date | Points |
|  | **Watch**: USGS videos and Glenn Sebastian Nature Trail video | Day 1 |  |
|  | **Assignment**: Video questions | Day 1 |  |
|  | **Assignment/Activity**: Three point problems | Day 1 |  |
|  | **Assignment/Activity**: Foldable aquifer three point problem | Day 1 |  |
|   | **Watch**: Video on creating contour maps and calculating hydraulic gradient | Day 2 |  |
|  | **Assignment/Activity**: Water level contour map | Day 2 |  |
|  |  **Assignment/Activity**: Groundwater Discharge and Flow Rate | Day 2 |  |
|  | **Assessment:** Glenn Sebastian Nature Trail | Day 3 |  |
|  |  |  |  |
|  | **Bonus (Optional):**  |  |  |