EnviroScape User's Guide
"Watershed/Nonpoint Source Pollution"

Quick Reference Table for Demonstration #1 — *How Water Pollution Occurs*

Directions: The following tables are to help teachers prepare and orchestrate the discussions and demonstrations needed for effective use of the EnviroScape Model. *It is not a substitute for reading the guide pages which provide more background information.* This reference table is designed to assist with preparation and maintaining the flow of the numerous discussions and demonstrations while combining the model with the "pollutants."

Demonstration 1: How Water Pollution Occurs, pages 9–30

Steps and Pages	Discussions and/or Demonstrations	Supplies and/or Topics
Step 1 p. 9-11	**Teacher Preparation:** Summary Outline/Map of Model/Model Preparation	EnviroScape Watershed Model/Accompanying Supplies/User Guide See Vocabulary in glossary to become familiar with terms.
Step 2 p. 12	**Discussion:** Audience Awareness	**Topic:** What do you think when you hear the word "pollution?"
Step 3 p. 12-13	**Discussion:** Introduction	**Topic:** Watershed, Waterbody, EnviroScape, Water Cycle definitions and elaboration
Step 4 p. 13	**Discussion:** Two Sources (types) of Water Pollution	**Topic:** Point Source (PS) and Nonpoint Source (NPS) (define, compare, and contrast)
Step 5 **Activity #1** p. 14	**Demonstrate:** PS #1- Industrial Plant on Model **Discussion:** Observation, permits, and noncompliance	**Supplies: Soy sauce or red drink mix powder** (squirt or sprinkle on top of industrial plant) **Topic:** When the all the pollutants are on the model, and the students "make it rain," discuss observations, explain permits, & noncompliance of the industrial plant on the model.
Step 5 *continued* **Activity #2** p. 15	**Demonstrate:** PS #2 - Sewage Treatment Plant **Discussion:** Wastewater Treatment Plant (WWTP), CSO, and Upset	**Supplies: Sludge Mixture** (squirt cocoa powder sludge mixture in tanks), **Spray Water Bottle** (you can spray water on tanks to overflow when students "make it rain") **Topic:** Point out WWTP, describe its function, discuss *Combined Sewer Overflow (CSO)* and an *Upset* (Plant malfunction). See guide for background if needed.

Step 5 *continued* **Activity #3** p. 16	**Demonstrate:** PS #3 -Stormwater Drain on Model **Discussion:** Storm drains are generally considered PS but they carry NPS	**Supplies: Sludge Mixture** OR **Soy Sauce from packets** **Topic:** When storm drains are connected to storm sewers they are considered PS. Some are connected to WWTP. Also, the water pollution they carry is nonpoint source.
Step 6 p. 17	**Discussion:** Nonpoint Source Pollution (NPS) from various model locations	**Topics**: Identify and describe places on model that may contribute NPS: construction site, stream and lake shores, clear-cut forest, plowed fields, crops, highways, roads and parking lots, waste from cows and other domestic animals, residential area, and golf course.
Step 7 p. 18	**Demonstrate:** NPS/soil erosion/pesticides/fertilizer/oil, grease/manure, and pet waste/ trash (litter) **Discussion:** During demonstration discuss the various representations. **FYI:** Salt is important for safe road travel. However, road crews try to be careful in their application to avoid overuse. **FYI: The following information is not in the guide but relevant NPS pollutant:** *Plastics in litter become microplastics because they are not biodegradable. The sun breaks them into microparticles and they then harm aquatic and marine life.* See provided handout background material "Stream Team Academy Fact Sheet #31"	**Supplies:** items are listed in bold print below **Topics:** NPS in parenthesis below **Cocoa powder for soil (**sprinkle on construction site, lake shore, plowed fields, and clear-cut forests - you can add downed trees to forest area) **Red drink mix powder for pesticides** (sprinkle on lawns, golf course, and farm fields) **Green drink mix powder for fertilizers** (sprinkle on lawns, golf course, and farm fields representing overuse) **Soy sauce** for auto oil and grease (squirt on roads or ditches to represent poorly maintained autos and careless practices – dumping oil on ground) **Salt** (lightly sprinkle on roads over-salting during snow and ice) *NOTE: not described in the user guide - see the info on left.* **Cocoa paste and/or chocolate sprinkles for farm manure and pet waste** (dab on cocoa paste with toothpick or shake chocolate sprinkles on home lawns and farm near livestock) **Litter** (lightly scatter on model tiny trash bits paper, cut up Styrofoam, and plastics)

