Using Project WET Activities with Stormwater Extensions and The Urban Watershed – Stormwater Edition Supplement

This document contains Project WET activities which have been extended to cover the Stormwater Curricular Framework and Objectives below. These extensions were developed by the national coordinators' WETteam for Products and Publications and will soon be available on the Portal. They are intended to be used with full knowledge of original activity in the Project WET Curriculum and Activity Guide along with The Urban Watershed – Stormwater Edition supplement and share many of the elements from the activity such as background information, materials and/or objectives.

More extensions will be available soon on ProjectWET.org/Portal

Definition of Stormwater: The water resulting from a weather event that has run off impervious man-made surfaces such as streets and parking lots into nearby sewers or waterways.

Stormwater Framework and Objectives

UNDERLINED ACTIVITY = No extension necessary to use with Stormwater Objectives -- Use stormwater background information and activities in the Urban Watershed Guide – Stormwater Edition to supplement these Project WET activities.

1. **Introduction to Stormwater** – Use Stormwater background information to supplement these activities
   - Blue Planet
   - Drop in the Bucket
   - Incredible Journey

2. **Natural Watersheds.**

   In which learners understand how watersheds function, why watersheds matter to people.
   - Seeing Watersheds - Use to understand what a watershed is and how it is delineated
   - **Rainy Day Hike** (extension below)
   - Blue River - Use to show the functioning of natural watershed
   - Thunderstorm - Use to show how storm events can bring water into an urban setting

   Objectives:

   Students will
   - Explain how the distribution of state revenue to provide services might affect water quality
   - Demonstrate the process used to meet drinking water standards through a physical activity.
   - Discuss the relationship between water treatment and water quality standards.
   - Explain that there is a relationship between clean water and what it costs to keep the water clean and safe for drinking.
   - Relate how microorganisms can benefit or harm our water resources.
   - Explain the water supply and wastewater collection system provided by local governments
   - Identify reasons for cleaning water from a source before and after we use it.
   - Distinguish between the processes for drinking water and wastewater treatment

     Compare natural and man-made processes for cleaning water.

3. **Urbanized Watersheds and Water Quality Impacts.**

People use and alter watersheds. Learners explore how stormwater is produced, how its handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.
   - **Nature Rules** (extension below)
   - Watershed Mural (extension coming soon)
   - Storm Water – Use as written in the Guide
   - Reaching Your Limits (extension coming soon)
   - **Sum of the Parts** (extension below)

Super Sleuths (extension below)
A-maze-ing Water - Use as written in the Guide
Water Quality? Ask the Bugs (extension coming soon)
Macro Mayhem (extension coming soon)
Blue River (extension below)
Seeing Watersheds (extension below)
Color Me a Watershed (extension below)
Common Water (extension below)

Objectives:

- Calculate the volume of water that falls onto an area of the school parking lot.
- Compare this volume to common water-consuming activities.
- Create methods for slowing the water runoff from impervious surfaces
- Identify sources of stormwater runoff
- Describe the effect fertilizer has on algal growth.
- Describe the role of the environmental compliance officers and the municipal court system in enforcing water quality and environmental laws.
- Explain how urban runoff and stormwater contribute to water pollution.
- Describe ways that people contribute to and can prevent point and nonpoint sources of pollution
- Explain aspects of the science behind climate change
- Discuss the impact of climate change on local area
- Research Climate Change action organizations and consequences

3. Storm Water Management

Learners discover how to prevent and remediate stormwater impacts to lakes and streams where the stormwater is discharged.

Just Passing Through (extension coming soon)
Sum of the Parts (extension below)
Get the Groundwater Picture (extension coming soon)

Objectives:

- Analyze their development choices for the city and the impact on water quality.
- Identify the effects of impervious surfaces and green space development on water quality.
- Compare the processes of two different sewer systems in use in Georgia cities.
- Explain how storms and heavy rain may cause water in each system to contaminate surface waterways.
- Invent possible solutions to problems with current stormwater systems and create models to show their ideas.
- Distinguish between a city's drinking water and wastewater systems.
- Evaluate the merits and problems with separated and combined sewer systems
- Demonstrate the sequence of the man-made water cycle

4. Action!

Learners take personal action to prevent water pollution through stormwater and participate (or simulate participation) in community action.

