Lesson Title: Swamped! Mitigating Local Runoff to Protect Our Waters

Summary: In this lesson students learn about the impact of impervious surfaces on runoff and water quality in their local community, and identify ways community members can reduce their impact. The school community is located next to the Great Swamp National Wildlife Refuge where numerous streams drain and few streams exit. Given the high population density surrounding the Great Swamp, there is a potential for high volume runoff into the waterbodies of the watershed inclusive of both point and non-point source pollution. Conversely, the Great Swamp can contain the water runoff volume and clean the water entering it. This lesson is designed to build an awareness about the Great Swamp's role in local water quality. The activities in this lesson begin by assessing how the amount of runoff changes when land-use changes. Next, students model what happens to the amount of runoff when land-use and soil types change, as well as what happens to precipitation in their community before and after land use changes. After a field trip to collect stream data around their community at locations where it enters their swamp and after it leaves their swamp, they create a data-driven project that communicates ways the community can get involved in protecting their water supply. The series of lessons used are provided in this document including instructions for the field trip inserted immediately after the plans for Activity #4 that describes the work students complete from the fieldtrip.

Background:

In thinking about the future, it is imperative that our students are prepared to address all types of issues, including those related to local water quantity and quality. This project encompasses the following SENCER Ideals as they explore ways to reduce local water runoff and its subsequent impacts on our local bodies of water:

- SENCER robustly connects science and civic engagement by teaching "through" complex, contested, capacious, current, and unresolved public issues "to" basic science.
- SENCER invites students to put scientific knowledge and the scientific method to immediate use on matters of immediate interest to students.
- SENCER shows the power of science by identifying the dimensions of a public issue that can be better understood with certain mathematical and scientific ways of knowing.
- SENCER, by focusing on contested issues, encourages student engagement with "multidisciplinary trouble" and with civic questions that require attention now. By doing so, SENCER hopes to help students overcome both unfounded fears and unquestioning awe of science.

A problem-based learning model invites students to consider their local water quality, and develop a product that will encourage community members to consider their water quality. By employing science and engineering practices of the Next Generation Science Standards (NGSS), students come to understand how water quality is related to our local land cover and land use, and create tools to communicate ways we can reduce runoff and, when runoff occurs, ways we can ensure good water quality. To complete this project, students present their research and communication tool to community members as a way to spread the word that we can all assist in keeping out water clean.

Problem Statement for Students:

Chatham, like most of the rest of New Jersey, is densely populated. With the settlement of people comes changes to our natural environment. Some of these changes, if left unabated, could lead to irreversible impacts on our local ecosystem, and thus the ecosystem services provided by our local ecosystems, like clean air and water. Even though our community may seem built-out, development is still taking place, and with that development there is an increase in surface runoff into our local water bodies. How much does the type of land surface impact the amount of water, and water quality of the runoff going into our local water bodies? What are the challenges to ensure that clean, plentiful water is available for communities in our area that rely on the same water supply? What are the solutions to these challenges?

Grade Level: 11 - 12

Time: approximately eight 50-minute class periods

Lesson Format/Structure: This "lesson" is a project that follows a problem-based learning model (PBL) and that includes three activities, a field trip, and project work-time.

Student Learning Objectives:

- When presented with the local water quality problem scenario, students define the problem from scientific and civic perspectives.
- Using mathematics and computational thinking, students calculate changes in runoff to ascertain how various land covers affect the quantity of runoff after a precipitation event.
- Students use a model to manipulate land covers and soil types to determine how each affect the quantity of runoff, and then apply the model outputs to determine what types of surfaces are categorized as impervious surfaces around their communities.
- Students use a model based on evidence determine the locations within their community which may have a negative impact on the water quality.
- Students carry out a field investigation following numerous watershed assessment protocols to test their understanding of how water quality in local streams can vary around a suburban community, and what role a wetland plays in a watershed.
- Students will use a form of communication to educate their community about the effects of impervious surfaces on water quality, and what they can do to enhance the quality of water coming from their yards.

NGSS Performance Expectations:

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. *[Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]* **DCI: ESS2.A:** Earth Materials and Systems

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HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. *[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]* **DCI: ESS2.C:** The Roles of Water in Earth's Surface Processes

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HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. *[Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]* **DCI: ESS3.A:** Natural Resources

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HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* *[Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local*

efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).] **DCI: ESS3.C:** Human Impacts on Earth Systems. * = engineering practices are a fit for this PE

NGSS Components Addressed: The following elements of NGSS are addressed in each activity of the lesson, all of which will assist learners in developing proficiency in the associated performance expectations listed above.

<table>
<tr><th>Activity</th><th>Science & Engineering Practices[1]</th><th>Disciplinary Core Ideas[2]</th><th>Crosscutting Concepts</th></tr>
<tr><td rowspan="3">Problem Introduction and Swamped! Part 1 - Catch it if you can</td><td>(9-12) Using Mathematics & Computational Thinking; Developing and Using Models</td><td>(9-12) ESS2.A: Earth Materials and Systems
ESS3.C: Human Impacts on Earth Systems</td><td>(9-12) Cause & Effect; Scale, Proportion, and Quantity</td></tr>
<tr><td colspan="3">Blended 3-D Teacher & Student Actions:
Teacher: Introduces the overarching problem (see above).
Pose case scenario and lead a brainstorming session on what we know and need to know to solve the case. Assist students with determining outcomes. At the end of the activity, debrief students about the accuracy of their calculations to model the quantity of runoff.

Student: Identify data needed to ascertain the quantity of runoff when a land use practice is changed. Using this data, they perform calculations to quantify this value.</td></tr>
<tr><td colspan="3">Connections to Common Core Math & ELA:
Mathematics -
MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
ELA/Literacy -
WHST.9-12.1 Write arguments focused on discipline-specific content.</td></tr>
<tr><td rowspan="3">Swamped! Part 2 - Capturing Precipitation</td><td>(9-12) Developing & Using Models</td><td>(9-12) ESS2.C: The Roles of Water in Earth’s Surface Processes</td><td>(9-12) Systems & System Models</td></tr>
<tr><td colspan="3">Blended 3-D Teacher & Student Actions:
Teacher: Reviews work from the previous day and then engages students with a satellite image of their school grounds to discuss what happens to the precipitation that falls on the school grounds. Ask students how to verify their ideas, and from their previous experience they will likely mention that using models will assist them with verification. Introduce them to Micro Site Storm Model. Debrief the activity at the close of the class period.

Student: Students participate in the discussion about the flow of water on school grounds, and then run the model to test their ideas. They investigate their own ideas at the end of this activity, and reflect on applications for what they learned in the activity.</td></tr>
<tr><td colspan="3">Connections to Common Core Math & ELA:
Mathematics –
MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">reporting quantities.
ELA/Literacy –
WHST.9-12.1 Write arguments focused on discipline-specific content.
WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.</td></tr>
<tr><td rowspan="3">Swamped! Part 3 - My Watershed</td><td>(9-12) Developing & Using Models</td><td>(9-12) ESS2.C: The Roles of Water in Earth’s Surface Processes
ESS3.A: Natural Resources</td><td>(9-12) Systems & System Models; Stability & Change</td></tr>
<tr><td colspan="3">Blended 3-D Teacher & Student Actions:
Teacher: Challenge the students to trace a drop of water as it flows through their community. After they list all of the obvious ways it might flow from high to low, introduce them to Activity 3 and their topographic maps to refine their description of how a drop of water flows through their community. Afterwards, introduce them to Model MY watershed and the other data tools for in this activity, and allow them time to investigate the uses of each.

Student: Use map skills to identify key map features that will affect the flow of water through their community. Because the data tools in this activity provides them with a personal view of their watershed, they will be able to provide preliminary thoughts about what they will find in the water when they go on their field trip to various streams in their community.</td></tr>
<tr><td colspan="3">Connections to Common Core Math & ELA:
Mathematics –
MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
ELA/Literacy –
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</td></tr>
<tr><td rowspan="3">Swamped! Field Trip</td><td>(9-12)Analyzing & interpreting Data</td><td>(9-12) ESS3.A: Natural Resources</td><td>(9-12) Cause & Effect; Patterns; Systems & System Models</td></tr>
<tr><td colspan="3">Blended 3-D Teacher & Student Actions:
Teacher: Prior to the trip, on the trip, and after the trip ask students about the purpose of the field trip. Encourage their powers of observations while at each site, and connect their observations to their experiences with the classroom activities in this project. Probe students about possible solutions to water quality issues found in their community that includes problems identified on their field trip.

Student: Full participation in the field trip to collect data and make connections between data and their hypotheses about what they expected to find before water went into their wetland, and when it came out.</td></tr>
<tr><td colspan="3">Connections to Common Core Math & ELA:
Mathematics –
MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</td></tr>
</table>

	ELA/Literacy – WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.		
Swamped! Project	(9-12) Asking Questions and Defining Problems; Engaging in Argument from Evidence; Obtaining, Evaluating, and Communicating Information	(9-12) ESS3.C: Human Impacts on Earth Systems	(9-12) Cause & Effect
	Blended 3-D Teacher & Student Actions: *Teacher*: Introduce the problem and assist students with the identification of all the associated parts of the problem, such as the what where, when, how, etc. After completing all the activities, students should be ready to adopt a project topic that will assist in solving the problem. Walk students through the expectations of each topic and how each topic will assist in solving the problem. *Student*: Students form teams and select a topic from the list, and begin developing their project. Students complete their project in a stepwise fashion: topic selection, project proposal design, research, final products (presentation materials and a tool to communicate their findings).		
	Connections to Common Core Math & ELA: *Mathematics –* MP.2 Reason abstractly and quantitatively. HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *ELA/Literacy –* RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.		

[1]Combined in lesson sequence, practices both science and engineering.
[2]Both science content and engineering design Disciplinary Core Ideas.

Assessment(s)	
Formative Assessments	
Swamped! Part 1	In this activity students calculate the difference a type of land use and soil type has on the amount of runoff. They use this data to make an informed decision about the housing density on a piece of farmland. Students are assessed on their ability to use formulas to make data-driven decisions and to problem solve.

