2013

Planning for a Rainy Day: A Lesson Study Model Eliciting Activity Toolkit

Amanda M. Tazaz, Lance King, Melissa Dyehouse, Robert Schoen, Rachel Wilson, Steve Blumsack and Carmen Green

Lesson Study MEA Toolkit

Planning for a Rainy Day

Photo Credit: C. Brough, 2012, Retrieved on 1/2/13 from: http://www.sxc.hu/photo/1401220

Helios Education Foundation

FCR STEM

CPALMS

This MEA and resource toolkit was written in 2013 by Lance King, Amanda Tazaz, Rachel Wilson, Steve Blumsack, Robert Schoen, Melissa Dyehouse, and Carmen Green. The writing of this MEA was funded in part through a grant from the Helios Education Foundation to the Florida Center for Research in Science, Technology, Engineering, and Mathematics (FCR-STEM).

Suggested Citation:

Tazaz, A., King, L., Dyehouse, M., Schoen, R., Wilson, R., Blumsack, S., & Green, C. (2013). Planning for a Rainy Day: A Lesson Study Model Eliciting Activity Toolkit. Tallahassee, FL: Learning Systems Institute, Florida State University.

Table of Contents

Description of the Toolkit

This toolkit supports the development of an integrated STEM instructional unit on stormwater management that aligns with Florida's Common Core State Standards (CCSS) for seventh-grade mathematics, and English language arts, as well as NGSSSs for seventh-grade science. The elements of this toolkit were assembled based upon their suitability for constructing a 3-5 day unit that focuses upon a Model Eliciting Activity (MEA) on stormwater runoff mitigation. The toolkit is organized into three main sections.

Section 1 contains assessment items gleaned from the National Assessment of Educational Progress (NAEP) and Trends in International Mathematics and Science Study (TIMSS) that probe student understanding and knowledge pertaining to the water cycle and water quality.

Section 2 contains each element of the "Planning for a Rainy Day" MEA, complete with questions and prompts that are designed to guide lesson study teams through the process of designing a unit of instruction around it.

Section 3 contains links to ancillary resources, including informational text, videos, and activities that address concepts that are relevant to the MEA on stormwater management.

Your task as a lesson study team, is to analyze the materials that are included in this toolkit and evaluate how they can be incorporated in a unit plan that complies with the Next Generation Sunshine State Standards for science and Common-Core State Standards for English language arts and mathematics that are indicated in Table 1. Ultimately, your team will design a three to five day unit that incorporates the MEA. As you study these resources it is important to make note of any deficiencies or gaps that will need to be addressed and make modifications in the lesson resources and activities where needed. As you study these materials, be sure to respond to the prompts that are indicated by the pointing finger icon  .

This MEA toolkit is also designed to support the incorporation of close reading strategies for informational text that is included in the MEA. A table containing the essential steps of the Comprehensive Instructional Sequence is included in Appendix D.

The resources selected for this toolkit align with the standards in the Common Core State Standards (CCSS) for Mathematics and English Language Arts, and the Next Generation Sunshine State Standards (NGSSS) for Science that are indicated in Table 1.

Table 1. Relevant State Standards

NGSSS SC.7.E.6.6	Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.
LACC.7.RI.1.1	Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
LACC.7.RI.1.2	Determine two or more central ideas in a text and analyze their development over the course of the text; provide an objective summary of the text.
LACC.7.RI.1.3	Analyze the interactions between individuals, events, and ideas in a text (e.g., how ideas influence individuals or events, or how individuals influence ideas or events).
LACC.7.RI.2.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of a specific word choice on meaning and tone.
LACC.7.SL.1.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. b. Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed. c. Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed. d. Acknowledge new information expressed by others and, when warranted, modify their own views.

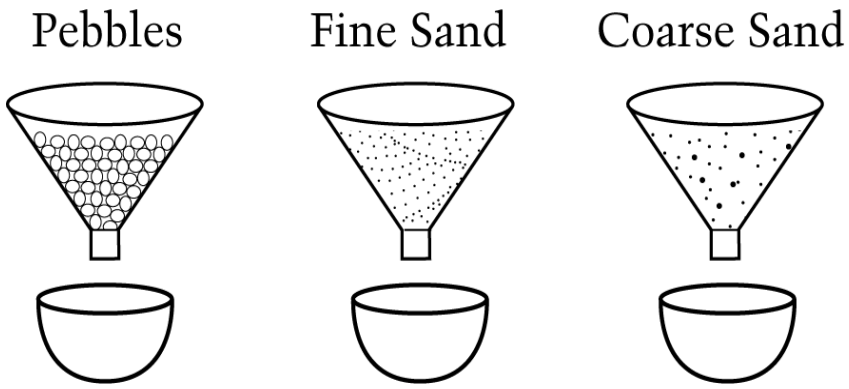
LACC.7.SL.1.2	Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.
LACC.7.SL.2.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
LACC.7.W.4.10	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
MACC.7.EE.2.4	Use variables to represent quantities in real-world problems and construct equations.
MACC.7.G.1.1	Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
MACC.7.G.2.6	Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.
MACC.K12.MP.1.1	Make sense of problems and persevere in solving them.
MACC.K12.MP.2.1	Reason abstractly and quantitatively.
MACC.K12.MP.3.1	Construct viable arguments and critique the reasoning of others.
MACC.K12.MP.4.1	Model with mathematics.

Section 1. Exploring Assessment Items

The assessment items in this section were released by the National Assessment of Educational Progress (NAEP). Analyze and respond to them individually before discussing them as a team. For each item, identify the knowledge that is being assessed and answer the following questions:

- How did you respond to the item and how might students respond to it?
- What insights or prerequisite knowledge will students need to answer the item satisfactorily?
- What preconceptions or misconceptions might students have related to this item?
- What do you think students will find difficult about this item and why do you think this is so?
- At what point in your instructional unit would you implement this assessment item, if at all? Justify your response.