Some projects students could participate in to provide Stormwater Action:

Stenciling Drains
Watershed clean up
Stormwater Activity -(scavenger hunt for BMP)
Create a rain garden

Project WET Activity Stormwater Extensions

Blue River Stormwater Extension

Background: *Use from original activity*
Objectives: *Add to those in original activity*

With these changes the participants will-

- Demonstrate the movement of water through a river and the urban watershed.
- Compare and contrast the amount of water flowing based on climate (seasonal variations) and weather (precipitation)
- Identify the changes in the water that can occur in an urban setting.

Stormwater Framework:

2. Urbanized Watersheds and Water Quality Impacts.

People use and alter watersheds. Learners explore how stormwater is produced, how it's handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

Materials: *Add to those of original activity*

- Small cards labeled with various pollutants that may wash into the river after a storm: oil, grease, trash, heat, chemicals, salt (these could also be represented by beads or other objects that are easily passed along with the "water")
- Signs to hang around necks of students representing city features—parking lots, roads, building roofs, green space

Extension procedure:

Follow the activity in the Project WET Curriculum and Activity Guide. Make this change to Part II the second time through:

Simulate the formation and flow of a river in an urban setting.

1. Have a few students represent various city features such as parking lots, roads, building roofs, and green space, while others form the basic river with tributaries. The city figures should wear signs for identification.
2. Students representing impervious city features will add small labeled cards (or representational items) to the river flow as it passes by.
3. The students representing green space will try to gather as many cards as they can and hold them to simulate absorption into a pervious surface.
4. Discuss the "data" gathered at the mouth of the river in terms of an Urban Watershed and Storm Water. How does it change with increased or decreased flow?
5. Discuss better ideas for control of storm water. How can they lead to improvements in water quality?

STEM Education Connections:

Students can explore ways to protect the waterways from nonpoint source pollution in an urban environment with such engineering projects as green roofs, buffer zones, permeable pavements and rain gardens. Prepare class presentations of their findings. Search teachengineering.org for lesson and activities that offer hands-on experience for each of these projects.

Color Me a Watershed Stormwater Extension

Background: *Use from original activity*
Objectives: *Use from original activity*
Stormwater Framework:

2. Urbanized Watersheds and Water Quality Impacts.
People use and alter watersheds. Learners explore how stormwater is produced, how its handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

Materials: *Use the materials from the original activity*
Extension procedure:
Use the Options to break up the activity into questions and directions to make it easier for teachers to direct students' attention to Stormwater issues.

** Idea for Facilitators: Use each Option of the activity to demonstrate the use of the activity at different grade levels. Elementary loves the coloring in Option I, Middle school gets tasked with calculating area – which is all over the common core test and high school gets tasked with the run-off calculations – give the answer key for Area of Land Coverage on page 242 to the High School group for their eyes only to be kept from Middle School group.*

Option 1 Directions and Questions: *(*can use with Elementary group if dividing a workshop)*

1. Choose a color to represent each land use area and note the color on each map key.
2. Lightly color each land use area on each map using the colors your team chose above.
3. Once coloring is complete, compare land use in each time period. Note changes in each type of land use area.

Discuss the following questions:

1. What happens to forest cover through time from Map A to Map C? What land use(s) is replacing the forest through time?
2. Which map has the most land devoted to human settlement?
3. Where is most of the human settlement located? What factors may have been involved in the decision to locate human settlement in the present location?
4. What effect may the human settlement have on the watershed?
5. How would your team have handled human settlement differently, if you were starting with Map A today?

Option 2 Directions and Questions: (*can use with Middle School group)

1. Choose a color to represent each land use area and note the color on each map key.
2. Lightly color each land use area on each map using the colors your team chose above.

Once coloring is complete:

1. Determine the land area of each map. Each grid unit = (1) square kilometer (km2).
2. FOR EACH TIME PERIOD MAP. Calculate the land coverage for each land use type (i.e., forest, agriculture, grasslands, etc.) in square kilometers and percentage of total watershed land area shown on the map. Record in the chart below.
3. Assume an unusual storm dropped 5 cm (0.05 m) of rain evenly across the entire watershed shown on the map. Calculate the amount of water in cubic meters (m3) that fell on the land portion of the watershed.