Step 8 p. 19-20	**Demonstrate:** Stormwater runoff of the sources from step 7 above **Discussion:** Why does this happen for each NPS?	**Supplies: Spray Water Bottle and/or Cloud Water Bottles** – Once all of the various pollutants are on the model, have a few students spray and "make it rain" on all of the NPS all at once. Make sure the rain is slow enough to watch and discuss runoff. Beware of using too much water! **Topics:** Describe observation of each NPS from each location and explain why it happens (see below). *Construction Site* has no vegetation, silt fencing, berms or straw bales to hold back soil from erosion. *Lawns and Golf Courses* that have over-applied pesticides or fertilizers can run off with a rain and enter water bodies and in some cases groundwater. *Highways, Roads, and Parking Lots* collect oil, grease, and antifreeze from paved surfaces as well as salt to melt snow and ice. Stormwater carries them to water bodies and groundwater. *Stream banks and Lakeshores* with no vegetation to hold soil are subject to erosion by water, wind, and snowmelt. *Forest Clearings* not managed well leave soil exposed to erosion from water, snow melts, and wind. Forest roads without stop-gap measures can erode as well. *Farm Fields* improperly plowed or left without vegetation causes soil to be eroded by runoff. *Crops* with improper or excessive application of pesticides or fertilizers means that those pollutants will get washed into waterbodies by rain or snowmelt. *Manure* is a natural fertilizer, however when over-applied, applied on frozen ground or applied before a rain it can runoff and contaminate a waterbody and groundwater.

Step 8 *continued* p. 21-23	**Discussions:** Why all these NPS are harmful – Nutrients/Toxic Substances / Bacteria/Soil itself? **FYI:** *The guide does not mention the Gulf of Mexico's Dead Zone which is the result of excessive nutrients from farming lands in the Mississippi Basin.* **Excess nutrients are potential pollutants, not nutrients themselves.**	**Topics:** *Nutrients* are essential to life but excessive nutrients can harm fish and plant life. Nutrients in fertilizers (Nitrogen and Phosphorus) cause excessive algae and aquatic plant life in waterbodies that suffocate plant life. When the plants die and decay, they use up dissolved oxygen needed by fish and aquatic life — causing fish kills. *Bacteria* are microscopic organism that can help species, but some can cause waterborne diseases when in contact with people (such as typhoid fever, and dysentery). An open cut exposed to harmful bacteria in the water can cause an infection. Swimmer's itch is caused by a microscopic bacterium. Raw shellfish can be infected with bacteria that causes salmonella if ingested. *Toxic Substances* are poisonous metal compounds and chemicals from sources like household cleaners and pesticides. Also, toxic acids from the burning of fossil fuels fall to the earth as acid rain and cause illnesses to aquatic life and reproductive abnormalities. Humans can have allergic reactions or illnesses since toxic substances can concentrate in the food chain.

Step 8 *continued* p. 24	**Discussion:** How and why soil can become a NPS pollutant. **Soil becomes a sediment when washed into waterbodies and waterways.**	**Topics:** Soil carries many nutrients, toxic substance, and bacteria to water bodies in runoff. Soil washes away from streets, construction sites, clear-cut land, etc. eroding land and builds up sediments at the bottom of lakes, streams, and rivers. Excessive sediment buildup can then impede boating, necessitating costly dredging to keep shipping lands, marinas, and harbors open. Excessive sediments in stormwater can plug storm drains causing flooding. Excessive sediments darken the water causing the absorption of more sunlight. Water temperatures are raised which reduces dissolved oxygen. As a result, aquatic life is stress or killed. Excessive sediments inhibit the production and deposit of eggs by fish.
Step 9 p. 25	**Demonstrate:** Turbidity stirred up sediments (can be PS or NPS of water pollution) **Note:** One or two cows are not a major source of pollution. A herd or large groups of animals do pose a potential threat to water quality.	**Supplies:** Use your finger to stir up the sediments in the waterbody on the model near the cows. **Topics:** Cloudiness of the water occurs when cows and other domestic animals enter the waterways. The cloudy water makes it difficult for aquatic plants to get enough sunlight to produce the oxygen that aquatic life needs to survive. The suspended sediment can smother fish and interfere with fish finding food. When cows and domestic animals deposit their waste in waterbodies bacteria levels increase. The erosion of stream banks can occur by domestic animals trampling vegetation on the bank.