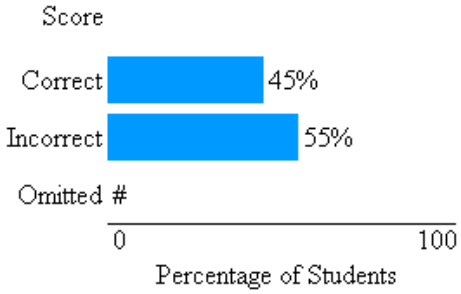
1. Three funnels were filled with equal volumes of pebbles, fine sand, and coarse sand, as shown in the diagram below. The same amount of water was poured into each funnel.



Which correctly lists the order in which the water passed through the funnels, from fastest to slowest?

A. Pebbles, fine sand, coarse sand
B. Pebbles, coarse sand, fine sand
C. Fine sand, coarse sand, pebbles
D. Coarse sand, pebbles, fine sand

NAEP national performance results in Science at grade 8: 2009
Order soils in terms of permeability



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

Questions 2-4 refer to the following information.

Most soils are a mixture of particles of different sizes. Water moves through soil at different rates, depending largely on how much of each size particle makes up the soil. The table below shows the percentage of each size particle in five different soils (A, B, C, D, E) and the rate at which water moves through each of the soils.

RATE OF WATER MOVING THROUGH DIFFERENT SOILS

Soil	Percentage Largest Particles (%)	Percentage Medium-Sized Particles (%)	Percentage Smallest Particles (%)	Rate of Water Draining Through Soil (cm/hr)
A	100	0	0	21
B	85	10	5	6.1
C	40	40	20	1.3
D	20	65	15	0.69
E	0	0	100	0.05

2. Describe the relationship between the size of the soil particles and the rate at which water moves through the soil. Use the data in the table to support your answer.

.....

.....

.....

.....

.....

3. Explain why the size of the soil particles affects the rate at which water passes through the soil.

.....

.....

.....

.....

4. The data for soil D was collected from an unused grassy field. This field later became a field for playing sports. After one year, players noticed that after heavy rain, water was puddling on the field and draining more slowly down through the soil.

What most likely happened to the soil to make the water drain more slowly?

.....

.....

.....

.....

.....

Explain why this change would result in slower drainage.

.....

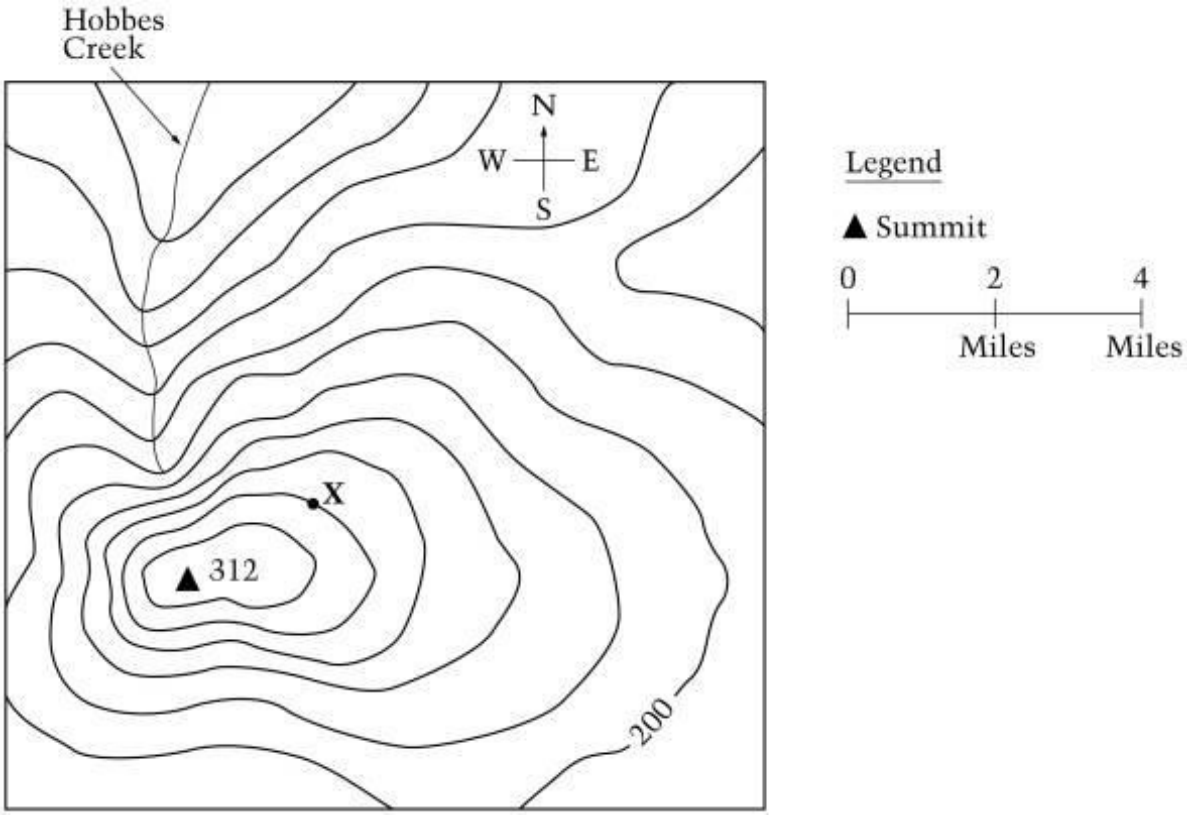
.....

.....

.....

.....