Record on the chart on Student Copy Page page 245.

4. How much water do you think will run-off the land in the watershed?
5. Do you think this volume will increase or decrease with the changes in land coverage over time. Why?

Option 3 Directions and Questions: (*can use with High School group)

1. Choose a color to represent each land use area and note the color on each map key.
2. Lightly color each land use area on each map using the colors your team chose above.

Once coloring is complete:

1. Assume an unusual storm dropped 5 cm (0.05 m) of rain evenly across the entire watershed shown on the map. Use the data from the 'Area of Land Coverage' table to calculate the amount of water in cubic meters (m3) that fell on each watershed land use area in each time period. *Record in the chart on page 245.*
2. Each land use sheds water at a different rate. Use the hypothetical estimates of runoff to calculate the amount of water in cubic meters (m3) that will runoff into the stream.
Record in the chart on page 245.
3. Which land coverage absorbs more water? Why?
4. Which map represents the watershed that is able to capture and store the most water?
5. What problems may arise if water runs quickly over surface materials, rather than moving slow or soaking into the ground?
6. How might water quality be affected by changes in the watershed?

STEM Education Connections:

teachengineering.org Find activities that help students problem-solve for runoff and erosion.

Common Water Stormwater Extension

Purpose: To develop the idea that stormwater runoff can carry nonpoint source pollution which can accumulate in a common body of water over time affecting the quality of the water.

Background: Use the background information in the Urban Watershed – Stormwater Edition

Objectives: *Use from original activity*

Stormwater Framework:

2. Urbanized Watersheds and Water Quality Impacts.
People use and alter watersheds. Learners explore how stormwater is produced, how it's handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

Materials: *Use from original activity*

Extension procedure: At the end of each round, each water user will identify what possible pollutants came from his or her activities. Discuss how runoff in an urban environment can affect the water quality of the common shared source and ways that it can be controlled.

Some Stormwater suggestions:

Round 1:

Fields once covered by forests or prairie plants may be exposed to wind and rain from planting crops. The soil can wash into the streams.

If stream paths and riparian barriers have been altered flow may increase and erode banks during storm events.

Round 2:

Town is developing pervious surfaces with roads, roofs which can increase stormwater runoff and heat accumulation.

The large farm increases the chance of soil and animal waste runoff into streams.

Round 3:

The town is increasing its pervious surface coverage exasperating stormwater runoff and heat accumulation.

The introduction of a factory and the use of automobiles allows point and nonpoint pollution to be added to the waterways during storm events.

Power company can emit pollutants into the air, which can be added to the water or runoff when it rains.

The large farms increase the chance of soil runoff into streams and also the possible introduction of herbicides, pesticides and fertilizers into the waterways.

Round 4:

Larger town increases the incidence of all above and adds additional stress to the waterways and natural habitats.

STEM Education Connections:

Use www.teachengineering .org to find these Water Quality-based engineering activities:

1. A Guide to Rain Garden Construction - Students are presented with a guide to rain garden construction in an activity that culminates the unit and pulls together what they have learned and prepared in materials
2. Can You Catch the Water? --Students construct a three-dimensional model of a water catchment basin using everyday objects to create hills, mountains, valleys and water sources.
3. Chromatography Lab -- To increase students' awareness of possible invisible pollutants in drinking water sources, students perform an exciting lab requiring them to think about how solutions and mixtures exist in water.