Swamped! Part 2	In this activity, students use a model to determine how land use, land cover, and soil type affect the amount of precipitation that goes into runoff, infiltration, and evapotranspiration. They collect and analyze this data and apply it to a local scenario about zoning in their community. Students are assessed on their ability to apply model results to date-driven decisions and to problem solve.
Swamped! Part 3	In this activity, students trace the movement of water throughout their community using topographic maps, online data tools, and online models as a way to ascertain the dimensions of their local watershed. The online model allows them to apply what they learned in the previous lesson to their local watershed. They run the model using various water conservation methods and apply the outputs to their understanding of how water quality changes as it moves throughout the community, and what homeowners can do protect the water from contamination. Students are assessed on their ability to apply model results to data-driven decisions and to problem solve.
Swamped! Field Trip	Students were debriefed at the end of the field trip while still in the field to find out if they made connections between the data and their understanding of the dynamics of a wetland that purifies water. In addition, students reported their data analysis to their classmates who were not on the field trip.
Swamped! Project	Along, the way to completion, students are required to submit "checkpoints" which includes an overview of their final project, their research notes, and a rough draft of their powerpoint presentation and "tangible" (pamphlet, video, etc). These checkpoints will determine the strength of student progress, and allow for feedback to ensure students remain on target for a successful product when they are finished.
Summative Assessment	
Student teams are assessed on their final products - a powerpoint presentation and associated oral presentation to a community audience, and a "tangible" (pamphlet, video, etc) - using a project rubric.	

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Activity 1: Swamped! Part 1 - Catch it if you can

Activity 1 Essential Question: How do land use practices impact the quantity of runoff after a precipitation event?

Introduction:
Before starting this activity, introduce the overarching problem for this set of activities. This activity is used to explore environmental impacts of land use change, or to explore sustainable practices for land use. This activity only ties in one impact of land use change; use this limitation to raise the question about other impacts and how they can be pre-assessed before the development occurs. You may also want to tie into the discussion how Environmental Impact Statements (EIS's) are designed, and have the class create a mock-EIS for a local project.

Materials:
- EnviroScape Model - if available, otherwise, use the materials listed below
- 4 9”x13” trays of soil
- small houses, trees, pieces of felt which can model grass, red powdered drink mix
- spray bottle
- Activity 1 handout
- handout with data tools needed to complete the calculations

Activity Sequence

Student Prior Knowledge	(6-8) ESS2.A: Matter cycles within and among Earth’s systems (6-8) ESS3.C: Human activities have altered the biosphere. Activities and technologies can be engineered to reduce people’s impact on Earth
Engagement (phenomena/ engineering scenario)	To engage students, ask them what would happen to the local environment if a development was built in a neighboring open space. Use this brainstorming to guide student thinking about environmental impacts and how they are measured. If needed, use the materials to create models of different land uses, and use the spray bottle to make it rain over the models. Assist students with discussing cause and effect and how they vary with each intensity of land use. [Additional discussion could include distinction between correlation and causation. Distinguishing actual causal relationships may be difficult due to simultaneous multiple changes that occur during development. Additional testing may be needed.]
Gathering Data or Exploration	Introduce the case and work through the problems with the students.
Reasoning or Explanation/ Elaboration	Using the data collected from their calculations, students explain how land use can impact the quantity of runoff in a community, and elaborate on types of solutions to reduce the impact of the runoff.
Reflection or Evaluation	Students use the results of this activity to consider land use and runoff in their own community, which is a segué into the next activity. Discuss the accuracy of their calculations to model the amount of runoff for each type of land use practice.
Assessment(s) (formative & summative)	In this activity students calculate the difference a type of land use and soil type has on the amount of runoff. They use this data to make an informed decision about the housing density on a piece of farmland. Students are assessed on their ability to use formulas to make data-driven decisions and to problem solve.

Additional Notes:

- Students may be challenged initially with the equations, but the guided example was designed to assist them in their use of the equations.
- Allow students to work with partners as a way to check the results of the calculations.
- Clean-up: Discard disposable materials, and store reusable materials for later use.

Additional Resources:

None

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Activity 2: Swamped! Part 2 - Capturing Precipitation

Activity 2 Essential Question: How do land use practices affect runoff when combined with other variables such as soil type?

Introduction:
Now that they have the idea that the types of land use practices found in an area can increase or decrease the amount of stormwater runoff going into our local bodies of water, students will investigate how well the surfaces in their area retain stormwater runoff using a general model in this activity. They will use a model that will allow them to test different types of surfaces other than those in the Part 1 for their ability to retain water. Next they'll look more closely at their school and community to hypothesize what happens to water around there after a precipitation event.

Materials:
- Computers - 1 per student or student pair
- Website access: Model Microsite Runoff at https://wikiwatershed.org/ then select "Runoff Simulation"
- Activity 2 Handout [*see customizable version of handouts*]

Activity Sequence

Student Prior Knowledge	(6-8) ESS2.C: Water cycles among land, ocean, and atmosphere. Water movement causes weathering and erosion, causing landscape changes.
Engagement (phenomena/ engineering scenario)	What happens to stormwater runoff when we change land use practices? Students label a satellite photo of a 1 km^2 plot that includes their school yard with "I" for infiltrate and "R" for runoff. This will help them visualize the movement of water off their school grounds.
Gathering Data or Exploration	Students use the Model Microsite Runoff modeling tool to gather and graph data relative to land use practices first and then to soil type. After interpreting their data, they investigate their own question that combines the two variables (land use type, and soil type).
Reasoning or Explanation/ Elaboration	After analyzing and interpreting data to identify relationships, students construct explanations for the patterns found in the data.
Reflection or Evaluation	Students reflect on the results of their own investigation, and on their labeled satellite image to evaluate their progress in understanding the role of land use practices and soil type play in water infiltration. In addition, they complete the application for this activity which links the activity to land use planning in their community.
Assessment(s) (formative & summative)	In this activity, students use a model to determine how land use, land cover, and soil type affect the amount of precipitation that goes into runoff, infiltration, and evapotranspiration. They collect and analyze this data and apply it to a local scenario about zoning in their community. Students are assessed on their ability to apply model results to date-driven decisions and to problem solve.

Additional Notes:
- Students may have problems interpreting the satellite image of their location in the first step of this activity. Alternatively, provide a digital version of the image (projected or their course learning management system) so they can clearly define impervious and impervious surfaces.
- Assist students with constructing the bar charts, or set up an Excel table that converts the data into a chart for

them.

- If needed for some learners, allow students to work with partners to complete their original investigation.

Additional Resources:
None

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Activity 3: Swamped! Part 3 - My Watershed

Activity 3 Essential Question: What is included in your watershed?

Introduction:
Now that we know what can happen to our precipitation as it strikes different surfaces, let's trace it as it flows from one place to another. What determines where it flows? This activity will help students identify their local watershed and give them information that can be used in problem solving a water protection plan for their area by running a model that includes a variety of conservation techniques.

Materials:
- tissue paper
- topographic Quads for their area
- tape
- colored pencils
- Computers - 1 per student or student pair
- Model My Watershed: https://app.wikiwatershed.org/
- USGS StreamStats: https://streamstatsags.cr.usgs.gov/streamstats/
- USGS National Map – Hydrology: https://viewer.nationalmap.gov/viewer/nhd.html?p=nhd

Activity Sequence

Student Prior Knowledge	(6-8) ESS2.C: Water cycles among land, ocean, and atmosphere. Water movement causes weathering and erosion, causing landscape changes. (6-8) ESS3.A: Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable.
Engagement (phenomena/ engineering scenario)	Using a topographic map, trace a drop of water from your yard to the lowest point in the area. Describe the surfaces the drop of water comes in contact with as it travels. The topographic map portion of this activity serves two purposes: 1) introduces students to 2-dimensional representations of their area, and 2) orients them to the area that will be included in their upcoming field trip. Although there are plenty of digital mapping tools available, a paper map provides students with a surface on which they can easily manipulate by drawing on it if it is laminated, or by overlaying it with tissue paper and outlining areas of interest.
Gathering Data or Exploration	In the second part of this activity, students run a model and gather data from Model My Watershed which includes all the land uses that occur in their watershed at the various HUC levels (8, 10, 12). The results will provide them with runoff data and water quality data. Next, they run the model again, but with applying a variety of conservation techniques within the HUC-10 level. The other data tools in this activity allows students to isolate the drainage basins for the minor streams in their watershed to a level that they can identify the specific origins of any pollutants found in their local bodies of water.
Reasoning or Explanation/ Elaboration	Students use the model outputs to describe the movement of water through their community, and to list any sources of impairments that may affect the quality of their water. In their elaboration they should discuss the use of conservation practices designed to retain the water within their yards as a way to reduce runoff.
Reflection or Evaluation	Student reflections are similar to above, although they should be relevant to their watersheds, and should include the effect of some of the conservation practices

	they modeled.
Assessment(s) (formative & summative)	In this activity, students trace the movement of water throughout their community using topographic maps, online data tools, and online models as a way to ascertain the dimensions of their local watershed. The online model allows them to apply what they learned in the previous lesson to their local watershed. They run the model using various water conservation methods and apply the outputs to their understanding of how water quality changes as it moves throughout the community, and what homeowners can do protect the water from contamination. Students are assessed on their ability to apply model results to data-driven decisions and to problem solve.

Additional Notes:

- This activity can be done without using a topographic map; however, topographic maps assist in developing spatial skills in a way that online mapping tools cannot.
- Check all links before beginning this activity.
- Allow students to work in pairs, or at least near each other since some students catch on quicker when using maps and online data tools. Modify the lesson as needed for those students who may need modification.
- Store materials for future use.

Additional Resources:

None

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Activity 4: Swamped! Part 4 - Field Trip

Activity 4 Essential Question: What's in our water?

Introduction:
The field trip connects students to the results of the activities they have been working on, the overarching problem for this project, and their backyards. The fieldtrip design is included in next several pages. While on the trip, students collect chemical, visual, and biological data at three sites where water flows into their local wetland, and from one location where water flows out of this wetland. They apply their understanding of wetlands to the analysis of the data, and begin to brainstorm ways to prevent water pollution in the local streams. It is likely that not all students attend the field trip, and therefore debriefing the trip experience and data at the end of the trip, and then again (led by those who went on the trip) with those not attending will ensure that all students are engaged in trip experience in some way. Invite the Director of Water Quality Programs from the local watershed association to class to introduce the field trip and the activities that will take place on the trip. [Note: If your area does not contain wetlands, try contacting your local water quality office (state or federal agency or private watershed organization) for alternative framing for this lesson.]