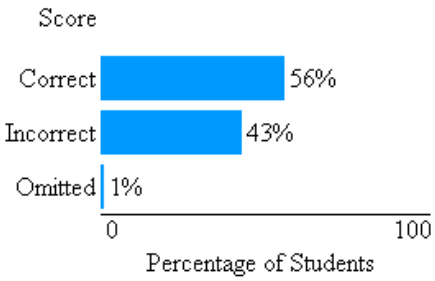
<u>Questions 5-6</u> refer to the topographic map below, which shows Willow Hill (elevation 312 feet) and Hobbes Creek. On the map, each contour line represents 20 feet of elevation.



5. What is the elevation at point X?

A. 240 feet
B. 250 feet
C. 280 feet
D. 300 feet

NAEP national performance results in Science at grade 8: 2000

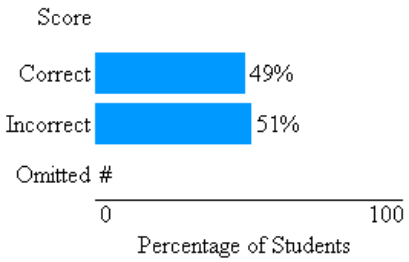


NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2000 Science Assessment.

6. In which general direction does Hobbes Creek flow?

A. To the north
B. To the east
C. To the south
D. To the west

NAEP national performance results in Science at grade 8: 2000

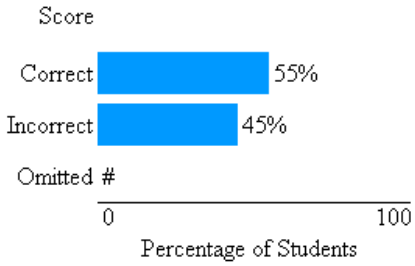


NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2000 Science Assessment.

7. Which side of Willow Hill has the most gradual slope?

A. North side
B. East side
C. South side
D. West side

NAEP national performance results in Science at grade 8: 2000



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2000 Science Assessment.

This item is from the 2007 TIMSS.

8. Describe one way that groundwater can become polluted.

.....

.....

.....

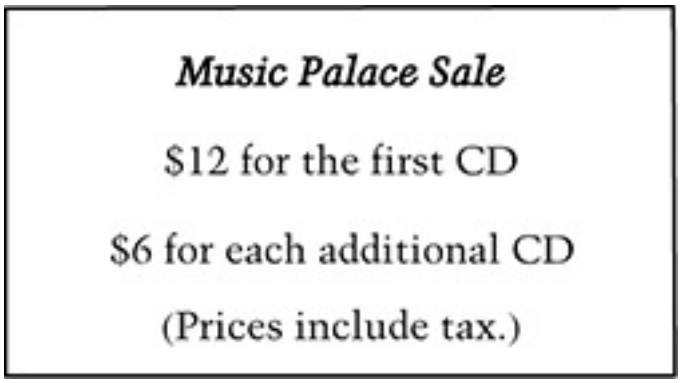
.....

.....

.....

The following mathematics items were released from the 2011 NAEP.

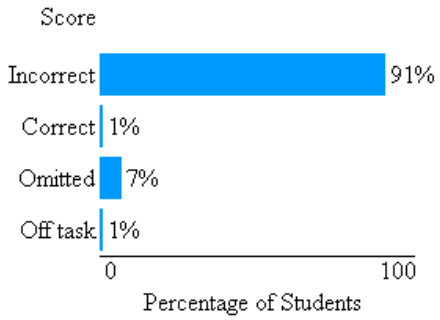
The Music Palace is having a sale.



9. Write an expression that shows how to calculate the cost of buying *n* CD's at the sale.

Answer: _____

NAEP national performance results in Mathematics at grade 8: 2011



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. Off task applies to responses that do not address the question presented, are illegible, or cannot otherwise be scored.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2011 Mathematics Assessment.

10. In order to prepare a piece of ground for building a brick patio, a rectangle measuring 8 feet by 10 feet must be marked off. Then the dirt within the rectangle must be dug out to a depth of 6 inches. Finally, the resulting space must be filled with sand.

(a) What is the volume of sand needed, in cubic feet, to fill the space?

Answer: _____ cubic feet

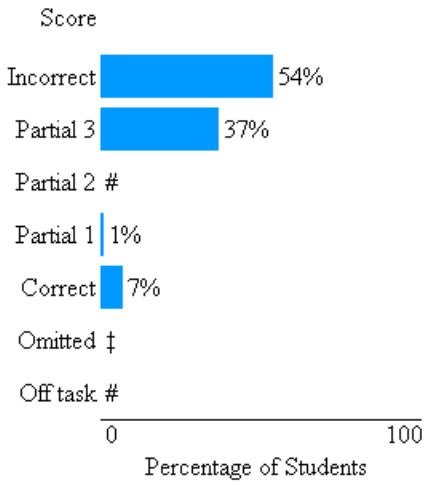
Show your work. If you used your calculator, show the numbers and operations that you used to get your answer.

(b) Sand costs $4 per cubic foot. What is the total cost of the sand needed to fill this space, including a $35 delivery charge?

Answer: $_____

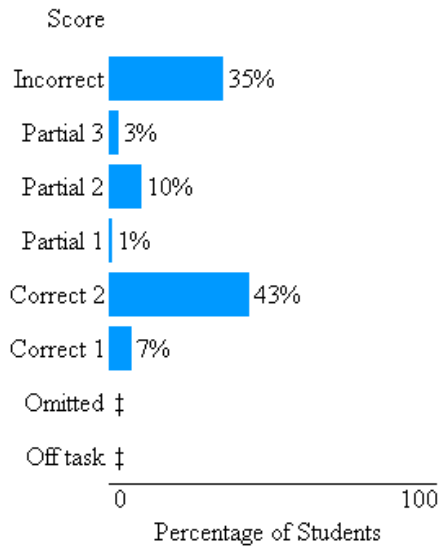
Show your work. If you used your calculator, show the numbers and operations that you used to get your answer.