Nature Rules Stormwater Extension

Background: *Use from original activity*

Objectives: *Use from original activity with this addition-*

Students will compare storm effects in rural and urban areas after the same events

Specific Topic Framework:

2. Urbanized Watersheds and Water Quality Impacts.

People use and alter watersheds. Learners explore how stormwater is produced, how its handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

Materials: *Add to the original list*

Microphone

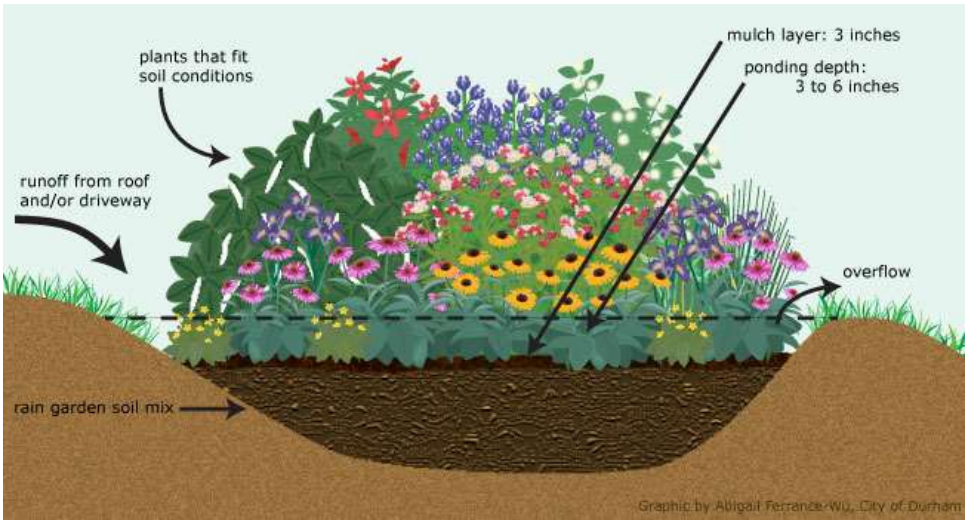
Computer and Computer Projector (optional)

Extension procedure:

1. In addition to the research instructions in the activity, students should also try to discover the effects of the storm in rural areas and compare with those in urban areas. They should note any urban changes over time that have been developed in that area where the damage occurred. If possible they should also collect photos and videos of the sites.
2. Students should also investigate stormwater management ideas in urban areas to mitigate the damage in urban areas from storms such as increasing previous surfaces, building rain gardens, and using constructed wetlands to control runoff and nonpoint source pollution.
3. Students will use their research and written reports to stage a TV newshour. Selected members of the audience might serve as experts with scripts written by the students who have studied a particular water disaster.

STEM Education Connections from teachengineering.org

Green Infrastructure and Low-Impact Development Technologies — Grade Level: 7 (6-8) Students are introduced to innovative stormwater management strategies that are being used to restore the hydrology and water quality of urbanized areas.



Rainy Day Hike Stormwater Extension

Background: *Use from original activity*
Objectives: *Use from original activity with the addition of-*
identify ways that stormwater affects the flow of water across the schoolyard.
Stormwater Framework:
1. Natural Watersheds.
In which learners understand how watersheds function, why watersheds matter to people.
Materials: In addition to the materials mentioned in the Activity, load the two Water Flow teams up with cheap levels from a dollar store to help them 'guesstimate' areas of potential fast vs. slower water flow.
Extension procedure:

1. Break the class into teams of 3 to 6. There are (2) teams on water flow, as this is usually the team that takes the most time
2. Limit the study area size and prioritize the team assignments below based on class size.
3. Give each team *very* clear boundaries for safety.

TEAM #1 – OVERSTORY

1. Locate the base of every tree within our study boundaries.
2. Draw a circle on the map to show base of each tree. Please draw the circles roughly to the scale of the map and proportionate to the circumference of the tree.
3. Estimate the percentage of visible sky straight above the study area.
4. Estimate the percentage of ground covered by fallen tree leaves, branches and other debris covering the study area.
5. Discuss the question with your team – How do you think the trees affect water flow in a storm?

TEAM #2 – DOWNSPOUTS & DRAINS

1. Locate every downspout in the study area.
2. Note the location of each downspout on the map using an agreed upon symbol.
3. Locate every storm drain in the study area.
4. Note the location of each storm drain on the map using an agreed upon symbol
5. Discuss the question with your team – How do you think the downspouts and storm drains affect water flow in a storm?