Materials:
- clip boards
- waders
- sunscreen and bug spray
- Data sheets: visual assessment, macroinvertebrates, water chemistry
- Visual assessment supplies: tape measure, marker flags, weighted rubber ducky, thermometer
- Water chemistry: chemical test kits (nitrates, phosphates, pH, DO) , turbidity column/meter, thermometer
- Macroinvertebrates: collecting supplies (nets, trays, spoons, eyedroppers), identification keys
- camera
- Note: Review equipment list before going into the field, and where possible, duplicate the supplies

Activity Sequence

Student Prior Knowledge	(6-8) ESS3.A: Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable.
Engagement (phenomena/ engineering scenario)	What do you think we'll find around the community in regards to water quality? Why? Show students a map of the locations for field work, and remind them of the data they collected and viewed in the previous activities. Prepare students for field work before the day of the trip by walking them through the protocols, and what to expect when they are in the field in regards to comfort, and level of work.
Gathering Data or Exploration	Students are divided into teams for the day to collect data. Depending on the number of students, there may be duplication of datasets. That is okay so long as everyone is involved in some way.
Reasoning or Explanation/ Elaboration	Circulate among the small data collection teams, and prod them about the implications of what they are finding relative to water quality.
Reflection or Evaluation	Take time at the end of the trip, and again the next day for those students who did not attend the trip to debrief the data collected.
Assessment(s) (formative & summative)	Students were debriefed at the end of the field trip while still in the field to find out if they made connections between the data and their understanding of the dynamics of a wetland that purifies water. In addition, students reported their data analysis to their classmates who were not on the field trip.

Additional Notes:

- A field trip has many tasks which makes it less of a challenge to identify the appropriate tasks for some students.
- It is imperative that field safety be part of the pre-trip conversation. Warn students about bugs, poison ivy, slipping in the water and on wet surfaces, etc.
- Clean and store equipment for future use

Additional Resources:

None

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Note: For a next iteration of this unit, students also collected indoor and outdoor air quality data using a Personal Air Monitor (PAM) from AQTrek (http://aqtreks.com/index.html). Like with the water quality data, the air quality data and solutions were shared with local stakeholders.

Great Swamp Watershed Association

Watershed Friendly Living Project Lesson Plans (estimated time: 1 week – 5 weeks) [*This is the plan for the fieldtrip noted in Activity 4 above*.]

(Note: *All sections of this lesson do not need to be completed. Depending on the amount of time available you can choose the depth at which your students engage in this project*.)

NGSS: (The lessons outlined are building towards performance expectations HS-LS 2-6, HS-LS 2-7, HS-LS 2-8, HS-LS 4-6.)

Disciplinary Core Ideas: LS2.C, LS4.D, ETS1.B

Science and Engineering Practices*: *Depending on the direction each group takes with their project, possible Science and Engineering Practices include:* Planning and Carrying out Investigations, Constructing Explanations and Designing Solutions, Scientific Investigations use a Variety of Methods, Scientific Knowledge is Open to Revision in Light of New Evidence, Asking Questions and Defining Problems

Cross-Cutting Concepts*:* Stability and Change, Science is a Human Endeavor

Objectives:

1. SWBAT apply content knowledge gained throughout the year to real-life problems.
2. SWBAT devise solutions to real-life problems.
3. SWBAT feel empowered by educating others about their chosen topic.
4. SWBAT describe what a watershed is and identify the watershed they live within.
5. SWBAT explain the importance of protecting watersheds.

Materials:

- Computers/laptops/chromebooks – at least 1 per group (ideally 1 per student)

Suggestion- If possible, have students complete and submit all parts of this project via Google Docs. Create a folder on your Google Drive for each group and have them share all of their work with all members of their group and with you. This ensures that all members can work on all parts of the project at all times and it allows you to monitor their progress throughout the course of the project.

Suggestion- Arrange your room so that students sit in their groups each class period. This helps to promote collaboration.

Suggestion- To increase motivation you can present this as a challenge. There is a scoring rubric which can be used to give each group a quantitative score at the end, so that can be used to determine a *winning group*. At the start decide on some sort of prize the winning group will be awarded. Ideas include: school apparel, gift cards to Barnes and Noble, Starbucks, Dunkin Donuts, etc., donation of a small sapling to the school with the winners' names on a plaque in front of it.

Suggestion- Where applicable, encourage students to turn this into a *hands-on* project. If appropriate to their topic students can build their "solutions" to their topics. For example, a group studying ways to decrease storm water runoff might build a rain garden, or a group studying how to make use of rainwater might build a rain barrel for the school. The ideas are endless! Encourage the students to come up with the solutions to these problems!

Project Overview:

At the core of this project should be the message of empowerment for the students. Typically taught at the end of the year, this project is an opportunity for students to apply what they have learned to *real-life* problems with the intent of developing solutions. The exact premise in which you introduce this project to your class should be made specific for your town/school/students. What is important is that the students are working to develop solutions to real-life problems, which they then share with other members of the school and even influential community members (such as, town council men and women, school board members, members of the watershed association, other teaches, the principal, and the superintendent).

An example introduction to this project, which you can modify and use to meet your needs, is as follows:

The Great Swamp Watershed Association is dedicated to protecting and improving water resources in the region by monitoring local streams, advocating for intelligent land use, and educating our communities about water quality and quantity and their effect on the health and natural beauty of the local environment. The GSWA is in the process of developing a watershed friendly living website which will focus on; what homeowners in the __Fill in your town_ community can do to protect and improve water quality, water quantity, and storm water runoff.

You will be provided a list of topics to choose from. Along with your group, you will research the issue, determine possible solutions, and create a product (fact sheet, pamphlet, brochure, etc.) and presentation (PowerPoint) which will be used by the GSWA to educate homeowners.

Depending on the time available, this project could be scaled down and completed in one week, or if done in its entirety it could span a five to six-week time period. Please notice that many of the lessons are optional, so you can choose the ones which are appropriate for your situation and time period.

Full Project (5-6-week time period)

Part 1: Project Proposal

1. Lesson #1: Introduction to the Project
2. Lesson #2: Planning Day- Class
3. Lesson #3: Planning Day- Group

Part 2: Research and Sources

4. Lesson #4: Research
5. Lesson #5: Research and Citations Documentation

Part 3: Survey Information

6. Lesson #6: Survey Planning
7. Lesson #7: Survey Results Analysis

Part 4: PowerPoint Presentation

8. Lesson #8: Google Slide Presentation

Part 5: Informational Handout

9. Lesson #9: Guest Speaker
10. Lesson #10: Informational Handout Planning and Design

Part 6: Presentation

11. Lesson #11: Guest Speaker- Public Speaking
12. Lesson #12: Dry Run- Practice Presentations
13. Lesson #13: Presentations

Part 7: Project Reflection

14. Lesson #14: Reflection

Scaled Down Project (1-week time period)

Part 1: Project Proposal

1. Lesson #1: Introduction to the Project
   Lesson #3: Planning Day- Group

**Lessons #1 and #3 can be merged into one and completed in one class period.*

Part 2: Research and Sources

**If completed in a one-week time period, the research should have taken place at an earlier time.*

Part 3: Survey Information

**The survey part will most likely need to be left out due to the time constraints.*

Part 4: PowerPoint Presentation

2. Lesson #8: Google Slide Presentation

Part 5: Informational Handout

3. Lesson #10: Informational Handout Planning and Design

Part 6: Presentation

4. Lesson #13: Presentations

Part 7: Project Reflection

Lesson #14: Reflection

**Lesson #14 can be completed the same day as the presentations (directly following them).*

Project Outline:

(Notes: Each "lesson" will take about a 40-50 minute block of time unless noted otherwise.
Each "lesson" and handout is coded using the following system, Part-Lesson-Document.
For example: "3-6b" means, **part 3**, **lesson #6**, and that it is the **second document** in the lesson.)

Part 1: Project Proposal

Lesson #1: **Introduction to the Project**

1. Place folded index cards, with the students' names on them, at lab tables (or clustered desks) to **establish groups**. Depending on the dynamic of the class either predetermine the groups or allow students to decide.
2. Engage the students by **introducing the project**. Begin by either reading or projecting the following on the board:
    a. **The problems are real….it's time to apply your knowledge to be part of the solution.**
    b. ***Anything else you're interested in is not going to happen if you can't breathe the air and drink the water. Don't sit this one out. Do something. - Carl Sagan***
3. Provide the students with the **background information** for this project. As mentioned above, this should be made **specific to your town/community/students.** The following is an example which you can modify and adapt to your situation.
    a. The Great Swamp Watershed Association is dedicated to protecting and improving water resources in the region by monitoring local streams, advocating for intelligent land use, and educating our communities about water quality and quantity and their effect on the health and natural beauty of the local environment. The GSWA is in the process of developing a watershed friendly living website which will focus on; what homeowners in the __Fill in your town_ community can do to protect and improve water quality, water quantity, and storm water runoff.
    b. You will be provided a list of topics to choose from. Along with your group, you will research the issue, determine possible solutions, and create a product (fact sheet, pamphlet, brochure, etc.) and presentation (PowerPoint) which may be used by the GSWA to educate homeowners.
    c. If there is going to be a "challenge" with this project (as explained above), introduce it here.
4. Hand each student a copy of the **Project Overview** (1-1a). Either discuss as a class or provide students ~5 minutes to read through independently.
5. Establish the following **expectations** with the students:
    a. Please sit at this assigned table with your group members every day.
    b. Bring your laptop/chromebook to class everyday (if possible).
    c. You **need citations for EVERYTHING**! This project will be shared with community members and may even be posted on a website and therefore everything must be supported with factual data from reputable sites.
    d. You will submit each section below by sharing the document with: (include your e-mail here)
6. Present students with the list of **Topic Choices** (1-1b)
    a. *(Note: These are examples and may be used, however they should be modified and adjusted to be specific to your community/school.)*
7. Allow students to read through topic choices and select their top three choices.
8. Have students complete the **Topic Preference** (1-1c) form (1 per group) and hand to the teacher before leaving.

Lesson #2: **Planning Day- Class** (*optional*)

*(Note: If desired, this lesson could be conducted prior to the filling out of the **Topic Preference** form and instead could act to allow groups to further explore the topics before selecting their top three.)*

1. As students enter the room remind them to sit with their group, however the focus of this lesson is to promote class discussion of topics. During this discussion, students will discuss the topics and brainstorm ideas for research, surveys, and presentation materials.
2. Provide each group with the topic choice that was selected for them from the Topic Preference form.
3. Allow students ~10-15minutes to briefly discuss their topic as a group. Provide them the following **guiding questions** (you can write or project them on the board).
    a. What do you find the most interesting about this project choice?
    b. What do you believe the biggest challenge with this topic will be?
    c. What are you most excited to learn regarding this topic?