NAEP national performance results in Mathematics at grade 8: 2011
Solve multi-step problem involving volume (calculator available) (Part A)



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. Off task applies to responses that do not address the question presented, are illegible, or cannot otherwise be scored.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2011 Mathematics Assessment.

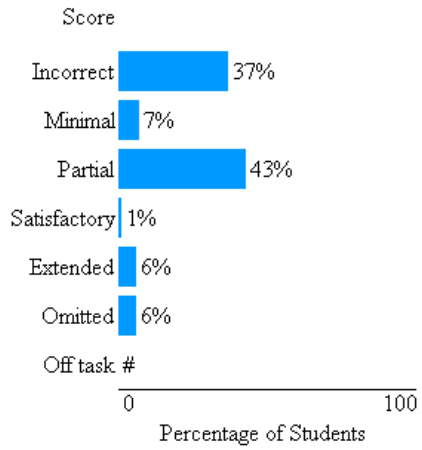
NAEP national performance results in Mathematics at grade 8: 2011
Solve multi-step problem involving volume (calculator available) (Part B)



‡ Reporting standards not met.

NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. Off task applies to responses that do not address the question presented, are illegible, or cannot otherwise be scored.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2011 Mathematics Assessment.

NAEP national performance results in Mathematics at grade 8: 2011
Solve multi-step problem involving volume (calculator available) (Composite)



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. Off task applies to responses that do not address the question presented, are illegible, or cannot otherwise be scored.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2011 Mathematics Assessment.

11. The Morrisons are going to build a new one-story house. The floor of the house will be rectangular with a length of 30 feet and a width of 20 feet.

    The house will have a living room, a kitchen, two bedrooms, and a bathroom. In part (a) below create a floor plan that shows these five rooms by dividing the rectangle into rooms.

    Your floor plan should meet the following conditions.

    - Each one of the five rooms must share at least one side with the rectangle in part (a); that is, each room must have at least one outside wall.
    - The floor area of the bathroom should be 50 square feet.
    - Each of the other four rooms (not the bathroom) should have a length of at least 10 feet and a width of at least 10 feet.

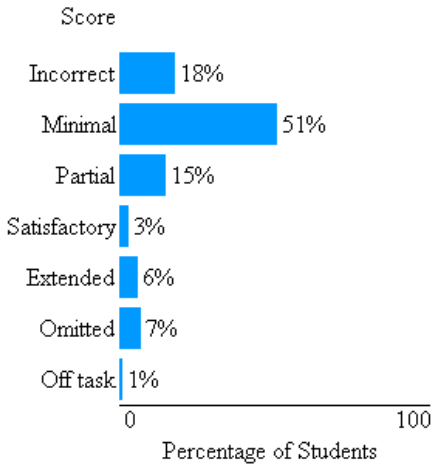
Be sure to label each room by name (living room, kitchen, bedroom, etc.) and include its length and width, in feet. (Do not draw any hallways on your floor plan.)

(a) Draw your floor plan on the figure below. Remember to label your rooms by name and include the length and width, in feet, for each room.

(b) Complete the table below by filling in the floor area, in square feet, for each room in your floor plan.

Room	Floor Area (in square feet)
Living	
Kitchen	
Bedroom	
Bedroom	
Bathroom	
Total Floor Area	600

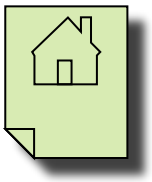
NAEP national performance results in Mathematics at grade 8: 2009
Draw floor plan given conditions and compute areas



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. Off task applies to responses that do not address the question presented, are illegible, or cannot otherwise be scored.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Mathematics Assessment.

Section 2. Exploring the Model Eliciting Activity (MEA): Planning for a Rainy Day

Reading Passage 1



REQUEST FOR PROPOSALS
Rainy School District

The school board of Rainy, Florida is seeking cost-effective, environmentally friendly proposals for designing the storm water management plan for a new middle school. A tract of land has been selected as the proposed site. The total construction budget for the project is $29,000,000, although sufficient bids that come in under this amount will receive first preference.

In an effort to control flooding and remove pollutants from stormwater runoff, the school board requires that each proposal include plans for a stormwater pond as well as one or more of the Best Management Practices (BMPs) recommended by the local water management district.

Fact sheets on five of these BMPs are attached for your review.

All proposals should include the following:

- A stormwater management plan that includes details of a stormwater pond in addition to a description of which BMP(s) should be built at the site.
- A stormwater management site plan that includes a complete visual display of the proposed site.
- A budget that includes total construction costs, along with a general equation that can be used to calculate total construction costs if modifications are requested. Also include an equation showing how you computed the maintenance costs for the BMP(s) for the next 20 years as well as the final total maintenance costs for each BMP used. These maintenance costs do not have to be included in the construction budget of $29,000,000. (A calculation table is included in the attached proposal template.)
- A justification of why your plan is environmentally responsible and cost-effective. It is possible that your proposal may serve as a model for future school sites, so it should also provide a step-by-step explanation of the procedure you used to determine what to build and an explanation of your decisions.

Additional data, information, and instructions are included in the following pages and attachments. The Fact Sheets provide additional important information that might be helpful in your planning.

Thank you and we look forward to seeing your proposal.

Sincerely,

The School Board of Rainy, Florida

Lesson Study Reflection

Read Rainy School District's request for proposals (RFP) and respond to the comprehension questions individually, before discussing the RFP as a team. While reading the RFP, be sure to record notes about how you think your students will respond to this document.

Next, as a team, go back through the RFP and follow the Comprehensive Instructional Sequence (CIS) steps outlined in Appendix D. More detail about CIS techniques can be found here (http://www2.nefec.org/reading/page-377/).

- What did you team come up with when going through the CIS steps (e.g., hook question, essential vocabulary)?
- How would you integrate the CIS into this lesson?

