Wiyot Tribe
Environmental Department

Clean Water Act §319 Non-Point Source Pollution Control Program

NON-POINT SOURCE POLLUTION EDUCATION CURRICULUM

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1.0 Introduction

The Wiyot people have a strong dependence on the Eel River, Humboldt Bay and its tributaries, and the Mad River for the valuable resources that serve tribal sustenance and cultural purposes. Non-point source pollution threatens the quality of these water-bodies and their respective watersheds, and by extension threatens the ability for those water-bodies to provide the resources upon which the Wiyot people depend. Educating tribal youth about the causes, impacts, and prevention of non-point source water pollution is an important means of instilling environmental stewardship in future generations and protecting tribal waters and their resources.

The Environmental Department of the Wiyot Tribe has been working with the Boys & Girls Club of Wiyot Country to improve environmental education for tribal youth. Currently, the Tribe's youth program has 20-40 tribal youth members participating in both cultural and environmental activities. The purpose of this curriculum, developed by the Wiyot Tribe Environmental Department, is to strengthen the tribal youth's knowledge on issues relating to non-point source pollution.

2.0 Program Summary

The following curriculum was established to teach tribal youth how non-point source pollution can have an effect on entire watersheds. Each lesson and activity will introduce a specific element of the watershed (i.e. wetlands), the effects of non-point source pollution, and how non-point source pollution can potentially affect other elements connected in the watershed. The curriculum will begin with an introduction to the water cycle, watersheds, and non-point source pollution. Later, the students will learn about the various environmental elements of a watershed and how non-point source pollution moves through each element. Watershed topics that will be covered include groundwater, urban/rural areas, wetlands, and large water bodies including rivers, lakes, and the ocean. The curriculum will be concluded with a lesson aimed at making the overall connection between non-point source pollution and its effects on the watershed. The curriculum will be implemented in Spring/Summer 2010.

3.0 Curriculum

Lesson 1: "Let's Begin"

During this lesson, students will review watersheds, the water cycle, non-point source pollution, and how to distinguish non-point from point source pollution. The lesson will begin by introducing the water cycle and how water moves through a watershed. Students will review the difference between point and non-point source pollution and learn how pollution can affect all environments of a watershed. The lesson will also cover how pollution affects soil and air as it moves from one environmental medium to the next.

Activity: "Watershed Aquarium" – This activity is an introductory lesson to the overall concept of how ecosystems are interconnected. Students will create several watersheds and track the flow of water throughout each. In aquariums, students will create landscapes such as mountains, hills, and valleys using newspaper and Saran wrap. Using a spray bottle to simulate rain, water will be applied to one side of the aquarium to show how water flows through a watershed. Next, water will be sprayed at the top of two watersheds (called the *watershed divide*) in order to show how water flows into different watersheds. Non-point source pollution will be introduced using food coloring and students will observe how pollution can move throughout the watershed. Students will be asked to think of a nearby river or stream and ways that non-point source pollution could travel from as far as the headwaters of the watershed (see Appendix 2: Environmental Curriculum Activities – Figure 1).

- *Supplies:*
  - Aquarium (1)
  - Roll of Saran Wrap (1)
  - Roll of Scotch Magic Tape (1)
  - Sheets of newspaper (5)
  - Spray bottle (1)
  - Waterproof magic markers (1)
  - Food coloring (3 1-oz. bottles)
  - Miniature houses/buildings (Monopoly game pieces)

Lesson 2: "The Ground Beneath You"

During this lesson, students will learn about the major concepts of aquifers including the saturation zone, permeability, and confined vs. unconfined aquifers. Students will also learn how we access these aquifers and the common uses of well water in our society today. Lastly, the students will learn the common non-point source pollutants responsible for groundwater contamination, how they affect the water quality within the aquifer, and how this pollution can be prevented.

Activity: "Aquifer in a Cup" – Students will design their own aquifers in clear, see-through cups using sand, gravel, clay and water. First, students will design an unconfined aquifer using sand and gravel. A few drops of food coloring will be added to the top layer, rain will be simulated by sprinkling water on top, and students will observe how pollution travels through the soil to reach the aquifer. Next, in a separate cup, students will design both a confined and unconfined aquifer in the same cup using sand, gravel, and clay (which will act as a confining barrier). Students will begin by pouring sand and gravel up to the halfway line of a clear cup. Next, students will pour in a 1/4 cup of water to simulate an aquifer. Students will then place a layer of clay on top of this aquifer to act as a barrier, confining the bottom aquifer. Lastly, students will pour sand, gravel, and a 1/4 cup of water on top of the barrier to create both a confined and unconfined aquifer (see Appendix 2: Environmental Curriculum Activities – Figure 2).