Step 10 p. 26-27	**Demonstrate:** Point out residential area on model, use soy sauce for driveway NPS and spray with water to make runoff. **Discussions:** Sources of NPS water pollutants from our homes; from our water uses and disposal of assorted wastes. **Note:** These pollution sources from one home may seem small but when adding up the total number of homes in a watershed it can be significant.	**Supplies**: **Soy sauce** (squirt on driveway to represent vehicle fluids) **Water spray bottle** (spray to represent rain and create runoff from vehicle fluids) **Drop of dish soap** (place drop on vehicle before spraying to represent car washing) **Chocolate sprinkles** (sprinkle on the residential yards to represent pet waste) **Topics:** Improper or careless use and disposal of household chemical, oils, and cleaning solutions may become NPS water pollution. Pet waste add to NPS when not bagged and put in trash. Failure to maintain septic systems causes bacteria, toxic chemicals and/or nutrients to fuel excessive aquatic plants thus limiting recreation and harming aquatic life. When contaminates are dumped into abandoned wells or sinkholes groundwater is polluted.
Step 11 p. 29	**Discussion:** Storms drains may be the point source that carries nonpoint source water pollution.	**Topics:** Point sources connect a piping system to water bodies. Stormwater carries nonpoint pollution from land surfaces to waterbodies in a piping system making them PS and subject to regulation, in some cases.

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Quick Reference Table for Demonstration #2 — *Preventing Water Pollution*

Directions: The following table is to help teachers prepare and orchestrate the discussions and demonstrations needed for effective use of the EnviroScape Model. It is not a substitution for reading the guide pages which provide more background information. This reference table is designed to assist with preparation and maintaining the flow of the numerous discussions and demonstrations while demonstrating Best Management Practices on the Enviroscape model.

Demonstration 2: Preventing Water Pollution, pages 33-50

Steps and Pages	Discussions and/or Demonstrations	Supplies and/or Topics
Step 1 p. 33-35	**Discussion & Demonstration:** Best Management Practices (BMP)-ways to help reduce Nonpoint Source Pollution (NSP)	**After Demonstration #1 p. 9-30** - Remove plug of waterbody and allow dirty water to drain into container underneath. - Wipe out any grime with paper towel. - Empty the drain container and replace. - Replace plug ***(do not press down too hard on the plug).*** - Refill waterbody with 1 cup of clean water (measuring cup in supplies).
Step 2 p. 35	**Discussion:** Check awareness by asking how nonpoint source water pollution can be prevented.	**Topics:** Have students brainstorm how NPS water pollution can be prevented.
Step 3 p. 36 *[See p.39 to add option of silt fencing as a BMP]*	**Demonstration:** Use assorted supplies to make and place BMP on model. **Discussion:** Explain what each item represents and is designed to do while installing them on the model. **FYI:** Straw bales can decrease erosion and help until vegetation cover is established.	**Supplies:** **Fence livestock out of waterbody** - place along stream by farm to contain livestock. **Use clay to build a berm** - make a berm or dam with clay and place at the end of the plowed field by the waterbody. **Place sponges beside construction site and forest.** Sponges represent planted vegetation or straw bales. **Use sponges for wetland creations** - place the sponges to the right of plowed field and by the golf course. Place silt fences (made from toothpicks and electrical tape) near the construction site. Secure to the model with small pieces of clay.