As a team, address the following comprehension questions related to the tasks outlined in Rainy School Board's RFP:

Comprehension Questions

- How do you think students would react to this RFP?
- What are some issues that students might have in understanding the RFP?
- How do you think students' background or prior knowledge might help them to better understand it?
- Thinking of the issues discussed in your group, how might you help to resolve some of these issues for your students?
- What other discussion and comprehension questions might help you to understand whether your students understand the tasks called for in the RFP?

Modeling component

Model-eliciting activities (MEAs) are problem-based activities for which students can utilize problem-solving, communication, teamwork, mathematical modeling, and content knowledge to solve a realistic problem. This lesson will allow students to work in teams to develop a model, or procedure, to select the best options for mitigating stormwater runoff for the proposed middle school.

MEA Questions

You have been asked to solve a problem.

- What do you need to create a solution to the problem?
- Who will use your solution?
- What things need to be included in your solution?
- What might be difficult about solving this problem?

Create Initial Solution

Using the data set in Tables 2-4 and proposal template 1, work in your team to draft a proposal to Rainy School Board.

Table 2 – Building Construction Data

ITEM	AREA, SQUARE FEET (IMPERVIOUS AREA)	COST PER SQUARE FOOT
Building:	150,000 ft^2	$130 (Costs based on single story building. Two story buildings cost an additional $10 per sq. ft.)
Parking Lot:	48,000 ft^2	$75 (includes driveways needed to connect parking areas and roads)

- Determine the total cost of the building and the total cost of the parking lot and add these two quantities together to calculate the net construction costs.

Table 3 – Stormwater Pond Data

Treatment Volume:	The pond must capture 1-1/4 inches of runoff from the impervious areas (including the building and the parking lot) to provide the required pollutant removal.
Flood Control Volume:	In addition to the treatment volume, the pond must capture 75% of the rain that falls on the impervious areas during a 25-year, 24-hour storm. Rainfall data has been obtained from the Florida Dept. of Transportation and is attached for your use.
Pond Cost Data:	The construction cost of the pond is $5 per cubic foot.

- Use the attached precipitation depth data map (Appendix B) to determine the total rainfall for a storm that lasts 24 hours and occurs once every 25-years (the 25-year, 24-hour storm). Assume this school will be built where you live.

- Use the information in Table 3 to determine both the treatment and flood control volumes required for the detention pond and add these together to determine the total treatment pond volume that is required for this site.

- Using the Stormwater Pond Data, determine the construction cost of the stormwater pond.

Table 4 – BMP Data

BMP:	Green Roof System	Rainwater Harvesting System	Pervious Pavements	Parking Lot Swales (Dry Retention)	Vegetated Buffers
*Construction cost per square foot :	$20 per ft^2 of building	$18 per ft^2 of building	$15 per ft^2 of parking	$12 per ft^2 of parking**	$250,000 per acre (3 acres required)

*Annual maintenance costs are 5% of initial construction costs.
** The cost for parking lot swales is based on the original area of 48,000 ft^2 and includes the extra length of driveway needed for this option.

Additional Instructions:

- Use the attached site plan to lay out your site (Appendix C). The site plan shows the locations of large live oaks and other large trees. It also has topographic contours which show the land slope. Remember, stormwater runoff always runs perpendicular to the topographic contours.

- Cut out the building and parking lots and lay them out on the site plan, along with your BMPs. You can cut the building and parking lots on the dotted lines to form them into different shapes. Your team must decide the layout. Questions to consider:
    - What will be the layout for the school building? Will it be one large building or will it consist of separate buildings connected by walkways? Will any trees need to be removed to accommodate your plan?

    - Don't forget to put the stormwater pond on your site as well. What is the best location for the pond?

- Select your BMP(s) from the attached Fact Sheets (Appendix A). Include the reasons for your selections in your proposal using the Template on the following page.

- Determine the annual maintenance cost of your BMP(s)? The maintenance cost for 20 years? Include this cost in your proposal.

Extra Credit:

Look up the location of your school using the online Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Is it a sand, sandy loam, sandy clay loam, or other type of soil? Is this soil normally wet or dry? Is it good for farming or other uses? Is it suitable for septic tank systems?

Lesson Study Reflection

Step 1: In your lesson study team, read the initial RFP letter and think about your responses to the Comprehension and MEA questions. Then in your team, discuss your reflections and answer the following questions:

- Do you feel ready to create your solution?
- What questions do you have?
- What else do you want your students to know at this point?
- How is this different from other problems your students have solved?

Step 2: As a team, work through the Planning for a Rainy Day MEA. Reflect on how you worked through the problem and think about how your students might approach it and where they might encounter difficulties.

Next, in your team, discuss the following questions:

- How did you solve this problem and how might students solve this problem?
- Was it difficult to write an equation for the total cost of the school?
- How did you organize the data?
- What are some issues that students might have in understanding the problem?
- Thinking of the issues discussed in your group, how might you help to resolve some of these issues for your students?

Proposal Template 1

Dear _____,

Our Team, _____, has selected the following BMP(s) for your project:

_____

_____

_____

Please refer to our site plan, attached. Reasons for our selection are:

_____

_____

_____

_____

_____

Cost of Project:

Building Cost (including Parking)	$
Stormwater Pond Cost	$
BMP(s) Cost	$
Total Cost	**$**

BMP(s) 20-year maintenance cost: $_____

Sincerely,

_____

Lesson Study Reflection

Following your team's discussion, trade your MEA responses/procedures with another lesson study team. Read the other team's procedure and individually note your answers to the following questions:

- Is the procedure clear?
- What steps are ambiguous?
- How can you help the other team improve their procedure?

Then, as a team discuss the following questions:

- How can you facilitate peer editing in your classroom?
- What other lessons can be brought into MEAs by encouraging peer editing?
- What strategies could you use to improve students' solutions?