TEAM #3 – WATER FLOW

1. Delineate your team's assigned section of the study area on the map.
2. Study the ground in your assigned section of the study area and predict where water will flow or puddle in the next storm. Use the levels and look for evidence of past flows to test your predictions.
3. Delineate where you think puddles will form on the map.
4. Draw arrows on the map to indicate where and the direction you think water will flow on the map. Use a single lined arrow to indicate slower flows and double-lined arrows to indicate faster flows.
5. Discuss the question with your team – How do you think the speed and direction of the water flow will affect the landscape in a storm?

TEAM #4 – WATER FLOW

1. Delineate your team's assigned section of the study area on the map.
2. Study the ground in your assigned section of the study area and predict where water will flow or puddle in the next storm. Use the levels and look for evidence of past flows to test your predictions.
3. Delineate where you think puddles will form on the map.
4. Draw arrows on the map to indicate where and the direction you think water will flow on the map. Use a single lined arrow to indicate slower flows and double-lined arrows to indicate faster flows.
5. Discuss the question with your team – How do you think the speed and direction of the water flow will affect the landscape in a storm?

TEAM #5 – POLLUTANTS

1. Note the location of any trash cans within the study area and note location on your map.
2. Search the ground in the study area for any sign of trash, oil or potential sources of fertilizer – and note type of pollutant and location on your map.
3. Discuss the questions with your team – Do you think these pollutants will affect water quality in a storm? What do you think the pollutants are affecting anything now? Why were we asked to note the location of the garbage cans?

TEAM #6 – FLOW SURFACES

1. Locate, delineate and label on the map any impermeable surface areas within the study area.
2. Locate, delineate and label on the map any flower beds, natural or human made landscape zones, lawns or other permeable surface areas within the study area.
3. Estimate the percentage of the study area covered by impermeable and permeable surfaces.
4. Discuss the question with your team – How do you think these surfaces will affect the water flow in a storm?

STEM Education Connections:

teachengineering.org search activities under stormwater, surface flow, runoff

---

Seeing Watersheds Stormwater Extension

Background: Use the background information in the Urban Watershed – Stormwater Edition

Objectives: *In addition to those in the original activity*

Students will:

- Describe how precipitation in an urban environment leads to runoff and how that runoff impacts the stream
- Demonstrate the effects of stormwater on pollution using a 3-D model
- Identify ways to reduce and/or prevent urban stormwater pollution
- Define nonpoint source pollution and recognize common activities leading to it

Stormwater Framework:

1. **Natural Watersheds** (use activity as written)

In which learners understand how watersheds function, why watersheds matter to people.

2. Urbanized Watersheds and Water Quality Impacts (use this extension in the Warm Up)

People use and alter watersheds. Learners explore how stormwater is produced, how its handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

Materials: *In addition to those in the original Warm Up part of the activity*

- plastic tray, one per group of students
- powdered paint and sand mixture (sediment)
- chocolate jimmies (pet waste)
- red Kool-Aid (pesticides)
- cooking oil (oil and gasoline from cars)
- food grade glitter (trash)
- spray bottle, water with a drop of liquid soap to break adhesion and cohesion

Extension procedure:

Participants will learn 1) how water from precipitation becomes runoff and flows down watersheds through storm drains in cities and neighborhoods, 2) how this stormwater runoff causes erosion and picks up pollution, and 3) how to reduce or prevent urban stormwater runoff.

Activity:

1. Use a tray to hold the wax paper to catch the additional water runoff created in this extension
2. After completing the original Warm Up section of the activity and identifying various watersheds found on wax paper land surface, have students sprinkle a new crumpled wax paper model with sand mixture and spray with water. Note what happens.
3. Students will then add the other materials one at a time, spraying and noting what happens after each is added.
4. Let students share what happened to the materials added to the wax paper watershed.
5. Lead a discussion on the impact to the environment:
    - How are these materials like pollutants?
    - How did the pollutants get into the watershed in the first place?
    - Can you always tell exactly where the pollutants entering the stream came from? (nonpoint source pollution)
    - In the city what happens when it rains? Where does the water go from the street storm drains?
    - How does an urban environment lead to runoff when it rains and how might that runoff impact the streams and rivers?
    - Are there ways to prevent these materials from entering the waterways?