- *Supplies:*
  - Clear plastic cups (100)
  - Sand (1 10-lb. bag)
  - Gravel (1 10-lb. bag)
  - Modeling clay (1 10-lb. bag)
  - Colored drink powder (1 jar)
  - Watering jugs (3)

Field Trip: Old Reservation Wellhead – The community drinking water well for the Table Bluff Reservation community is located on the tribe's old reservation property near McNulty Slough, neighboring farmlands, residential property, and a public road. During this trip, introduced concepts on aquifers will be related to the Tribe's well and students will be asked to think about the origins of potential sources of non-point source pollution that may affect the tribe's water quality.

Lesson 3: "Where You Live"

During this lesson, students will focus on non-point source pollution generated in the urban and rural environments. We will cover important concepts such as the relationship between water uptake/runoff and impervious/permeable ground cover, water discharges and the effect on streambeds, and the types of pollutants most commonly found in urban and rural settings. Examples will be provided to give students an idea of how non-point source pollution can have devastating consequences in very different settings. Students will also learn how these pollutants travel through our environment, the impacts of these pollutants, and the steps that can be taken to prevent non-point source pollution.

Activity: "Pollution in Your Neighborhood" – Students will use this hands-on activity to observe how non-point source pollution can occur in their own backyards. Two demonstration boxes will be constructed; one will contain conceptual models of both an urban and a rural environment, and another that will contain a conceptual streambed. On one side of the first box, students will use concrete pavers (impermeable surface), sand and gravel to construct an environment representative of a large urban area; on the other side of the same box, students will use grass sod (permeable surface), sand, and gravel to construct an environment representative of a rural area. Within these environments, students will add potential pollution sources in the form of miniature houses/buildings, cars, tractors, and farm animals. Pollutants will be added to the landscape in small quantities using food coloring (drops) and in large quantities using dry, colored drink powder. Additionally, sediment in the form of sand and gravel (simulating construction site/dairy runoff) will be identified as a non-point source pollutant. Rain will be simulated using a water jug and students will observe how pollution moves through both environments. Students will experiment with biological pollution buffers such as grass by moving pieces of sod around the environment in order to "trap" non-point source pollution. A second box containing sand, gravel, and rock (representing a streambed) will be constructed beneath the outlets (a storm drain for the urban setting) of the first box to demonstrate the effect of flow rates on the hydrology of a streambed. Students will also

observe the ways non-point source pollution moves through different settings, and the different rates of pollutant transmission from source to streambed. This will also give the students an opportunity to distinguish between pollution types, as storms drains are point source pollution sites (see Appendix 2: Environmental Curriculum Activities – Figure 3).

- *Supplies:*
  - 4' x 8'sheet of ¾" marine grade plywood (1)
  - 2" x 6" redwood (24')
  - 2" deck screws (2 lbs.)
  - Silicone sealant (2 tubes)
  - Low VOC deck polyurethane (1 gallon)
  - 1" diameter PVC tubing (1' in length)
  - 1' X 1' Concrete pavers (4)
  - 1' X 2' lengths of sod (grass) (2)
  - Food coloring (3 1-oz. bottles)
  - Colored drink powder (1 jar)
  - Sand (20 lbs)
  - Gravel (10 lbs)
  - Water jugs (1)
  - Miniature farm toys (cows/tractors)
  - Miniature cars
  - Miniature houses (Monopoly game pieces)
  - Construction of this demonstration will also require a power drill with drill and driver bits, a 1" hole-cutting bit, a caulk gun, and a circular saw

Field Trip: Potawot Constructed Wetlands – During this trip, the students will learn how constructed wetlands help play a role in filtering out pollutants derived from urban sources. Students will see first-hand how on-site non-point source pollution in the area is contained on site and treated, preventing pollution of off-site water resources.

Lesson 4: "The Importance of Wetlands"

During this lesson, students will learn how wetlands are an integral part of the ecosystem in naturally filtering out non-point source pollution. Students will learn about the global decreases in wetland acreage and how wetland preservation, restoration, and construction support an important element of the global ecosystem by filtering pollutants, controlling flooding waters, and serving as critical habitat for flora and fauna.