Reading Passage 2

REQUEST FOR PROPOSALS
Rainy, Florida School District

Dear Team,

Thank you very much for your proposed plan. However, shortly after we received your proposal, our school board was made aware of a wetland that lies down slope from the school. It is a sensitive environmental habitat that is used for feeding and nesting by an endangered species of bird, the Florida Sandhill Crane (*Grus canadensis pratensis*). Disruption of the normal wetlands could adversely affect survival of this species as well as other types of wildlife in the area.

The Rainy Water Management District has determined that 85% removal of nitrogen from the school's stormwater runoff is needed to protect the wetlands. The stormwater pond removes 45% of the nitrogen. Graduate students from Rainy University tested the BMPs and determined that they will remove the following percentages of total nitrogen from the runoff:

BMP:	Green Roof System	Rainwater Harvesting System	Pervious Pavements	Parking Lot Swales (Dry Retention)	Vegetated Buffers
Percent removal of Total Nitrogen from stormwater runoff:	40%	45%	20%	22%	25%

Unfortunately, we still only have $29,000,000 total budget and would like the proposal to remain as cost-effective as possible.

Please determine if your procedure still works taking this new information into account. Write us a revised proposal saying whether your procedure for selecting your BMP(s) changed or not; if so, describe and explain these changes. Make sure that your proposal still includes a step-by-step explanation of the process you used to determine what to build and an explanation of your decisions. We look forward to seeing your updated proposal.

Sincerely,

The School Board of Rainy, Florida

Proposal Template 2

Dear _____,

Our Team, _____, has selected the following BMP(s) for your project:

_____

_____

_____

We did / did not make the following changes to our procedure for selecting the best management practices. Our changes are:

_____

_____

_____

_____

_____

We think you should select our system because:

_____

_____

_____

_____

_____

_____

Sincerely,

_____

Lesson Study Reflection

In your team, determine if your proposal still works with the new requirements for nitrogen removal. If the site plan works, determine if it can be improved upon. If it does not work, determine if it needs to be tweaked or if additional steps need to be added.

Make the changes that your team finds necessary and draft a response to Rainy School Board either justifying your previous site plan or modifying it.

Then, discuss the following questions with your team:

- What questions do you have?
- What questions can you ask your students to deepen their learning?
- What do you think your students can learn from doing this MEA?
- How can MEAs in general, be effective in improving STEM education for your students?
- What can you learn about your students from doing MEAs in your classroom?

Section 3: Informational Texts, Videos, and Additional Lesson Resources

Stormwater Matters Video

The video *What is stormwater and why is it important?* provides an overview of stormwater's effect on our environment. Most of the region's water falls from the sky and eventually ends up in Puget Sound. But the route stormwater takes and the pollutants it comes into contact with along the way tells us a lot. It helps explain the whys of the health of our rivers, lakes and the Sound and the need to monitor and protect our natural resources.

http://www.kingcounty.gov/environment/waterandland/stormwater/videos/what-is-stormwater.aspx

Reduce Runoff: Slow It Down, Spread It Out, Soak It In

The U.S. Environmental Protection Agency and the U.S. Botanic Garden produced this 9-minute on-line video, "Reduce Runoff: Slow It Down, Spread It Out, Soak It In," that highlights green techniques such as rain gardens, green roofs and rain barrels to help manage stormwater runoff. The film showcases green techniques that are being used in urban areas to reduce the effects of stormwater runoff on the quality of downstream receiving waters.

http://water.epa.gov/polwaste/green/video.cfm

Bay 101: Stormwater Runoff

Mike Fritz of the Chesapeake Bay Program explains why stormwater runoff is a major source of pollution to the Chesapeake Bay. Where does all that stormwater go? What goes along with it? Find out here, and learn what we need to do to prevent stormwater runoff from polluting the Bay.

http://www.chesapeakebay.net/issues/issue/stormwater_runoff

Stormwater Treatment Areas: Clean water for the Everglades

Video by the South Florida Water Management District about its Stormwater Treatment Areas mandated by the Florida Forever Act of the state legislature as a result of a 1988 federal lawsuit against the State of Florida for polluting waters of Arthur R. Marshall Loxahatchee National Wildlife Refuge in Palm Beach County, Florida -- part of the Everglades.

http://www.youtube.com/watch?v=FeUHSRzUYcE

South Florida Water Management District – Water Quality Improvement

Helpful information and videos from South Florid a Water Management District pertaining to improving water quality: stormwater treatment areas.

https://www.sfwmd.gov/our-work/wq-stas

http://www.sfwmd.gov/portal/page/portal/xweb%20protecting%20and%20restoring/water%20quality%20stormwater%20treatment%20areas

Final Lesson Study Reflection

Watch the short video entitled, What is Stormwater and why is it important?

As a team, discuss the following questions:

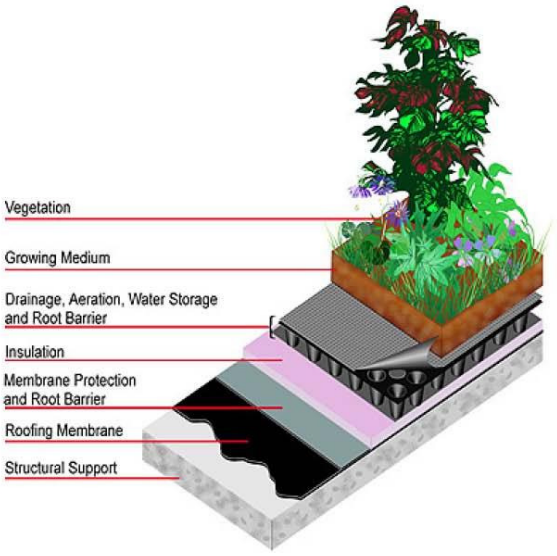
- How would you incorporate this video in your unit plan for the MEA? Would you show it at the beginning, middle, or the end of the unit?
- What important points regarding stormwater management are raised by this video?
- What things might students have difficulty understanding?
- Why do you think it might be more effective for students to discuss the video in groups rather than answer independently?
- What else might you do to enhance students' understanding?