4. **Class input.** In a "round-table" discussion format, allow the class to discuss each groups topic. This discussion should be student-driven with you acting as the facilitator.
    a. Depending on the number of groups and number of minutes in a class period, divide the time so that each group has an equal amount of time. During this time;
        i. A representative from each group should read their topic to the class.
        ii. At least one member from each of the other groups should either- make a comment, ask a question, or make a suggestion.
        iii. Encourage back-and-forth discussion between groups.
        iv. This should be a positive/helpful/encouraging discussion.
5. *Suggestion: It is helpful to create a tentative schedule for the project at the very beginning. Please see the* **Project Calendar** (1-2a) *document for a sample schedule for this project.*

Lesson #3: **Planning Day- Group**

1. As students enter the room remind them to sit with their group.
2. Provide the students one class period to discuss their topic and brainstorm ideas for research, surveys, and presentation materials as a **group**.
3. Circulate from group-to-group to ask questions and facilitate as group members continue to plan.
4. The focus of this class period (and due at the end of the period) is the **Project Proposal** (1-3a) form. This form will guide students through the planning process. (1 per group)
    - *Note: Although many groups will deviate from this plan, it is very helpful to focus them on the big picture and to encourage them to think ahead.*

Part 2: Research and Sources

Lesson #4: **Research**

(Note: Depending on the time you have available for this project, provide the students approximately 4-8 class periods for research. Below is a general overview of what the "research" class periods should include.)

1. Students should be required to use a variety of resources to research their topic. Here is a list of possible resources:
    a. Internet- Be sure to discuss reliable and acceptable sources with your class, if you have not already done so earlier in the year.
    b. Library- Books as well as science journals and media archives can be useful resources. A suggestion is to schedule one or two class periods for your class to meet in the library. If possible, meet with the librarian ahead of time and provide him/her the topic list and ask them to pull relevant books onto a cart for your class.
    c. Surveys- Please see *Lesson #6*.
    d. Experts- If desired you can make it a requirement that each group contacts at least one expert. "Experts" can be very helpful resources. Make suggestions for each group of possible experts. Ideas are as follows; local town officials, landscape companies, employees of the waste water treatment plant, professors at local colleges, watershed ambassadors, other teachers, GSWA staff.

        Suggestions for success:

        i. Discuss proper/professional etiquette that should be followed when corresponding with adults.
        ii. Ask/require students to *CC* you on their e-mail correspondence with the experts and assist them with making 1st contact (if needed).
        iii. Provide students with class time to make phone calls to experts.
        iv. Remind the students to take notes during the phone calls.
2. Throughout the research lessons, be sure to:

a. Regularly check in with each group. Ideally, sit down and talk with each group at least once per class period to monitor and facilitate their progress.
b. Set deadlines, for other parts of the project, throughout the research phase to ensure that the students are on task and productive.

Lesson #5: **Research and Citations Documentation**

1. As mentioned above, discuss reliable sources and citations with students, if it has not been taught previously. Please visit the following website for lessons on how to identify reliable sources and cite them.
    - Resource: http://www.scholastic.com/teachers/top-teaching/2010/11/reliable-sources-and-citations
2. Inform students of the format which you would like them to use to document their sources (i.e. APA, MLA).
3. Throughout the research phase, require students to document their sources.
4. The exact way in which you monitor the documentation of sources is at the teacher's discretion. Suggestions include:
    - Ask students to create (and share with you) a google doc in which they will record their sources on a daily basis.
    - Require/encourage students to use a website (such as: https://www.noodletools.com/) to track their sources.
    - Schedule periodic *check-ins* of the research and citations documentation.
5. Require students to complete and submit the **Research and Citations** (2-5a) form. This form mentions the use of *NoodleTool* as the documentation for the citations, however you can adjust it to whatever format you choose for the citations.

Part 3: Survey Information

Lesson #6: **Survey Planning**

(Note: This lesson will most likely occur over the course of approximately 1-3 class periods, some of which will take place during the research phase.)

1. Rationale: Since many of the topics involve homeowners and behavioral changes, surveying the affected population is a helpful research tool.
2. Provide students with a copy of the **Survey Grading Rubric** (3-6a).
3. Encourage adequate planning, prior to the creation/dissemination of the survey. See below for instructions on how to assist students with the planning phase.
4. Explain to the students that the information that they are intending to gather from their survey will determine:
    a. Their sample size.
    b. The age/gender/locale/socioeconomic status/etc. of the surveyed sample.
    c. The point at which their survey should be administered (i.e. Is it a survey to learn about current practices? Is it a survey to determine whether or not people would be willing to make changes? Is it a survey to gather information about possible solutions?).
5. Discuss survey techniques/etiquette with students, if it has not been taught previously. This should include, but is not limited to:
    a. Surveying tools (google forms, survey monkey, etc.)
    b. Parameters to keep in mind when developing an effective survey (i.e. amount of questions, types of questions, importance of determining the sought after information prior to the design of the survey).
    c. How to determine the appropriate sample size, meaning, how many people must be surveyed in order for the information to be relevant? 20?50?100?
    d. Dissemination of the survey. What is the most appropriate? (i.e. Face to face? Telephone? Social media (adding the survey link to facebook, twitter, or e-mail)?)

e. Require students to include a statement on their survey which explains that the survey information will be kept anonymous and outlines what the survey will be used for.

6. Require students to complete and submit the **Survey Planning** (3-6b) form (1 per group).

Lesson #7: **Survey Results Analysis**

1. Rationale: Just as important as the surveys themselves is the analysis and graphing of the gathered information.
2. Once survey information has been gathered, instruct students to:
   - Analyze and discuss the survey data
   - Create a graphical representation of the information
   - Include the survey data in their presentation
3. Require students to complete and submit the **Survey Analysis** (3-7a) form (1 per group).

Part 4: PowerPoint Presentation

Lesson #8: **Google Slide Presentation**

(Note: This lesson will most likely occur over the course of approximately 1-3 class periods, some of which will take place during the research phase and during the creation of the information handout phase.)

1. Provide students with a copy of the **Presentation Rubric** (4-8a) (1 per student) at this time. The **Presentation Rubric** should be used to guide students in the create of the **Google Slide Presentation** and planning of the presentation itself.
2. See ***Lesson #9 in Part 5*** for additional instructions.
3. If possible students should be encouraged to create a **Google Slide Presentation,** in place of a PowerPoint, so that group members can work on it simultaneously and whether physically together or separate.
4. Determine and inform students of a due date for the completion of the Google Slide Presentations.
   a. Suggestion: The due date should be a day or two in advance of the presentation date. This will allow for the Google Slide to be used during the *practice presentations.*

Part 5: Informational Handout (brochure, fact sheet, pamphlet, etc.)

Lesson # 9: **Guest Speaker- Project Design**

(*Optional lesson: This can be taught by the teacher of the course however, if an "expert" is available it is often more effective and helpful for the students.*)

1. Provide students with a copy of the **Informational Handout Rubric** (5-9a) so that they know the expectations.
2. Contact an expert (i.e. photo teacher, visual art teacher, employee at a graphic design store, etc.) and ask them to visit your class to teach a lesson that covers:
   a. Possible avenues for creating brochures, fact sheets, or pamphlets (i.e. Microsoft Publisher, Vistaprint, Zazzle, DesignCrowd, etc.)
   b. Appropriate information to include in the handout
   c. How to make the handout visually appealing (minimize text and maximize engaging pictures/diagrams/etc.)
   d. Also ask the expert to address *how to make effective PowerPoint Presentations* (see Part 4)- appropriate number of slides, more visuals- less text, etc.

Lesson # 10: **Informational Handout Planning and Design**

(Note: This lesson will most likely occur over the course of approximately 1-3 class periods, some of which will overlap other phases of this project.)

1. Students should work with their groups to first plan and then create their informational handouts.

2. Provide each group with a copy of the **Informational Handout Planning** (5-10a) form.
    a.
3. Determine and inform students of a due date for the **Informational Handout Planning** form and for the **Informational Handout** itself.
4. Circulate from group-to-group to ask questions and facilitate as group members create the **Informational Handout**.
    a. Suggestion: Require students to print out a set number of brochures/pamphlets (~10-20) to allow for circulation/distribution to audience members during the presentations.

Part 6: Presentation

Lesson # 11: **Guest Speaker- Public Speaking**

(*Optional lesson: This can be taught by the teacher of the course however, if an "expert" is available it is more effective and helpful for the students.*)

1. Review the **Presentation Rubric** (4-8a) with the students so that they know the expectations.
2. Contact an expert (i.e. debate teacher, public speaking teacher, performing arts teacher, local college professor, etc.) and ask them to visit your class to teach a lesson that covers:
    a. Appropriate attire for the day of the presentation
    b. Public speaking skills (eye contact, posture, voice projection, etc.)
    c. Appropriate layout for presentation (introduction of group members, introduction of topic, discussion of research, survey methods, time for questions, etc.)

Lesson # 12: **Dry Run- Practice Presentations**

1. If possible reserve a room besides your regular classroom for the presentations.
    a. Rationale: Changing the venue tends to amplify the importance of the presentations and results in the students taking the project more seriously.
    b. Ideas for alternative locations include: school auditorium, community room, local library, school media center, or another larger room within the school.
2. A day or two in advance of the actual presentations, bring your class to the presentation room *(If not possible, just practice in your room.)* and have students run through their presentations. This dry run should include:
    a. Groups practicing in the order in which they will go in during the actual presentations.
    b. A test of the technology by opening each groups Google Slide Presentation.
    c. Asking the students to act as audience members when not presenting.
        i. *Optional:* Give each student a blank **Scoring Rubric** (6-13a) and ask them to complete it for the other groups.
        ii. Ask groups to compare and discuss their **Scoring Rubrics,** at the end of each groups presentation, and then collect them.

Lesson # 13: **Presentations**

1. About two weeks prior to the presentation date, send out e-mails to invite guests. Inform the students of the possible guests and stress to them the importance of this project. Explain that they will be making a difference by educating members of the school and community. Possible ideas for guests include:
    a. Other faculty and staff of the school
    b. Other students (possibly from another science class or even from a study hall)
    c. Parents
    d. Administration- Superintendent, Business Administrator, Principal, Assistant Principal
    e. Buildings and Grounds Workers / Custodians
    f. Board Members
    g. The Mayor
    h. Members of the Town Council
    i. Members of the Town Green Team and/or Environmental Commission

j. Watershed Ambassadors
k. Journalists from the town newspaper

2. Each group should be given approximately 6-10 minutes to present. Keep the time and hold up index cards to warn groups with their time is almost up. Reserve about 1-2 minutes at the end of each group for questions from the audience members.
3. Write out the agenda, with approximate times, in advance of the day. In addition, if google slides were used to make the presentations, you should download them to the computer in advance of the presentations in case the internet is down.
4. If audience members are willing, provide them with clipboards and the **Scoring Rubrics** (6-13a) and ask them to provide each group with feedback.
5. Complete the **Scoring Rubric** for each group.