Activity: "Investigating Soil and Plants" – Students will examine both wetland and upland soils to determine differences and construct hypotheses. Close observation of the soils should lead students to inquire why there are noticeable differences in color, dampness, and number of organisms present in the soil. Similarly, students will be in charge of caring for two upland plants and one wetland plant for 2 weeks. One upland plant will be watered every few days when it is dry while the other, along with the wetland plant, will be completely saturated.

Students should notice that the saturated upland plant will begin to wither under the anoxic conditions of the soil while the wetland plant survives. We will review concepts relating to wetland soil/plant biology and why wetlands play the role in filtering out non-point source pollution, thus being named the "kidneys of the watershed."

- *Supplies*:
  - Boxes for soil (2)
  - Handheld microscopes (4)
  - Hardware (trowels, forks, spoons)
  - Microscope (1)
  - Slides and cover plates
  - Garden plants – Geranium (*Geranium* sp.) (2)
  - Wetland plant – California pitcher plant (*Darlingtonia californica*) (1)
  - Clear plant pots (3)
  - Plant pot trays (3)

Field Trip: Arcata Marsh & Wildlife Sanctuary – This field trip will show students how nature cleans water. During this field trip, students will learn the importance of wetlands by visiting the City of Arcata's unique wastewater treatment facility, marsh, and wildlife sanctuary. The marsh's interpretive center will be utilized to show the relationship between salt-water estuaries and the coastal ocean.

Lesson 5: "Ocean Going"

During this lesson, students will learn how non-point source pollution can affect the water quality of large water bodies (i.e. rivers, lakes, and oceans) and affiliated tributaries. Using what they have learned up until this point, students will trace some pathways that non-point source pollution may take to eventually reach its final destination. Students will learn some of the common non-point source contaminants, where they may have originated from, and some preventative methods that can be taken at the source to safeguard water quality for the entire watershed.

Activity: "Pollution Police" - Students will visit a local state beach and pier in order to investigate runoff pollution. The use of water quality equipment from the Wiyot Tribe's Environmental Department will be demonstrated at Trinidad Pier. Similarly, students will use Hach test kits to collect their own data (pH, phosphorus, etc.) and draw up their own hypotheses and conclusions on the results. Students will review non-point source pollutants commonly found in the ocean and, if pollution is found to be present, where they believe the pollution originated from.

- *Supplies*:
  - YSI 6600 series water sampling sonde (1)
  - YSI 650 data logger (1)
  - Hach water quality testing kits (2)

- Water bucket (1)
- Notebooks (3)

Field Trip: Trinidad State Beach & Pier

Lesson 6: "In Conclusion"

In this lesson, students will review all the concepts previously covered concerning non-point source pollution and the effect that contamination can have on our environment. The connection will be drawn that even though contamination may occur in one environment, the entire ecosystem may suffer as pollution travels from one environmental medium to the other. Students will review all the topics that were covered in previous lessons in order to close the program with the take-home message that pollution in all forms can have an effect on all environments associated with a watershed.

Activity: "Solution = Prevent Pollution" – Students will review all the concepts that were taught by participating in an activity that shows the flow of water through a watershed. First, students will create a landscape by placing a bottom layer of rocks, a middle layer of sand, and an upper layer of gravel in an aquarium. On the left side, students will place soil on the top layer of gravel; on the right side, students will place a layer of clay. Next, students will create a wetland using a sponge, cotton swabs, dried flower heads, and pine needles. This visual representation will show how wetlands are vital in retaining water and filtering pollutants in order to control downstream water flow and improve water quality. Non-point source pollution will be introduced to the watershed using food coloring that may either infiltrate groundwater, runoff in the river, or be retained in the wetland. Students will review all the concepts covered from the lessons on non-point source pollution related to groundwater, wetlands, urban/rural environments, and large water bodies (see Appendix 2: Environmental Curriculum Activities – Figure 4).