Step 4 p. 37	**Demonstration:** Soil erosion from construction site, lakeshore, forest, and plowed farm field **Discussions:** Describe each NPS pollutant as placed on the model.	**Supplies:** **Cocoa for soil** (sprinkle on construction site, lakeshore, forest, and plowed field) **Green drink powder mix for fertilizer** (sprinkle on lawns, golf course, and plowed fields) **Red drink powder mix for pesticides** (sprinkle on lawns, golf course, and plowed fields) **Soy sauce for oil and grease from vehicles** (put on highway, roads, and industrial parking lot) **Cocoa paste or chocolate sprinkles for manure and pet waste** (place near livestock and in yards)
Step 5 **BMP Activities # 1-5** p. 38-43	**Demonstrations:** Best Management Practices #1-5. Each get sprayed with water one at a time **Discussions:** Point out area, spray with water, and then discuss how each one reduces various NPS water pollutants. **FYI:** Use **WOW! The Wonders of Wetlands** lesson *Wetland Metaphors* for more functions of wetlands. **Note:** See guide glossary for definitions of farm preventative measures	**Supplies:** *Spray water bottle lightly for each area* **BMP #1: construction site** - straw bales, silt fences, and planting grass help prevent runoff. **BMP #2: streambanks / lake shore** - vegetation strips, berms slow erosion. **BMP #3: forests** - vegetation strips reduce runoff and thus erosion. **Note:** Other practices include selective timber cutting, proper log road measures using straw bales or silt fences, spreading grass seed, and replanting trees. **BMP #4: farm area** - the berm and wetlands slow and reduce runoff of soil, decreasing sediment pollution. The wetlands remove nutrients, oil, bacteria, in runoff as trap sediments. They can remove and filter pollutants. **Note:** Other preventative measures include contour plowing, conservation tillage, planting cover crops, rotating crops, and using fertilizers and pesticides according to directions and soil tests. **BMP #5: driveways, roads, and parking lots** - these surfaces can't absorb water and are "impermeable" so runoff carries them to waterways. Vehicle upkeep and collection of fluids during fluid changes prevents pollution as well as safe disposal according to directions.

Step 5 **BMP Activities # 6-9** p. 44-49	**Demonstrations:** Best Management Practices #6-9 each get sprayed with water one at a time. **Discussions:** Point out area, spray with water, and then discuss how each one reduces various NPS water pollutants. **Note:** See Optional Activities p. 48-49 For terraces, mulching plowed fields, and storm drain stencils. **FYI:** Contact Missouri Stream Team for more information on storm drain stenciling. **FYI:** See Missouri Botanical Gardens website for information on rainscaping (rain gardens). **FYI:** Find out more about how to access nearest recycling facility or collection process in your community.	**Supplies:** *Spray water bottle lightly for each area* **BMP #6: cows and other domestic animals** - fencing can reduce water pollution but domestic animals may only have surface water sources of water available. Trees can shade livestock to help them keep cool. **FYI**: University Extension and USDA programs have cost shares to assist farmers with projects such as installing solar wells. **BMP #7: manure container** - place manure in container as a temporary measure until it can safely be spread as fertilizer. Never spread on frozen ground or it is sure to runoff. **BMP #8: lawns and golf courses** - place a sponge in the low-lying area of the golf course. See how wetland prevents pesticides and fertilizers from entering waterways. **Notes:** *Leave grass clipping on lawn so it decomposes and provide natural fertilizer. *Don't dump organic material into a waterway or storm drain. *Don't mow grass too short for it filters nutrients. *Grow native plants that need less water, fertilizers, and pesticides. *Use rainscaping or rain gardens to encourage infiltration of stormwater. **BMP #9: household activities** - point out residential area and note that everyday habits are the best management practices for household NPS pollution. **Notes:** *Read labels when shopping. *Buy biodegradable and recyclable when possible. *Follow instructions on use and disposal of all household chemicals and don't apply near wells or waterbodies unless instructions permit. *Don't burn trash or any left-over chemicals — again follow disposal instructions. *Use pet waste bags and put in trash. *Use less water. *Maintain septic tank properly. *Plant groundcover to avoid erosion. *Don't litter! *Recycle! *Use household hazardous waste collection facilities.
Step 6 p. 50	**Discussion:** Preventing Water Pollution	**Topics:** Summarize lesson and discuss what students learned and can do to help stop NPS.