**Suggestions for reaching a wider audience.*

- **Rationale:** The goal of this project is to empower students and lead them to the understanding that the most powerful way to make positive changes in the world is by educating others.
- That being said, there are many ways that students can share what they have learned and the solutions they have devised with a wider audience. **If time allows, you can facilitate a class discussion during the project reflection lesson (#14), to encourage students to brainstorm ideas for how they can share what they have learned and/or their handouts with target audiences.**
- Here are a few suggestions that either you can arrange for the students, or you can encourage them to do on their own:
    - Present at an upcoming environmental commission or green team meeting
    - Present at the local public library
    - Share their final handouts in a public space such as; the local library, township building, or even the local coffee shop
    - Ask the school administrators to make a place on the school website for the final projects
    - Mailing pertinent information to landscaping companies
    - Having handouts available at the local garden shops
    - Talking with the appropriate people to create demonstration projects (For example, maybe installing low flow fixtures in a public building, or speaking with the cleaning staff at school about switching to more eco-friendly products).

Part 7: Project Reflection

Lesson # 14: **Reflection**

1. Give each student a blank **Scoring Rubric** (6-13a) and ask them to complete it for their group.
2. Ask groups to compare and discuss their **Scoring Rubrics** and then collect them.
3. Have students discuss the project process and outcome with their groups.
4. Facilitate a class discuss about the project.
5. Require students to complete and submit the **Project Evaluation** (7-14a) form. (1 per student)
    - *(Note: Anonymous evaluation forms tend to yield the best feedback, however if you feel more comfortable, include a line for the students' names.)*
6. Thank the students for their hard work and remind them of the difference they have made and the differences their projects will continue to make!
7. In closing, leave the students with the following quote:
   "Education is the most powerful weapon which you can use to change the world." ~Nelson Mandela

Activity 5: Swamped! Part 5 - Project

Activity 5 Essential Question: What are the solutions to the challenges of protecting our water quality?

Introduction:
The problem was introduced at the front-end of the project, and at this point students are working in teams on their solutions. First they choose a topic from the list, or develop their own, and then create a proposal for how they are going to approach their topic in the allotted amount of time before their presentations. All topics include data of some ki8nd, and peer-reviewed research, both of which will support their arguments for the viability of their solutions. For more detail on the specifics of this project, visit the Great Swamp Watershed Association website (https://www.greatswamp.org/) for detailed steps for this project (Watershed Friendly Living), and all of the handouts and rubrics. Be sure to create "hard" checkpoints (specific dates) to ensure students are on target to complete their project by the due date. Provide students with rubrics so they know what is expected of them.

Materials:
- Computer access
- Access to field trip data
- Additional materials may be required as defined by the topics selected by the students

Activity Sequence

Student Prior Knowledge	(6-8) ESS3.C: Human activities have altered the biosphere, sometimes damaging it. Activities and technologies can be engineered to reduce people's impacts on Earth.
Engagement (phenomena/ engineering scenario)	Ask students for ideas on what they can do to ensure good water quality in their local watershed. Next, ask them what homeowners can do. Share the topics with the students, and allow student-teams select a topic. Ideally, only one team should adopt each topic since there are plenty of topics to from which to choose.
Gathering Data or Exploration	Circulate through all of the teams to discuss their data and assist them with acquiring the data where necessary. It is then up to the students to determine the best way to analyze and present their data, which will be to an audience on the due date for the project.
Reasoning or Explanation/ Elaboration	Students use their data and their research to explain why their solution is warranted, and how it will be effective in keeping our water clean.
Reflection or Evaluation	Students reflect on their final product and provide ideas on how they could improve it.
Assessment(s) (formative & summative)	Formative: Along, the way to completion, students are required to submit "checkpoints" which includes and overview of their final project, their research notes, and a rough draft of their powerpoint presentation and "tangible" (pamphlet, video, etc). These checkpoints will determine the strength of student progress, and allow for feedback to ensure students remain on target for a successful product when they are finished. Summative: Student teams are assessed on their final products - a powerpoint presentation and associated oral presentation to a community audience, and a

	“tangible” (pamphlet, video, etc) - using a project rubric.

Additional Notes:

- Students self-select groups which will assist learners needing extra assistance to complete their projects
- Be sure to check in with the groups on a daily basis asking them to explain their thinking as a way to ensure they are making positive progress.

Additional Resources:

Depending on the topics students chose, there may be additional resources needed.

Swamped! Activity # 1

Name_____

A.P. Environmental Science

Catch it if you can – Quantifying Storm Water Runoff

Background:

As our population grows so too does our need for housing and infrastructure. However, this development comes with costs. Our open spaces are not only homes to established ecosystems, but they provide the ecological service of water storage among other services. When we "develop" these spaces we are increasing the percent of impervious surfaces and therefore changing how water drains from the area after a storm. This is called a positive feedback since the modification of the land is causing greater storm water runoff. This runoff can be detrimental to the stream ecosystems in the area of the development since the runoff could be carrying toxic pollutants and/or sediments. The toxic pollutants could kill off organisms living in the stream, and the sediments could create turbid conditions preventing the sunlight from penetrating the water which is required by photosynthetic organisms at the bottom of the stream ecosystem food chain.

Scenario:

In the town of Jonesville a 50 acre wooded lot was recently sold to housing developer. As a precaution, the Jonesville Zoning Board wants to know what will happen to the rain water striking this lot after the parcel of land is developed since the wooded lot appears to be containing most of the water with very little runoff. Their concern is for the water quality of a nearby river should runoff on this lot increase after it is developed. The developer is proposing to build homes on ¼ acre lots, whereas the Zoning Board feels that fewer homes will mean less runoff and would prefer the developer consider building on 1 acre lots.

What is the Jonesville Zoning Board concerned about?

How will building homes on this lot affect storm water runoff on this lot? Use the space below to craft a hypothesis that includes an explanation.

What do we know?

- Current land cover: wooded lot
- Size of the lot: 50 acres
- Proposed future land cover: homes on ¼ lots
- There is a stream nearby
- Soil type for a sample that is 30% clay, 45% silt, and 25% sand
- Average rainfall rate for this area is 1"/hour

What do we need to find out?

The quantity of runoff before and after development for a wooded lot if there were 1/4 acre homes and 1 acre homes

To calculate these values from the above scenario, we'll need to refer to our data tools for some answers.

1. What is the soil type? (*Hint: use the soil triangle*) _____

2. What is the Hydrologic Soil Group for this soil type? (*Hint: use the table provided*) _____

3. Using your answer in question 2, what are the curve numbers for the following?

    Wooded lot: _____
    Homes on ¼ acre lots: _____
    Homes on 1 acre lots: _____

What are a few assumptions when using the above curve numbers?

Now we're ready to calculate the runoff from this lot using the NRCS runoff equation. (The details below are adapted from *Urban Hydrology for Small Watersheds, Technical Report 55. 1986,* USDA, NRCS, Conservation Engineering Division)

We'll begin with the wooded lot.

Step 1:
Calculate the "S" value which is refers to the ability of the soil type to retain water as related to the land use type. Use the curve number (CN) from above in the formula.

$$S = \frac{1000}{CN} - 10$$

Our S value for the wooded lot is_____

Step 2:
Initial runoff equation:

$$Q = \frac{(P - I_a S)^2}{(P - I_a + S)}$$

Where
Q = runoff (in)
P = rainfall (in) *(use 1 inch in this case study)*
S = potential maximum retention after runoff begins (in)
I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation: $I_a = 0.2\ S$. By removing I_a as an independent parameter, this approximation allows use of a combination of S (from Step 1) and P to produce a unique runoff amount.

Substituting the I_a value into the equation gives us our final equation we will use in this case:

$$Q = \frac{(P - .2\,S)^2}{(P + .8\,S)}$$

Our Q value for our wooded lot is _____

Our value above is in inches and we need to scale this up for our entire lot.

- To do this, first divide your Q value by 12 inches/ft
- Next multiple the above answer by 43,560 ft^2/acre
- Finally, multiple your previous answer by the number of acres in question. Your answer will be in cubic feet to represent the volume of runoff water for this precipitation event.

Final Runoff Volume: _____

Showing your work, complete the above steps for

Homes on ¼ acre lots:

S = _____

Final Q = _____

Homes on 1 acre lots:

S = _____

Final Q = _____

Comparison table: Add your computed values to the table below

Land use type	**Runoff volume in $feet^3$ for 50 acres in a 1" storm**
Wooded lot	
Homes on ¼ acre lots	
Homes on 1 acre lots	

Step 3:
The Zoning Board decided to allow the developer to build homes on the site under the condition that the excess water running off the site be contained on the site and not be allowed to run into the nearby stream. Using the runoff numbers for the ¼ acre lot homes and the 1 acre lot homes determined how much excess runoff there would be if the lot were left wooded. Use the space below to analyze the runoff data for these 3 sites and argue for or against each of the three land use types.

Choose a housing model the developer should use and then develop a plan to contain the excess water within this new development.

Conclusion:
How did this problem model reality?

Earlier in the calculations it was mentioned that there were assumptions that went into the curve numbers. There were assumptions that were made in order to solve this problem and to keep it simple. Describe at least 3 additional assumptions that would make this problem more complicated, but closer to what is considered by hydrologists surveying a site being considered for development.

How would the runoff be different if this 50 acre lot were instead going to be used as an urban center? Why do you think this?

A.P. Environmental Science **Name**_____

Swamped! –Part 2: Capturing Precipitation

Introduction:
Now that we have the idea that the types of surfaces found in an area can increase or decrease the amount of storm water runoff going into our local bodies of water, we will investigate how well the surfaces in our area retain storm water runoff. We will use a model that will allow us to test different types of surfaces other than those in the Part 1 for their ability to retain water. Next we'll look more closely at our school and community to see what happens to water around here after a precipitation event.

Phenomenon under investigation: What difference does land cover and land cover have on where the water goes in Chatham?