- *Supplies*:
  - Aquarium (1)
  - Spray bottle (1)
  - Rocks
  - Soil
  - Sand (1 10-lb. bag)
  - Gravel (1 10-lb. bag)
  - Modeling clay (1 10-lb. bag)
  - Food coloring (3 1-oz. bottles)
  - Small sponges (2)
  - Cotton swabs (4)
  - Dried flower heads
  - Pine needles

4.0 Program Evaluation

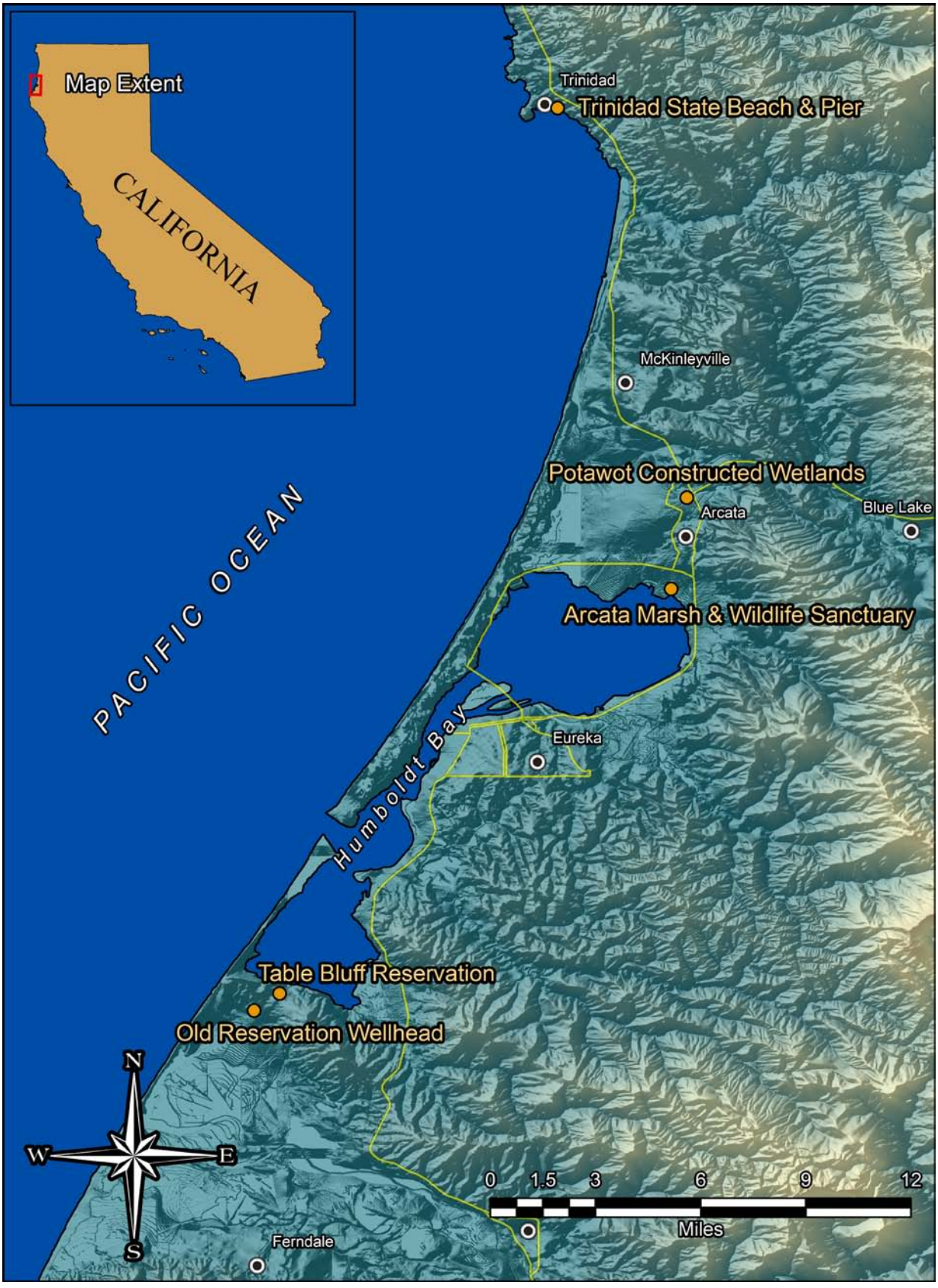
Good education program execution does not end with development or even implementation – in order to get the most from an education program, it is important to evaluate the program while it is being implemented. Did the lessons draw and maintain the students' interest? Did the demonstration materials adequately explain the lesson concepts? Can the activities be improved or better-presented to better suit the audience? Are the students absorbing the concepts and information presented? These are among the many questions that should be asked when implementing an education program.