Refer back to Table 1 and examine the standards that align to this unit. In your lesson study group, determine how each standard aligns to particular lesson components in the unit. Following that, discuss these questions:

- How could you strengthen the alignment of this unit to the standards?
- Are there standards that you think are missing from the unit?

Appendix A: Best Management Practices Fact Sheets

Fact Sheet 1: Green Roofs



Green Roofs are plant-filled roof top gardens that are more environmentally friendly than conventional roofs. To build a green roof, you need a structural support for the plants and soil, and waterproof membrane to prevent water from leaking through the roof. A drainage system is constructed under the plants and soil to collect any water that comes through. A variety of different plan s can be grown in green roof gardens.

Advantages:
Green roofs provide flood control by reducing the amount of stormwater runoff coming from buildings. They remove pollutants from the air as well as water through the growth of the plants. Green roofs help keep buildings and cities cooler and help prevent noise pollution. Green roofs c an provide habitat for wildlife and parks and gardens for people.. They can extend the life of roof materials by protecting them from the sun's UV rays. The Fairmont Waterfront Hotel saves money by growing herbs and vegetables for their restaurant on their roof.

Disadvantages:
Green roofs are expensive to build. For this reason, they are best suited to urbanized areas such as big cities. Frequent maintenance is needed. Plants must be watered when it is dry. Roof repairs can be costly. Stronger roof systems are required to support the plants, soil, drainage system and membrane.

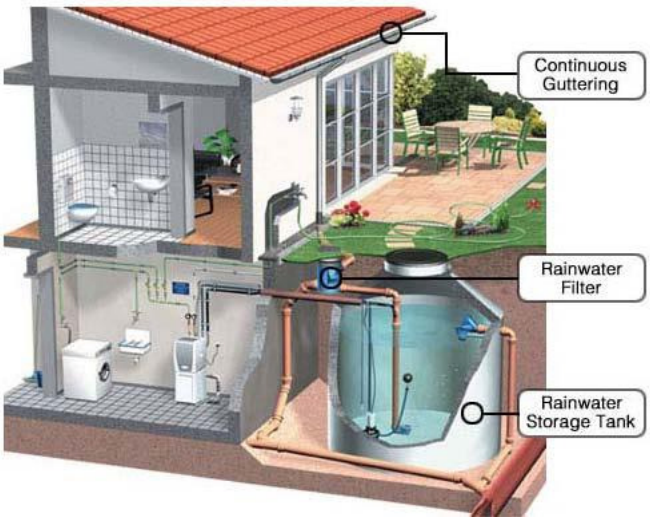
Sources:

www.myteacherpages.com/webpages/MAckroyd/files/greenroof-period1Jenn.ppt

http://www.seattle.gov/dpd/cms/groups/pan/@pan/@sustainableblding/documents/web_informational/dpdp017822.pdf

http://www.crwa.org/projects/bmpfactsheets/crwa_green_roof.pdf

Fact Sheet 2: Rainwater Harvesting



Rainwater Harvesting is a term that refers to capturing stormwater from roofs and other impervious areas, and reusing it. This is one of the oldest means of reusing water, dating back to cisterns used to capture rainfall and runoff during the Bronze Age. Today, rainwater harvesting can range from a small rain barrel at a house to a large tank. The tanks can be made of metal, plastic, concrete and other materials, and they can be located above or below the ground. Water is pumped out of the tanks and used to water lawns and gardens, wash cars, flush toilets, and many other uses.

Advantages:
Rainwater harvesting and reuse helps control flooding by capturing stormwater. The captured stormwater is reused for irrigating farms and other areas, which helps cut down on pollution. Money, water and energy resources are saved by reusing water. It helps preserve our groundwater supplies for drinking water by reducing demand on water treatment plants. Many different kinds of systems are available, including rain barrels for use by homeowners. Rainwater harvesting allows farming in areas where no other source of water is available.

Disadvantages:
There is a high initial cost. A storage tank must be constructed, along with roof gutters and piping. A pumping system is often required. The water may need to be filtered to remove leaves and debris. Regular cleaning and maintenance is required to keep the system operating properly. The amount of water is limited by the size of the tank. During a drought, no water can be collected.

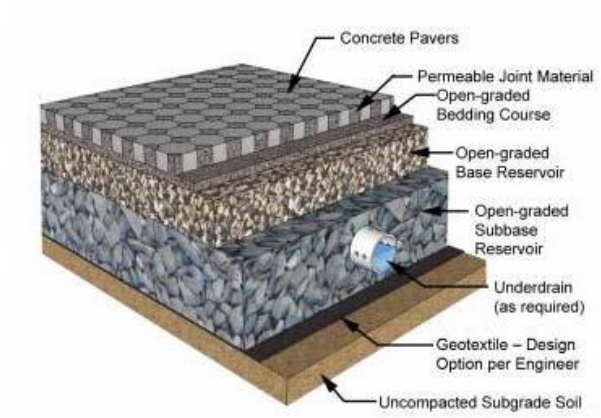
Sources:

http://rainwaterharvesting.tamu.edu/

http://www.ces.ncsu.edu/depts/agecon/WECO/documents/WaterHarvestHome2008.pdf

http://chesapeakestormwater.net/2012/03/design-specification-no-6-rainwater-harvesting/

Fact Sheet 3: Pervious Pavement



Pervious Pavement is pavement with openings that allows rainfall to seep through, reducing the amount of stormwater runoff from parking lots. The picture above, left demonstrates how quickly water can run through these pavements. On the right, the normal asphalt is slick and wet, while on the left, the pervious asphalt is almost dry. This is a pervious asphalt with large openings that let the water run through.