Initial thoughts:
What do you think happens to all the water from a precipitation event in Chatham?

Your question:
Use this space to craft a question to use to test your initial ideas.

Our backyard:
The map below is 1 km^2 area surrounding our school. Identify areas where you expect runoff (R), and areas where you expect water to infiltrate (I). *[Substitute an image of your school area to customize for your students.]*

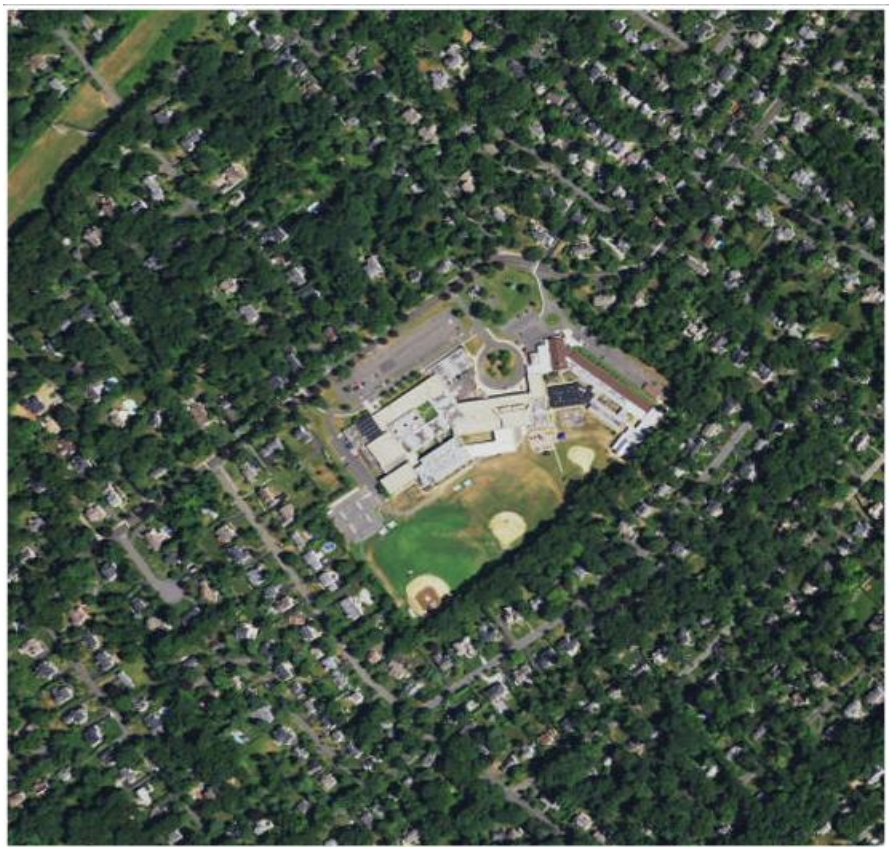

Figure 1: 1 sq km area surrounding Chatham High School, Chatham, NJ

Investigating Land Cover and Land-use:

1. Land-use and land cover refer to what is taking place on the land in a given area. When considering what happens to water after a rain storm, land use and land cover can play an important role in keeping the water in one place instead of allowing it into areas where it could puddle and cause minor to severe flooding. For example, think about the areas you labeled in the map above and list what you think are areas that would absorb precipitation and areas that would not. Use the space below to list types of land cover and land use where water would be absorbed (infiltrate) or water would runoff:

Infiltrate:

Runoff:

Let's run some models:

1. Now you are going to test your ideas with a model. Go to Model My Watershed – Micro Site Storm Model at https://micro.app.wikiwatershed.org/

2. Notice that the model platform shows three sections on the right precipitation rate, land cover, and hydrologic soil group. Before starting your investigation, familiarize yourself with the platform by manipulating the variables provided to produce various outcomes.

3. Running the model: Make sure the precipitation bar is set to 8.0 cm of rain and the hydrologic soil group is set to loam (B-Moderate Infiltration). Hover over each of the land cover choices to read brief descriptions. Click on the Developed – High (Intensity) icon as a land cover and see what happens to the amount of evapotranspiration, runoff and infiltration. Record your data in the table below. Change the land use type and collect the data for each type and record it in the table. Create a bar-graph of the data and submit it with your completed activity.

Land cover	Evapotranspiration	Runoff	Infiltration
Water			
Developed, Open Space			
Developed-Low			
Developed-Med			
Developed-High			
Barren Land			
Forest			
Shrub/Scrub			
Grassland			
Pasture/Hay			
Crops			
Wetlands			

In the space below, analyze your data. Recall that you only used one soil type while running this model.

4. Now we run the model for the different soil types. Keep in mind that soil is more than the brown-stuff! It includes organic matter, air spaces, and water too. The soil constituents (sand, silt, clay) may cause water to drain slow or fast depending on the combination of the three. The more clay there is in the soil, the lower the ability of the water to infiltrate the soil. Hover over each soil type to learn more about them.

Leave the precipitation value at 8 cm. Select a land cover that most closely resembles our area, and use that for each trial in this model run. As you did in the previous step test each soil type, and place your data in the table below. Once you've collected all of your data, create a bar-graph of the data and submit it with your completed activity.

Soil Type	**Evapotranspiration**	**Runoff**	**Infiltration**
A - High Infiltration			
B - Moderate Infiltration			
C - Slow Infiltration			
D - Very Slow Infiltration			

In the space below, analyze your data. Recall that you only used one land use type while running this model.

5. The final step is to reflect back at your thoughts and question from beginning of this activity, and to develop and investigation to answer your question, or a new question you may have since you started this activity. Use the space below to outline your steps, gather and analyze your data, and draw conclusions based on evidence from your investigation.

Question & initial thoughts:

Methods:

Data:

Data Analysis:

Conclusion:

Application:
Based on your investigations in this activity, if you were a zoning officer in your community, which type of land cover and soil would you prefer to have in your community to limit runoff, and increase infiltration? Explain your answer using data from this investigation.

Swamped! Activity # 3

A.P. Environmental Science **Name_____**

Swamped! –Part 3: My Watershed

Background: Now that we know what can happen to our precipitation as it strikes different surfaces, let's trace it as it flows from one place to another. What determines where it flows? This activity will help you to identify your local watershed and give you information that can be used in problem solving a water protection plan for your area.

Question / Initial Thoughts:

Use the space below to describe what you think is in your watershed and how water moves throughout your watershed.

Part 1: Mapping our Watershed

Materials:

- Topographic map of your area
- Tracing paper
- Tape
- Colored pencils

Procedure:

1. Survey your topographic map for features related to this topic, i.e. rivers, streams, populated areas, ponds, marshes, industries, etc...

2. Affix tracing paper to the corners of the map with the tape. Mark your school with an "X".

3. Locate the nearest stream or river. Using a colored pencil, trace the waterway as far as you can upstream and downstream. Draw in and label all upstream bodies of water, including lakes, tributaries, and marsh areas.

4. The sources of these waterways are the highest points in your area where rainwater and melted snow begin to drain. Use the same colored pencil to mark each of these sources with an "O" for origin. This entire colored area, land and water, is your watershed. Next, draw arrows to show the movement of water as it travels from high to low.

5. With another colored pencil identify with lines or dots the populated areas and all the places that could produce pollution and affect your watershed. These areas can represent houses, factories farms, golf courses, and other potential sources of water pollution.

6. Provide a key to identify which color was used for each part of the procedure.

Analysis:

1. Describe the major components of your local watershed.

How did you determine the direction the streams in your watershed flowed?

2. Describe 5 potential sources of point and non-point water pollution in your watershed.

3. Locate one of your "O's." Describe where pollution entering at that point may travel to as it moves through your local watershed.

4. If pollution enters the stream near your community, what natural mechanisms can prevent it from getting into other parts of the watershed?

5. Where does your watershed ultimately drain? _____

6. Explain why it might be useful to think of our oceanic planet as one giant watershed.

Part 2: Exploring the Characteristics of our Watershed

Now that you have the lay-of-the-land, you will explore your local watershed using digital data tools. Follow the steps below to investigate the characteristics of your watershed.

Materials:

- Computers with Internet access
- Model My Watershed: https://app.wikiwatershed.org

Procedure & Questions:

1. Go to Model My Watershed and spend a few minutes to familiarize yourself with the buttons and maps. Next, put your school address into the search bar to bring up your location. Change the view to "satellite."

How does the map on Model My Watershed compare to the topographic map? What are the benefits of using both models of your location?

2. Turn the different hydrologic unit code (HUC) layers one at a time starting with USGS Subbasin Unit (HUC-8), followed by USGS Watershed Unit (HUC-10), and then USGS Subwatershed Unit (HUC-12). While each layer is turned on, roll your

curser over the map to discover the names of each area within the layer.

Define" hydrologic unit code" based on what you see, and then describe what happens when you change layers.

Identify your watershed names for the following:

USGS Subbasin Unit (HUC-8): _____

USGS Watershed Unit (HUC-10): _____

USGS Subwatershed Unit (HUC-12): _____

3. Leave the USGS Subwatershed Unit (HUC-12) turned on and zoom out until you can see the entire subwatershed unit that includes your school.

How many subwatersheds are in your town? _____
List them:

4. Select one of the subwatersheds, and click someplace in the middle of the subwatershed unit. This will take you to a new screen that provides detailed land cover, soil, and animal analysis.

What is the area (km^2) of this subwatershed? _____

List the top 5 land covers found in this subwatershed and their percentages:

List the top 2 hydrologic soil groups (A-D) and their percentages:

5. In the upper right corner, click on Model, and select "Site Storm Model" and leave the model at Current Conditions, and set the precipitation to 5 cm. As you manipulate the variables, the output of the model will adjust itself. In the space below, copy the data from the Runoff and Water Quality tables.

Runoff Table:

Water Quality Table:

6. What do you think would happen if you change the land cover of the subwatershed?

Click on the “New Scenario” tab, and change your land cover or select a conservation practice. Once you select an option, you will identify areas in your subwatershed where you want that option. After identifying an area, run the model leaving the precipitation at 5 cm. Use the space below to document the changes in the runoff and water quality. Note that you can click the “Compare” button in the upper right to see how your model-runs compare.

Runoff Table:

Water Quality Table:

Reflection:
What can you use this watershed tool for?