While the Wiyot tribe's non-point source pollution education program is underway, environmental staff will evaluate its efficacy. This will be done informally, by making observations of student behavior and responses, with the intent of answering the above questions (and others). Since flexibility in lesson structure allows the educator to make adjustments that accommodate the audience, this curriculum will be subject to minor alteration as the program is administered. The educator can learn a lot from the students, and this experience can be applied to following lessons, or future curricula. Educators will evaluate the program while it is in progress and make decisions about any program adjustments, if needed.

5.0 Conclusion

The Wiyot Tribe is dedicated to educating tribal youth on topics relating to cultural and environmental practices. This curriculum is intended to outline an effective method of educating Wiyot youth on the causes and effects of non-point source pollution. By providing lessons and activities demonstrating environmental elements and concepts such as watersheds, the water cycle, wetlands, runoff, and human influence on the environment, tribal youth are learning about non-point source water pollution and what they can do about it.
This education program is another example of the Wiyot Tribe's continuing commitment to addressing pollution threats and reinforcing the attitudes of land stewardship for future generations.

Appendix 1: Map of Activity and Field Trip Sites



Appendix 2: Environmental Curriculum Activities

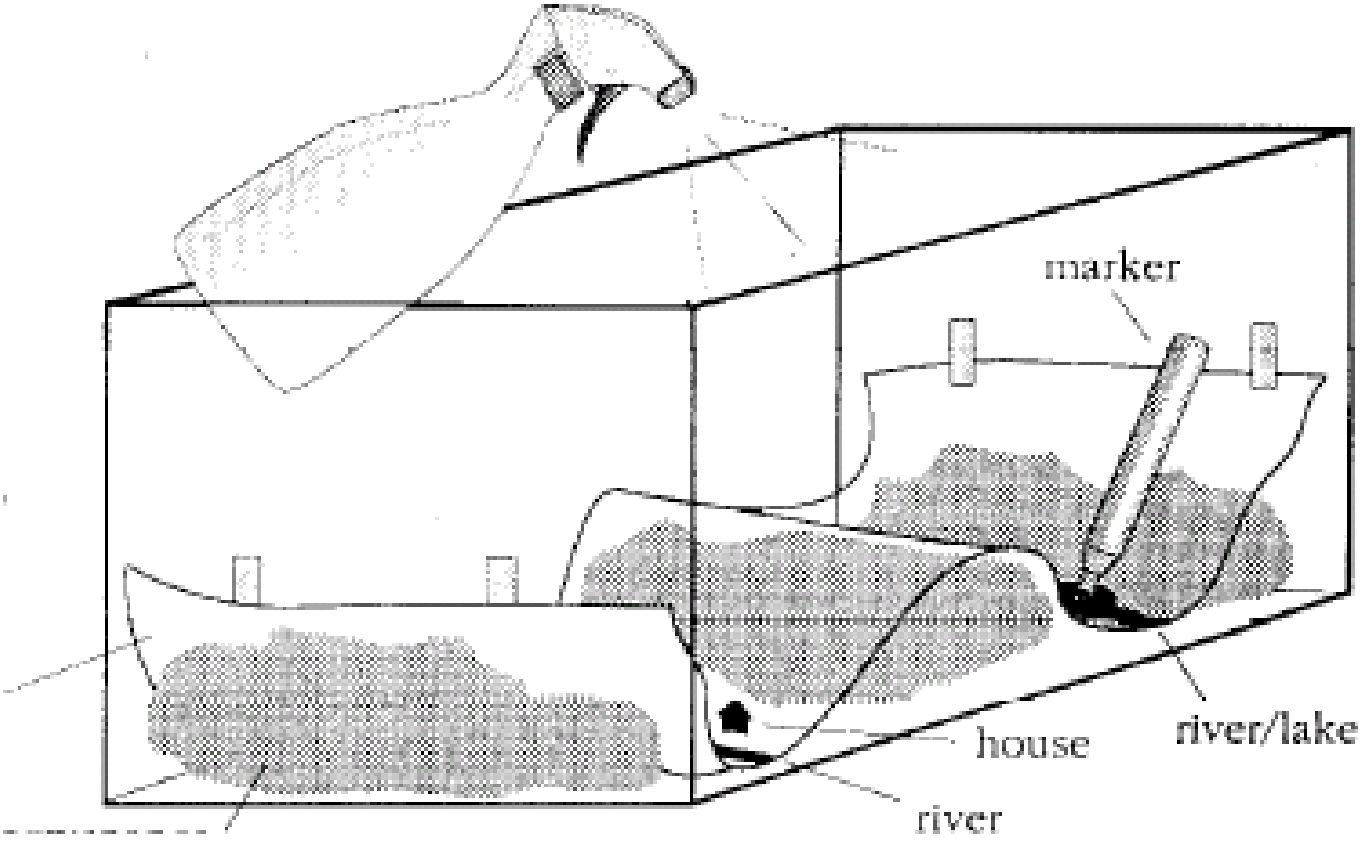


Figure 1. Introductory Watershed Model. An introductory activity designed to show how water flows throughout our environment. The model demonstrates the concepts of watersheds and how they relate to the water cycle.

U.S. Environmental Protection Agency (January 2010). *World in Our Backyard. Chapter I: Wetland Science*. Retrieved from http://www.epa.gov/region01/students/teacher/world.html

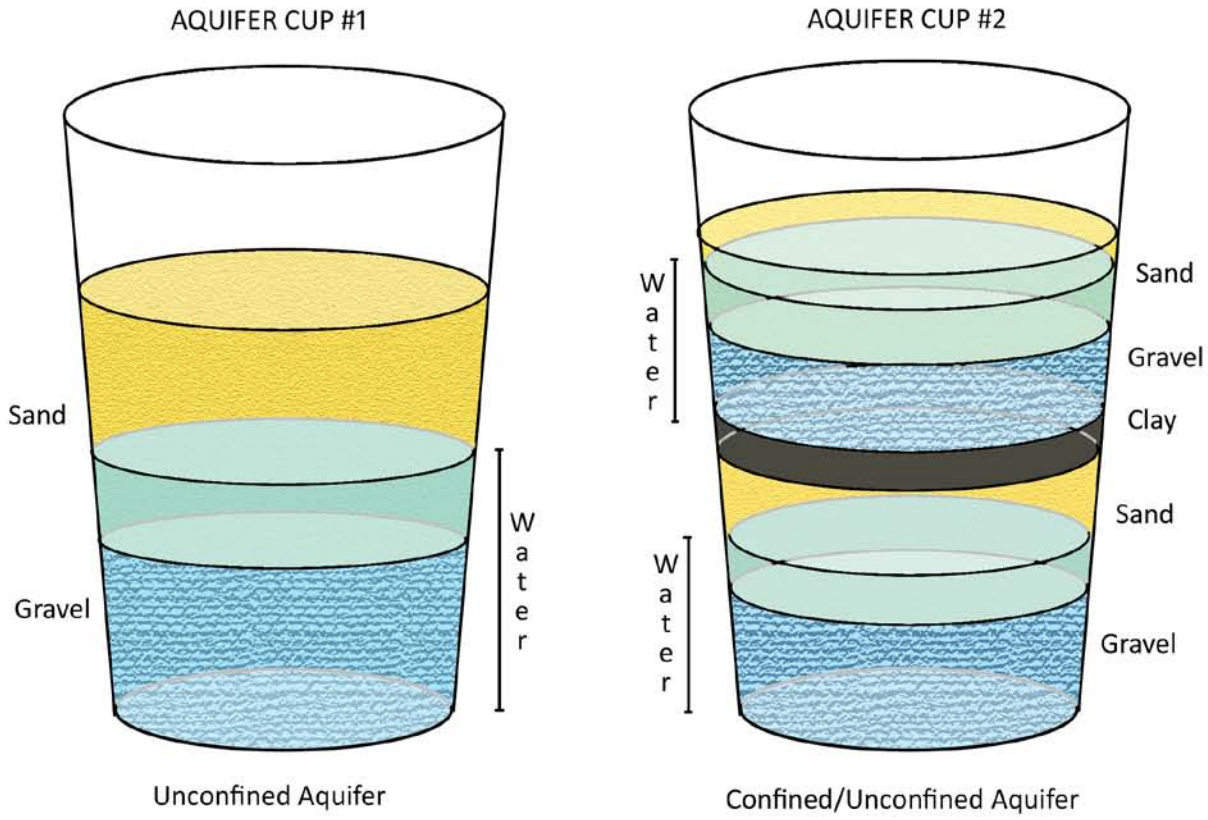


Figure 2. Aquifer in a Cup. An activity designed to display concepts relating to aquifers. An unconfined aquifer will be constructed to show how water is easily accessed just beneath the surface. A second aquifer, named a confined/unconfined aquifer, will be constructed to show how aquifers can be contained by layers of impermeable material such as clay. Non-point source pollution is added separately to each aquifer using dry, colored drink powder to visually represent aquifer contamination.