Sum of the Parts Stormwater Extension

Background: Use the background information in the Urban Watershed – Stormwater Edition

Objectives: *no change from the original*

Stormwater Framework:

2. Urbanized Watersheds and Water Quality Impacts.

People use and alter watersheds. Learners explore how stormwater is produced, how it's handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

3. Storm Water Management

Learners discover how to prevent and remediate stormwater impacts to lakes and streams where the stormwater is discharged.

Materials:

- Cardboard for street or brown paper cut in strips
- Markers to create the road with storm drains

- Colored beads to represent the various types of nonpoint source pollution that come off of each property and get sent downstream
- Container to collect beads.

Extension procedure:

1. Participants will create their "property" along a street that has drainage for runoff already in place (storm drains, effluent pipe(s) and a stream) instead of along a river.
2. Each participant will discuss what types of nonpoint source pollution may come from their property as the runoff drains from their site. The participants should identify the hard surfaces that affect runoff. This would include roof tops, patios, driveways, and sidewalks they may have added to their properties.
3. After each participant has discussed the type of nonpoint source pollution coming from their property, they will determine what BMP's should be used to manage their property to protect their water resources.
4. As in the original activity, they will then make the alterations to their property addressing these impermeable surfaces through design or redesign.

STEM Education Connections:

Statistical analysis:	State government websites (www.GeorgiaAdoptAStream.org)
	EPA Water Quality Portal (http://www.waterqualitydata.us/)
Engineering:	Explore Stormwater Activities on http://www.teachengineering.org

---

Super Sleuths Stormwater Extension

Background:

During storm events bacteria and other pathogens can wash into swimming areas and create health hazards, often causing beach or pool closures. Pet waste can be a major source of bacteria and excess nutrients in local waters. Standing water after a storm may contain pathogens from runoff and may be a hazard to those who play or splash through it, especially if the person does not wash his or her hands before eating or touching the face.

Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.

Objectives: *Same as original activity*

Stormwater Framework:

2. Urbanized Watersheds and Water Quality Impacts.

People use and alter watersheds. Learners explore how stormwater is produced, how its handled (or not) by infrastructure, and what the impacts of stormwater are on water quality of receiving bodies.

Materials: *In addition to those in the activity*

Doctor coat or set of toy doctor tools for each team

File folders for Teams-- each labeled with a number and containing these individual pages:

- information about one particular organism and its related disease and symptoms, marked FOR DOCTOR ONLY
- FOR INTERNS ONLY a copy of all of the disease descriptions from pg 121-122 and a page with these questions followed by writing space:
    - What symptoms are you having?
    - When did you first notice the symptoms? Have you recently been in a storm affected area?
    - Are you in any pain? Is the pain concentrated in a specific area?
    - Have you drunk water from an unusual source or gone swimming in a natural pond or lake lately?
- FOR PATIENT ONLY a set of symptoms for that particular disease, pg 118-120

Extension procedure:

1. Select the diseases from the activity that may be found in urban standing water after a flood event or heavy storm:
    - **Cholera**

- **Enterotoxigenic E. coli gastroenteritis**
- **Giardiasis**
- **Salmonellosis**
- **Shigella**
- **Hepatitis A**
- **Cryptosporidiosis**

2. Prepare the folders for each team.
3. Divide the class into 7 teams and have them choose a Doctor and a Patient. The remainder of the team members will act as Interns. Hand the Doctor of each team the folder for a particular disease and ask that it not be shared with the others just yet.
4. Ask the Doctor to hand the patient the symptom card from the folder. Ask the patients to read the symptoms without showing the others and "act" as if infected with the disease.
5. Doctor should pass the questions and disease descriptions to the Interns. Have the Doctor instruct the Interns to ask questions of the patient and take notes.
6. The Interns will try to discover the disease that the patient has using the questions and the disease descriptions. The Doctor will be able to confirm their decision from the information card in the folder.
7. Have the teams share information about each of the diseases and discuss how they may have been related to stormwater and urban development. Lead the discussion on how these diseases may be prevented and what steps can be taken in urban watershed design to prevent the access to or spread of the pathogens.

Resources:

http://water.epa.gov/action/weatherchannel/stormwater.cfm