Part 3: Where does the water go in our watershed?
Now that you know the characteristics of your watershed, you will explore how surface water flows throughout it, and the types of land use and land cover surrounding the surface waters that may affect water quality and quantity within your portion of the watershed. Follow the steps below to investigate the streams and tributaries in your watershed.
Materials:

- Computers with Internet access
- USGS StreamStats: https://streamstatsags.cr.usgs.gov/streamstats/
- USGS National Map – Hydrology: https://viewer.nationalmap.gov/viewer/nhd.html?p=nhd

Procedure & Questions:
1. Go to the USGS Stream Stats website at: https://streamstatsags.cr.usgs.gov/streamstats/ and in the "search for a place" box put in your zip code. Next, click on New Jersey in the left menu. You can close the dialogue box with the latitude, longitude, and other georeferencing data.

2. Zoom to Level 15, and click on "delineate" to add a point to the map. Click on a blue point on a stream in your area, and you will see a yellow partitioned area around the stream which is the drainage area for that stream.

3. When the delineation is complete, click "continue" in the left menu. Next, Under "Select Scenario" select "Seasonal Flow Statistics." Click on "Basin Characteristics" and then click on all of the boxes. Finally, click "continue" to build your report, and then "continue" to read your report. To save your file, click on "Download CSV" to save the file to your download folder on your computer.

Use the space below to summarize the characteristics of the drainage are you selected. You will find this information on the report you created.

5. In the upper left corner you will see a small stack  . Click on this stack to reveal more options to use with StreamStats. Click on Basemap, and then change the basemap to "ESRI Imagery." Zoom into your drainage area to begin to quantify the amount of impervious surfaces in that area, the sources of water contaminents, etc….
Explore the use of this data tool, and report your findings below.

6. One last data tool! – Go to USGS National Map – Hydrography at https://viewer.nationalmap.gov/viewer/nhd.html?p=nhd This data tool will provide you with additional information such as the direction of the flow of the streams.

Explore the various layers available and use the space below to describe what this data tool can be used for when studying our watershed.

A.P. Environmental Science **Group members:_____**

Swamped! Project Overview

Project Requirements:

- Note that you **need citations for EVERYTHING**! Your research and work will be used to educate others about your topic and may be posted on the internet and therefore, everything must be supported with factual data from reputable sites.

The following items will be submitted on the dates announced in class. Additional rubrics will be provided.

Part 1: Project Proposal – due _____

- Introduction / project overview
- Plans for research- how/where will you research? what will you research?
- What data will you use? Be sure to provide the "metadata"
- What will be your "product" – factsheet, brochure, pamphlet, video, website, etc?
- How will you present your findings with your ppt presentation?
- How will the research / work be divided amongst group members? Who will do what?

Part 2: Research and Sources – due _____

- Each group must present proof of research which can include any/all of the following:
  - Typed notes taken during research (must include citations)
  - Information printed from websites that were used as resources
- In addition to the above, each group MUST hand in 1 list of sources (exact format will be specified)

Part 3: PowerPoint – due _____

Part 4: Information Handout *(brochure, pamphlet, fact sheet, etc..)* – due _____

Part 5: Presentation – will be given on _____

- 5-6 minutes in length
- Each group member spoke and exhibited a clear understanding of the connection between the content and the project.
- An additional rubric will be provided prior to the presentation
- Presentations will be given to an audience comprised of; your classmates, environmental experts, school administrators and teachers

Flip over→

Project Layout

<u>The following will give you a rough idea as to the layout of your project:</u>

What is the problem? What is the issue?
How does it impact water quality, quantity, or storm water runoff in this area?

- Answers to the above questions should be very specific.

What is the current status of the issue in this town or in your neighborhood or at the school or in NJ?

- Define the current status in your region / town
- Pick scale that is the most appropriate for your problem

What can homeowners or land owners or landscapers do to address this?

- Concrete steps with specific solutions – great
- Vague / general – not great
- More detail is great

What is the solution moving forward? What will happen if we do that?

- What is the result to tie back into the issue?
- How can this benefit water quality?
- What can people do? What will be the benefit if they do "this"?
- Needs to be feasible / needs to be practical solutions to the issue

A.P. Environmental Science **Group members:_____**
Swamped! Project Proposal

Topic:_____

Introduction:
Clearly define what the project will encompass.

Data & Analysis:
What data will you use to support your claims?

What is the metadata? (provide information about your data)

How will you analyze and report your data?

Research:
What will you research? Where will you get your research?

What kinds of sources will you use for your research?

What do you plan to look into related to your project? What are sub-questions related to your topic that you plan to look into?

Everyone will create a powerpoint presentation …but what will be your "tangible product" – factsheet, video, brochure, pamphlet, etc? What do you expect it to look like?
How will you present your findings? – Any creative ideas for your powerpoint presentation?

How will the research / work be divided amongst group members? Who will focus on which sections?

Who	Tasks

Possible Swamped! Project Topics

1. **The REAL water cycle…**Understanding where your water comes from is one thing…but how can we put this delicately…knowing where it goes when you are done using it is kind of important too. You'll help residents understand what actually happens to the wastewater leaving your house. People are concerned about the idea that "used" water leaving their house might end up cycling around again. Help people understand what they need to be careful about dumping down drains, and what is of no great concern. What are the wastewater treatment issues in town and how can homeowners take the load off the waste water treatment system?
   At the end of your project people will understand exactly what the waste plant is removing, why, and what is still in the water that goes back into a local stream**.**

2. **How much is enough?** The grass is always greener on the other lawn…How can homeowners learn more about proper fertilizer application to make sure they don't apply too much? What impacts can too much fertilizer cause in waterways and how, in a practical way, can homeowners learn more and use less? How do you know when it is actually time to apply fertilizer to your lawn or flower beds? Ensure that information is clean and straightforward to understand; otherwise it will be treated like the direction on the back of the fertilizer bag and ignored! Local landscapers know their clients - what are they doing in fertilizer regimes and how could their practices be altered if needed?

3. **Water we all about?** Irrigation around the home uses a lot of water**…**money better used to send you to college! Smart watering practices save money, time and create healthier plants, but HOW? Explain clearly, what is the best way to water a vegetable or flower garden? A lawn? What are some of the potential water saving practices that homeowners could reasonably employ to reduce their water use? Is it better to water little and often a, or rarely and soak 'em? Homeowners need clearly presented ideas on water saving practices in their watering regimes. If they spend a little money what should they buy~ Soaker hose, mulch or a hose timer? There is a wealth of information out there, Help homeowners navigate keeping their plants alive while saving water.

4. **Getting Back to Tap.** Designer bottled waters are all the rage, whether they are $3/bottle water from Fiji, France or Costco. What if you could convince local residents to head back to their taps for all their drinking water instead? What would it take to get residents to give bottled water the heave-ho? Knowing WHY people use bottled water helps us to get at changing behavior…Convenience? Pollution concerns? How does the town deal with bottled water use at sporting and other events, what are the policies in place in the school and town to move away from bottled water? Maybe conduct a taste test of different over or under the tap filters? What is stopping us all from heading back to the taps, and what could be the cumulative impact if we could just convince folks to try…..?

5. **Harvesting Rainwater, solving storm water issues** Any rain that runs off your property after a rain shower becomes storm water runoff and contributes to flooding and downstream water flow. Just imagine if you could convince homeowners to be rain-water hogs, hanging onto the storm water on their property until it has a chance to infiltrate into the ground. What would the impact be? How can a homeowner learn more specifics about managing their rainwater from rooflines and down spouts? Using real world data from houses in town, how much water could rainwater harvesting projects store? What is the multiplier effect of neighborhoods getting involved….By the numbers how many gallons flow over properties in town during a typical summer thunderstorm?

6. **What lives under your sink?** What kinds of products do we end up washing down the drains of our homes every day? What ingredients are in the products we store under the sink or on the basement shelf…and what impact can they have in the water supply? Homeowners are confused about what chemicals they need to worry about and which are safe, help homeowners to really understand which cleaning and household cleaner components have big

impacts on water quality and which are harmless. Clear, concise information to let homeowners know red light or green light products would help them to make smarter purchasing decisions in the first place.

7. **Scoop the Poop**. Sure we all know we are supposed to pick up dog poop, but how many of us are religious about it every walk with Fido? What about in our yards? What is the real issue of pet waste in town, and how many dogs are we really talking about anyway in town?…Here is a good opportunity to craft an effective campaign based on your towns bad habits to make a difference and have your neighbors scooping the poop!

8. **Going, Going Gone.** Since hurricane Sandy, there have been a lot of changes in the tree scape around town. How many trees have been lost? But how are the shade trees planted around our properties part of being watershed friendly? What watershed benefits do shade trees provide in storm water management, shading and cooling of houses, and what other ecosystem services might they provide? What are the impacts of the trees lost in the recent storms and what should we be replacing these trees with?

9. **Why Becoming Disconnected is a good thing?** Make the case for rain barrels! Downspouts are engineered to carry water away from your roofline and down the driveway to storm drains as fast as possible. But what if instead you took that downspout and disconnected it from the storm drains? How much water could a homeowner REALLY harvest in a typical rainstorm and what could they do with it? Lay out some simple steps that homeowners could undertake to become rain water savers…What are the rain barrel options and where can they be obtained?

10. **Yawning on the Lawn…**Lawns are often as impervious to runoff as black top or patios, especially if they are compacted. Reducing lawn area and replacing it with more permeable surfaces helps the environment, but are homeowners willing to take this step? Do they understand why they should? Using money, time or altruism as your hook, try and convince homeowners what they could save if they reduced their lawns in inventive ways. What are some of the replacements for lawn that would help infiltrate water to the ground?

11. **Watershed Friendly Wildlife.** Being watershed friendly is about reducing water use, and improving water quality for people. But try and explain why some of the watershed friendly practices can benefit wildlife too. What specifics can homeowners do to attract birds, butterflies and more to their homes? Environmentally sensitive landscaping is one thing for sure, but what else can homeowners do to be good to creatures?

12. **Giving it the Treatment**. Help homeowners with public water supply understand how water gets from the river or well to their tap. What happens to it along the way to clean it? How can they understand the paperwork sent along with their water bills that explain how municipal water is tested? What about if they have a well? Who tests wells, what should you be worried about getting your water tested for, and what can we do with the results?

13. **Swamped!** – Create clear, concise information that homeowners can use to evaluate storm water runoff from their properties. Make sure that anything you say is supportable, can be backed up by science and is understandable by people with and without a science background. Be sure to identify the ecological services provided by swamps and wetlands, and how humans have been impacting these services. Your final product, which should be in a form that can be shared with community members, is your choice, although it needs to be approved before you start your project.