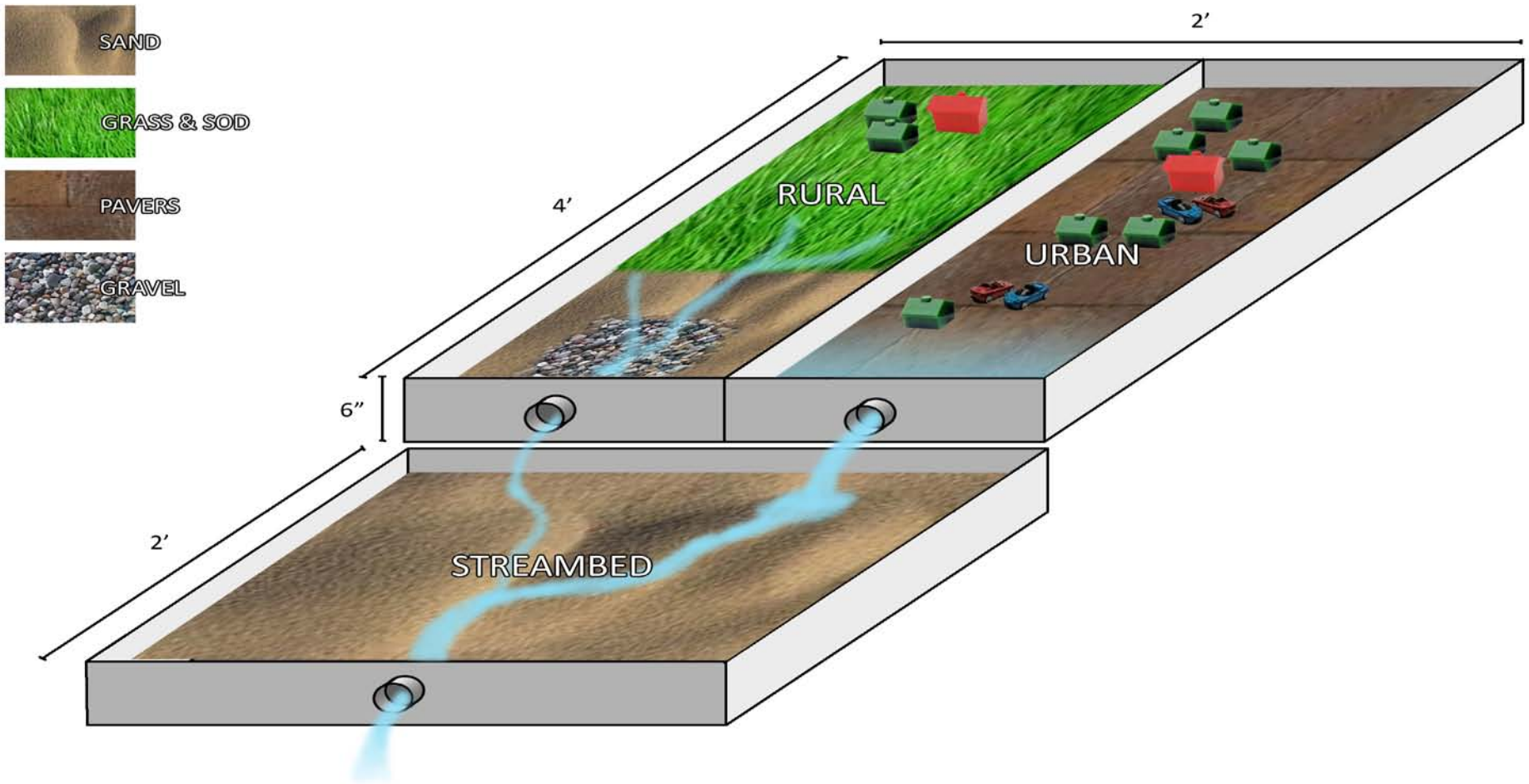


Figure 3. Pollution in Your Neighborhood. An activity designed to demonstrate non-point source pollution in the urban and rural environments. The rural environment will contain permeable surfaces such as grass, sand, and gravel while the urban environment will contain impermeable surfaces such as concrete pavers. Non-point source pollution is added to the environments using food coloring and/or dry, colored drink powder. A second box containing a streambed is placed below the first box in order to show how large water discharges alter the hydrology of a waterway.

