AUBURN UNIVERSITY OUTREACH PROGRAM
PROJECT INTERIM REPORT

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WATER EDUCATION FOR ALABAMA'S BLACK BELT (WET)

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INTRODUCTION

Project **WET** (**W**ater **E**duca**T**ion for Alabama) provides off-campus environmental and water-education activities designed to increase the appreciation, knowledge, conservation, and protection of water resources by K-12 students and teachers. **WET** is affiliated with the Auburn University Environmental Institute's (AUEI) Black Belt Environmental Science and Arts Program (BBESAP). The project is structured around a variety of indoor and outdoor activities held at Auburn University's E. V. Smith Center (EVSRC) in Macon County. The hosting center has easy access to surface water (ponds, wetlands, streams) and groundwater (through nested wells facilities), and offers a facility to hold laboratory setups for basic hydrologic experiments (e.g., aquifer models, permeameter, water quality). In these educational events, students and teachers come to the EVSRC to learn about groundwater flow and its interaction with surface water in an aquifer tank, hydrologic properties (porosity and permeability) of different aquifer materials (sands, gravels, and clays), and ways to assess water quality (water quality probes, testing kits, and aquifer tests). Our ultimate educational goal is to help this audience become knowledgeable about surface water and groundwater so they can identify "safe" aquifer zones, where sustainable, clean water resources are available for long-term development and use. The project is designed and organized by the Department of Geology and Geography and Environmental Institute of Auburn University, with support from the AU Outreach Program.

PROGRAM PLANNING

Our first field event was held on 12 October 2007 at the E.V. Smith Research Center, Horticultural Unit for sixth-grade students of the D.C. Wolfe Elementary school. Similar field day activities focusing on well testing will be held in the spring of 2008, once all well drilling and installations are completed by Geolab (contractor) in November 2007. Kay Stone of AUEI arranged with Macon County school superintendents for school participation in the WET program. The WET fall program was designed with 4 activities centering around an aquifer tank model, porosity/permeability assessments, Darcy's experiment, and dissolved oxygen (DO) measurements. Two Geology professors (Ming-Kuo Lee and Lorraine Wolf), three graduate students (Kelli Hardesty, Lee Beasley, and

Prakash Dhakal), and one undergraduate student (Kyle Lewis) designed and demonstrated these modules.

FALL 2007 EVENT

About 30 six-grade students from D.C. Wolfe Elementary participated in the Fall 2007 WET event. They were divided into three groups and rotated through three modules (groundwater/geology, rock art and descriptive writing, and soil studies) during the field day. The WET groundwater/geology module included four sub-activities: aquifer and water table tank simulations, porosity and permeability testing, permeameter experiment, and DO measurements. Below is a brief description of each WET activity:

(Activity 1) *Aquifer in a Tank Model* – The WET team has constructed a physical aquifer tank model (Figure 1) to demonstrate hydrology concepts. In this activity, students are introduced to vocabulary used to describe aquifer and groundwater characteristics (key words underlined). They then perform a series of tasks and observe and describe the results. These tasks are designed to illustrate fundamentals of Earth's hydrologic cycle:

- Using an example from a poster illustration, students draw on the tank the position of the water table, which separates the zone of saturation and unsaturated zone. They then add water to the tank and draw the new position of the water table. This illustrates the concept of recharge from precipitation.
- As students add water to the tank, they observe the water level rise in both a lake and in a cased well positioned in the tank. This step illustrates the connectivity between groundwater and discharge to water at the surface (e.g., stream, lake). A sample of the well casing is passed around for students to see how screening in a cased well allows water (fresh or contaminated) to flow into the well from an aquifer. This illustrates how contaminated groundwater can enter water supply wells underground.
- Using a handheld pump, students remove water from the tank. They observe the pattern of water movement and the affects of pumping on the water table as its position is lowered. This task illustrates the consequences of changing the balance between recharge (input) and use or discharge (output). It also illustrated the effects of drought.

Figure 1. An aquifer tank model built to demonstrate groundwater and surface water interaction and groundwater contamination. Students can see and mark saturated zone, water table, unsaturated zone. They also examine the well casing and screen. They add water to simulate recharge, and pump water from well to simulate drought and overuse.

(Activity 2) *Porosity and Permeability of Aquifer Materials* – In this activity, students are introduced to the concepts of <u>permeability</u> and <u>porosity</u>. They then compare differences in porosity and permeability of three common aquifer materials – gravels, sands, and clays. For porosity assessment, they add fixed volumes of water into three beakers, which are 60% filled with dry gravel, sand, or clay. They compare the amount of water ponding above the sediment after water completely percolates downward and fills up open pore spaces between solid sediment grains (Figure 2). They observed that gravel-size sediments have the greatest porosity because they can hold and store more water than sand or clay-rich sediments. Students also compare how fast water can flow through gravels, sands, and clays. They prepare three syringes with different sediment types and then allow water to flow through the syringes under the same hydraulic gradients as the plug (filter stops) at the bottom of syringes are removed simultaneously. Hardly any water flows through syringe filled with clay. Students conclude that gravels are most permeable because the water drains much faster.

Figure 2. Students assemble "aquifer in a beaker" and "aquifer in a syringe" models to compare the porosity and permeability of gravel, sand, and clay-rich sediments.