A.P. Environmental Science **Group members:_____**

Swamped! Research & Citations Documentation

Directions: Documentation of your research and sources are **due _____**. Please complete and hand in the following form.

1) **Place your list of "formal" (MLA or APA) citations on a Google Doc in your project folder, and share your project folder with me.**

2) **Briefly summarize what your group has learned through the research you completed this week.**

3) **Did you gather research from other places or people other than literature listed in your list of citations? If so, list and describe the outcomes below.**

4) **Did you e-mail anyone to find out information? If so, who?**

5) **Briefly outline your plan to complete your project using the research and data you've acquired.**

6) **Is there anything you still need to research and/or find out? If so, what?**

A.P. Environmental Science **Group members:_____**
Swamped! Topic Preference

#1 Choice: _____
→Briefly explain *(approximately 1 paragraph – no bullets or sentence fragment*s) **what drew you to this topic/ why you are interested in this topic.**

→Briefly explain ideas that you have for this topic.

→Briefly explain what you hope to learn if given this topic to research.

#2 Choice:_____

#3 Choice:_____

Swamped!
Informational Handout Planning

Topic: _____ **Group Members:** _____

Before beginning to design your brochure or pamphlet, answer the following questions:

1. Is your brochure/pamphlet going to be more educational in nature or action specific? Explain.

2. Take a moment to envision who you plan to distribute this handout to and how you will distribute it to them. *For example, will it be put out at school for teachers and students to take? The local library? Mailed to homeowners? Mailed to lawncare companies?* **This is a very important question as it should drive the design of your informational handout.**

3. How is this going to be used? Is the homeowner going to take this with them when they are shopping? Are they going to use it to influence others?

4. From the research, what do you want to convey to the reader? – (Make sure your information is - simple, clean, effective.)

5. How will the information be laid out? Bullet points, paragraph, visual, chart? Explain.

6. Have you considered the quantity of the information that you can appropriately fit in the brochure/pamphlet? Explain.

7. Which program are you going to use to create your product?

8. Before your proceed any further, call your teacher over to discuss the above questions with your group. Once given the OK by your teacher, sketch out and plan your informational handout on one of the attached templates.

Brochure Template:

Pamphlet Template:

Swamped! - Informational Handout Rubric

Topic: _____ **Group Members:** _____

Criteria	3 – Excellent	2 – Very Good	1 – Fair
Appropriate Layout of Information (i.e. bullet points, paragraph, diagrams, graphs, etc..)	Information is clearly displayed in a logical and compelling format/order. A variety of presentation methods (i.e. bullets, chart, table, diagram) are used.	Information is displayed in a logical format/order. A few different presentation methods (i.e. bullets, chart, table, diagram) are used.	Information is not displayed in a logical format/order. Less than 2 different presentation methods (i.e. bullets, chart, table, diagram) are used.
Clarity of Information	The reader knows **exactly** what to do/purchase or behavioral changes to make after reading the brochure/pamphlet.	The reader somewhat knows what to do/purchase or behavioral changes to make after reading the brochure/pamphlet.	It is unclear as to what the reader should do/purchase or what behavioral changes to make after reading the brochure/pamphlet.
Quality of Information	The information is pitched at the **BEST** level for the homeowner audience.	The information is pitched at an appropriate level for the homeowner audience.	The level of the information is inappropriate for the homeowner audience (i.e. too technical).
Quantity of Information	The amount of information is **appropriate** - there is not too much (text heavy) or too little information.	The amount of information is somewhat appropriate- there a little too much (text heavy) or too little information.	The amount of information is not appropriate- there is too much (text heavy) or too little information.
Incorporation of Survey Results	The survey information is clearly and appropriately included in the handout AND it makes a point.	The survey information is included in the handout and/or it makes a point.	The survey information is not included or it is unclear.
Citation of Sources (footnote? – need to show where info. came from)	Citations are appropriate and they are included in an appropriate manner.	Citations are included, however they may not be appropriate or the manner they are included in is not appropriate.	Citations are not present.
Links for more Information	Several (2-5) appropriate links are included that homeowners can go to for more information.	Too few (less than 2) or too many (more than 5) links are included that homeowners can go to for more information.	There is no section for "more information" with links to go to.
Aesthetic Appeal	All of the following are chosen well and draw the eye to the information: - Font size, font choice, color choices, flow of information, visuals, layout	Most of the following are appropriate and draw the eye to the information: - Font size, font choice, color choices, flow of information, visuals, layout	Less than half of the following are appropriate: - Font size, font choice, color choices, flow of information, visuals, layout
"Wow" Factor	The brochure/pamphlet "catches the eye". It is unique, creative, and makes someone want to pick it up and look at it.	The brochure/pamphlet looks great!	The brochure/pamphlet is not visually engaging.

Swamped! – Presentation Rubric (100 pts)

Name: _____ **Topic:**_____ **Score:** _____

		Excellent (10-9pts)	Very Good (8pts)	Good (7-6pts)	Poor (< 6pts)	Points
		Public Speaking at this level includes	*Public Speaking at this level includes*	*Public Speaking at this level includes*	*Public Speaking at this level includes*	
DELIVERY of the Presentation	**EYE CONTACT** *Develop rapport with the audience through eye contact*	• *Exceptional* eye contact with the entire audience, seldom returning to notecards.	• *Effective* eye contact with the audience - but some distracting use of notecards and/or visual aid.	• *Some* eye contact with the audience, frequently returning to the distracting use of notecards and/or visual aid.	• *Little or no eye* contact with the audience.	
	ELOCUTION *Articulate voice clearly and confidently*	• *Exceptionally* clear, correct, and precise pronunciation of all words and phrases.	• Clear, correct, and precise pronunciation of *most* words and phrases.	• Clear, correct, and precise pronunciation of *some* words and phrases.	• *Unclear, incorrect, and/or imprecise* pronunciation of words and phrases.	
	POSTURE and GESTURES *Use body language to enhance presentation*	• *Exceptional* posture: Standing straight with both feet on the ground, and/or • *Exceptional* gestures: hand gestures *enhance* audience's understanding.	• *Effective* posture: Standing straight with both feet on the ground, with some rocking back and forth; and/or • *Effective* gestures: hand gestures *assist* audience's understanding.	• *Somewhat effective* posture: Some standing straight, but with rocking back and forth and slumping; and/or • *Somewhat effective* gestures: hand gestures *sometimes assist* audience's understanding.	• *Ineffective* posture: Sits or slumps during entire presentation; and/or • *Ineffective* gestures: few or no hand gestures that assist audience's understanding.	
	ENTHUSIASM *Convey emotion during the presentation*	• *Exceptionally* strong and positive attitude about topic during the entire presentation.	• *Pleasant* attitude about topic during much of the presentation.	• *Engaged* attitude about topic during the some of the presentation.	• *Disengaged* attitude about topic during the most of the presentation.	
	ATTIRE	• Attire is *exceptional* – clean, neat, simple (not distractive), professional	• Attire is very appropriate – clean and neat.	• Attire is appropriate but not necessarily professional.	• Attire is not appropriate.	
	INTERACTION with the AUDIENCE and the QUESTION/ANSWER SESSION	• *Exceptional* encouragement of audience interaction; and • *Exceptional* knowledge of the topic displayed while responding confidently, precisely, and appropriately to all audience questions.	• *Effective* encouragement of audience interaction; and • *Effective* knowledge of the topic displayed while responding directly and appropriately to all audience questions.	• *Somewhat effective* encouragement of audience interaction; and • *Somewhat effective* knowledge of the topic displayed while responding directly and appropriately to all audience questions.	• *Insufficient* encouragement of audience interaction; and • *Insufficient* knowledge of the topic displayed while responding directly and appropriately to all audience questions.	
	PREPARATION for PRESENTATION *Evidence of planning and practice*	• The presentation was the perfect amount of time (each group member spoke for 2 minutes) and each group member had several index cards.	• The presentation was the appropriate amount of time and group members had index cards.	• The presentation was the appropriate amount of time or each group member had several index cards.	• The presentation was too long or too short and index cards were not used.	
POWERPOINT used for the Presentation	**LAYOUT** *Enrich and captivate the audience's understanding through the visual aid*	• An *exceptional* visual theme — colors, designs, and proportions; • An *exceptional* use of headings, subheadings, and text to create a consistent overall idea; and • An *appropriate* text length.	• An *effective* visual theme — colors, designs, and proportions; • An *effective* use of headings, subheadings, and text to create a consistent overall idea; and • A *mostly appropriate* text length.	• A *somewhat effective* visual theme — colors, designs, and proportions; • A *somewhat effective* use of headings, subheadings, and text to create a consistent overall idea; & • *At times, inappropriate* text length.	• An *ineffective* visual theme — colors, designs, and proportions; • An *ineffective* use of headings, subheadings, and text to create a consistent overall idea; and • An *inappropriate* text length.	
	ORGANIZATION *Introduction, body, conclusion*	• *Exceptional* organization of the presentation – the presentation has a clear introduction, a clear body, and a clear conclusion.	• *Effective* organization of the presentation – the presentation has an introduction, body, and conclusion.	• *Good* organization of the presentation – the presentation has a clear introduction, or body, or conclusion.	• *Ineffective* organization of the presentation. There is no clear introduction, body, or conclusion.	
	GRAPHICS, FONT, and/or ANIMATION/VIDEO *Effectively integrate multimedia into the visual aid*	• *Exceptional* use of graphics, sound, and/or animation/video to create a consistent overall idea; and • *Exceptional* sizing and resolution.	• *Effective* use of graphics, sound, and/or animation/video to create a consistent overall idea; and • *Effective* sizing and resolution.	• *Somewhat effective* use of graphics, sound, and/or animation/video to create a consistent overall idea; and • *Somewhat effective* sizing and resolution.	• *Ineffective* use of graphics, sound, and/or animation/video to create a consistent overall idea; and • *Ineffective* sizing and resolution.	

Swamped!

Final Project Presentations Scoring Rubric

Title of Project:	Date:

Scoring parameter	Points awarded (10 max each category)	Comments
How well did the group capture the essence of the project?		
Quality of the presentation/supporting materials, or presentation itself?		
How compelling and engaging was the presentation to listen to and follow as an audience member?		
How usable are the materials/video/presentation to educate others?		
Based on today's presentation, how likely would an environmental company be to offer the group an internship to work on Environmental science projects?		
	Total points /50	

Feedback on the presentation for the group, constructive comments and advice:

For more information about this lesson sequence, contact Missy Holzer, mholzer@monmouth.com