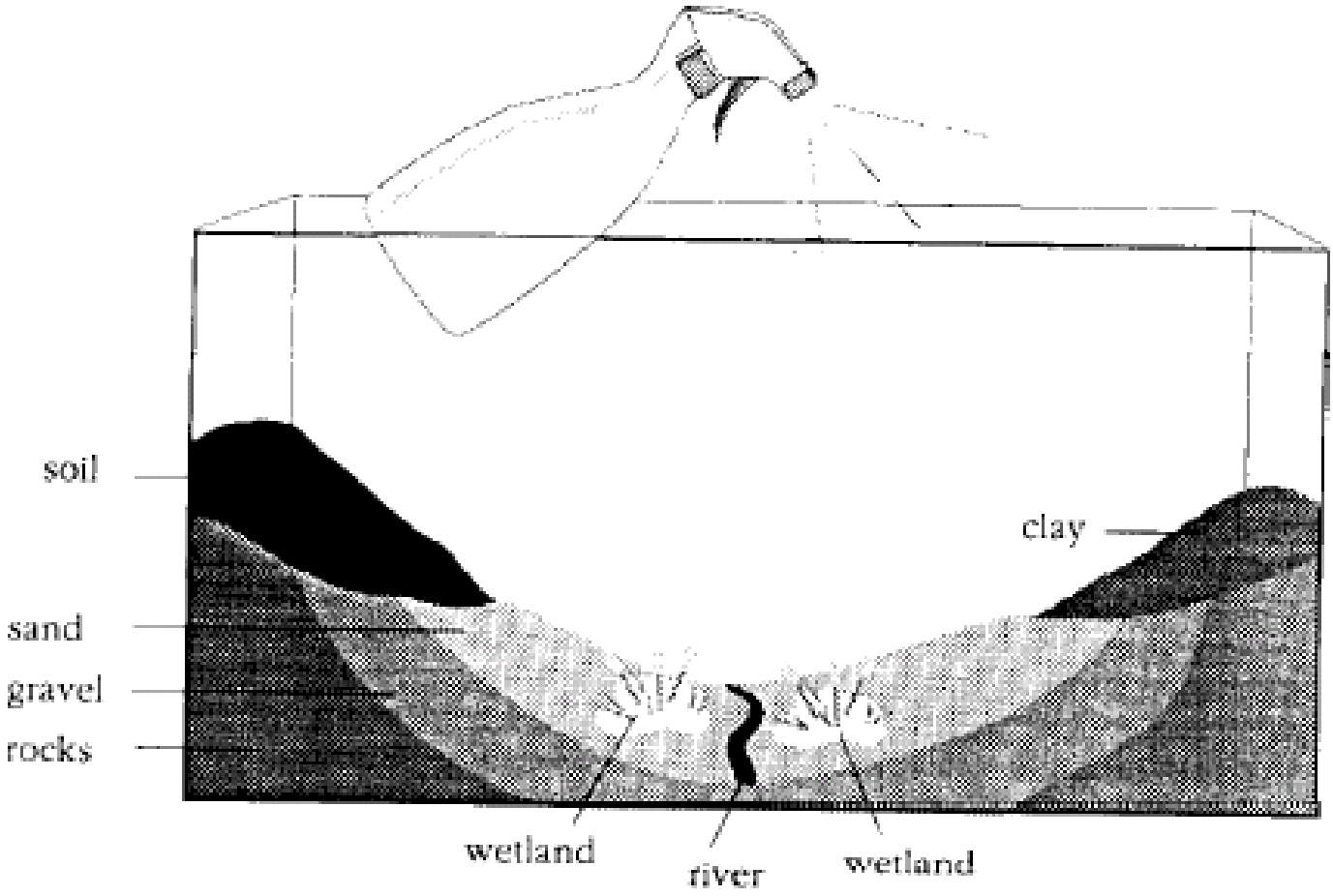


Figure 4. Connected Environments. An activity designed to incorporate watershed elements learned throughout the curriculum. Several watershed elements including groundwater, wetlands, and large water bodies will be reviewed in order to show connectivity within a watershed.

U.S. Environmental Protection Agency (January 2010). *World in Our Backyard. Chapter I: Wetland Science*. Retrieved from http://www.epa.gov/region01/students/teacher/world.html