(Activity 3) *Darcy's Experiment* – In this activity, we assemble a constant-head permeameter (Figure 3) to simulate the classic Darcy's experiment, allowing students to visualize flow and contaminant transport (a juice coloring is used) through a sand layer under a given hydraulic gradient. The chamber is a one-piece acrylic to permit viewing of the aquifer sample. An adjustable constant-head reservoir is mounted to the upright scale and its height can be easily adjusted to change hydraulic gradient. The greater the hydraulic gradient, the faster the water moves through the sand chamber.

Figure 3. Darcy's experimental setup for a permeameter. Water level difference in a constant-head funnel and a graduated cylinder maintains continuous water flow through a sediment chamber. Outflow from cylinder is collected to estimate flow rates.

(Activity 4) *Dissolved oxygen in natural water* – In this activity, we demonstrate titration analysis for dissolved oxygen (DO) on a surface-water sample collected from a swamp near the E.V. Smith Center. Various dissolved oxygen reagent powders are added into water bottle. The presence of a brownish-orange precipitate and a yellow water color indicate oxygen is present. Sodium Thiosulfate solution is then added, one drop at a time, until the water sample becomes colorless (Figure 4). The total number of drops of titrant is counted as the total dissolved oxygen (in mg/L). Students identify the amount of DO (low, medium, or high) in the water sample. A clean surface water contains high DO (>10 mg/L).

Figure 4. Geology student Kyle Lewis-Kasper demonstrates the use of HACH testing kit to determine dissolved oxygen content in a swamp water sample collected from the E.V. Smith Center.

Assessment and Evaluation

The overall goal of the WET project is to enrich the capacity and knowledge of students and teachers in the basics of hydrology so that they can utilize water resources information, achieve a deeper awareness of water-quality issues, and understand the interplay among natural and anthropogenic changes and the water cycle. At the conclusion of the WET activities, students were asked to answer the following questions:

1. **What happens to the aquifer when it rains?**
2. **What happens to the aquifer when it stops raining (during a drought)?**
3. **Which material (gravels, sands, clays) is most permeable (allow fast water movement)?**
4. **Which material (gravels, sands, clays) is most porous (more space to store water)?**
5. **How does contaminant get into the groundwater and how can we clean it up?**

We are very pleased to see that a very high percentage of participants were able to answer all these questions correctly, indicating that our project design was effective in the immediate timeframe of the activity. We will continue to work on the evaluation process to devise methods for determining whether the concepts learned are retained over time and match the middle-school earth science curriculum of Alabama.

Participating students and teachers were also asked to complete short surveys and to comment on the event activities. We will use their suggestions to improve future field days and better focus the individual modules. In general, comments from participants indicate that both students and teachers found the WET events stimulating and worthwhile. The following are specific comments and evaluations from teachers and students:

Teacher Evaluation:

1. The field trip was well structured with great hands-on educational and enjoyable learning activities for the students and the teacher.
2. The modules correlated with the classroom curriculum and the Alabama Course of Study for sixth grade. Each activity was age appropriate and met the COS objectives #2: describe factors that cause changes to Earth's surface over time; and #3: describe water and carbon bio-geochemical cycles and their effects on Earth.
   I think the program was very beneficial from an educational perspective. The students were able to practice the steps in the Scientific Method. They were guided in making observations and wrote about them. I was glad to hear that the students had a preview to the lessons on the fifth grade trip last year. I was also impressed with their responses during the presentations.
3. Continue checking the Alabama Course of Study when planning the modules. Provide a follow-up trip near the end of the school year to extend the activities.
4. The equipment and the art activities seemed to motivate the students. They maintained a high interest level from start to finish. They were not hesitant to explore new concepts and ask questions.
5. All the materials from this field day will be useful. Each student needs a book for note taking and journal writing. The journals they received will be used for notes

during the 2nd Nine Week. Making the pet rocks, observing minerals and rocks, investigating ground water and soil were great introductions to our next lessons in science. I will be able to use the handout and materials to enhance my lessons.

Students Evaluations:

Which modules did you find the most challenging (hardest)?

1. The hardest group for me was the water group.

What are some things you learned about groundwater from the geologists?

1. I learned that the water we use comes from the ground, I thought it came from somewhere else.

What did you like most about today's field trip and what other activities would you like to see added to future field trips?

1. The thing I liked most about today’s field was the water experiment. In the future I would like to see the study of animal added to the field trips.
2. That we should use gravel if you want to get fresh water. Our water comes from an aquifer.
3. Some thing I learned about ground was that if you get water from a ditch you can put some type of liquid in the water to make it a certain color. Also if it does it is being recharged.
4. One thing I learned from ground water was how you could keep your water from being polluted.

How did you rate today's modules on a scale of 1-4 with 4 being excellent and 1 being fair? Average of 4 evaluations

Rock art and descriptive writing : 3.75

Soil Studies: 3.75

Groundwater/geology studies: 4.0

CONCLUSIONS

Students gave a high ranking to our WET module, even though they considered our water experiments to be the most intellectually challenging. Our future evaluations will focus on a list of specific outcomes that can be easily measured (e.g., the student will learn how to measure DO, stream discharge, and water table depth, how to calculate a hydrologic gradient, ways to identify contaminants, conserve water resources, etc.) in addition to more qualitative assessments (e.g., Would you tell a friend to participate in this event?). Our project has a long-term goal of improved performance in science-related subjects, although this is not easily measured in short time. We will seek to develop ways to determine the longer term impact of the WET activities.