The picture on the right shows a different kind of pervious pavement, consisting of concrete pavers with a gravel layer underneath. Some concrete pavers have openings that plants can grow through. Other pavers are made of plastic with openings that are filled with dirt and planted with grass.

Advantages:

Pervious pavements help reduce stormwater runoff from parking lots. They help control flooding by capturing water, and they capture pollutants as well. They also help recharge the aquifer by returning stormwater underground. Many types of pervious pavement are available, including asphalt, concrete and plastic materials. Pervious pavement can make roads safer by making them less slick during rain storms.

Disadvantages:

Pervious pavements are more expensive to construct than regular asphalt pavement. Pervious pavement doesn't work well in clay soils. If percolation is poor, an underdrain pipe may be needed. Many pervious pavements are not as strong as regular asphalt and may not hold up well under heavy trucks. Pervious pavements required maintenance to remove sand and dirt so they don't get clogged up. Pervious pavements work better on flatter areas. They don't work well on steeper slopes.

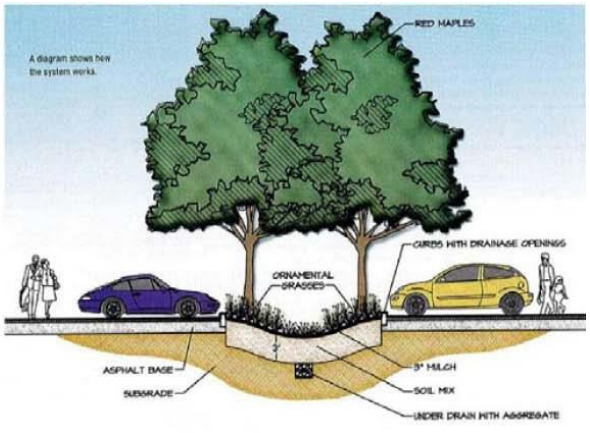
Sources:

http://www.unh.edu/unhsc/specs-and-fact-sheets-0

http://www.americantrails.org/resources/trailbuilding/PermPavers.PDF

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5

Fact Sheet 4: Parking Lot Swales



Parking Lot Swales are planted areas in parking lots that collect and store water. These vegetated areas are sometimes called bioswales. They capture stormwater runoff and filter it, removing pollutants in the process. The swales are usually long and linear, and placed between rows of parking or between parking aisles and driveways.

Parking lot swales can be used in a wide variety of climates and soils. The swales can serve many purposes and are a low-cost way to manage stormwater. When landscaped, they provide an attractive way to treat, store and convey stormwater runoff.

Advantages:
Parking lot swales are easy to design and incorporate into traditional parking lots. They can be used to hold stormwater, or convey it to a stormwater pond instead of a pipe. They help filter out nitrogen, phosphorus and other pollutants. The swales can be planted with trees and landscape plants that give the parking lot an attractive appearance. The swales help cool down the parking lot and fight the "heat island" effect of large paved areas.

Disadvantages:
Parking lots with swales cost more than regular parking lots. Landscaping within the swales must be maintained. If grassed, the swales must be mown regularly. High-velocity storms can erode the swales. Any washed-out dirt must be replaced. In clay or poorly draining soils, an underdrain pipe may be needed. Swales that do not drain properly can become mosquito-breeding areas.

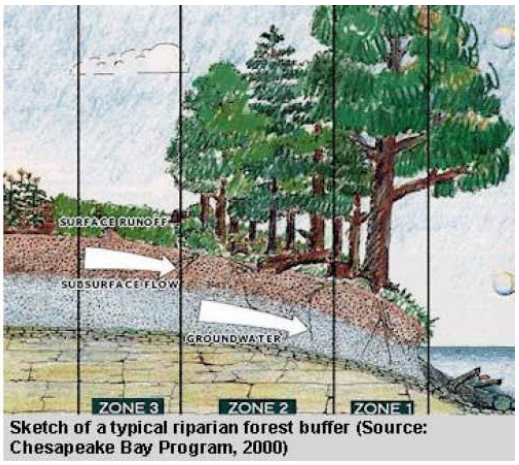
Sources:

http://www.portlandonline.com/bes/index.cfm?a=78489&c=45388X

http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_vegswale.pdf

http://buildgreen.ufl.edu/Fact_sheet_Bioswales_Vegetated_Swales.pdf

Fact Sheet 5: Vegetated Buffers



Sketch of a typical riparian forest buffer (Source: Chesapeake Bay Program, 2000)

Vegetated Buffers are strips of trees and plants placed between developed areas and natural areas to help reduce pollution in natural areas. They are especially helpful in protecting rivers, ponds and other water bodies. The buffers may be created by preserving existing wooded areas, or they may be planted. The plants and trees help filter the water and remove sediments, nutrients and pollutants. Their roots help hold the soil in place and prevent soil erosion. Buffer strips typically range from 50 to 200 feet wide and wider. Steeper slopes and clay soils require wider buffers to be effective. As shown in the picture on the left, above, buffer strips are very effective when running along the banks of a river.

Advantages:

Vegetated buffers help prevent pollution in rivers, ponds, lakes, wetlands and streams. They provide habitat for many species of bird and other wildlife. Maintenance is usually low when compared to other BMPs. Buffer zones can provide groundwater recharge where soils have some percolation. They provide a wind break along the banks of the river and help keep the banks from eroding.

Disadvantages:

Large areas of land are required. The amount of land needed may not always be available. The buffer must have a good cover of trees and landscaping or it won't work effectively. Some maintenance is required. Areas of erosion will occur and must be fixed to prevent further erosion. Vegetative buffers must be protected from vehicles and people that trample the landscape. They are not good for conveying high-volume concentrated flows – pipes and ditches are needed for this.

Sources:

http://www.mass.gov/dep/water/resources/buffers.htm

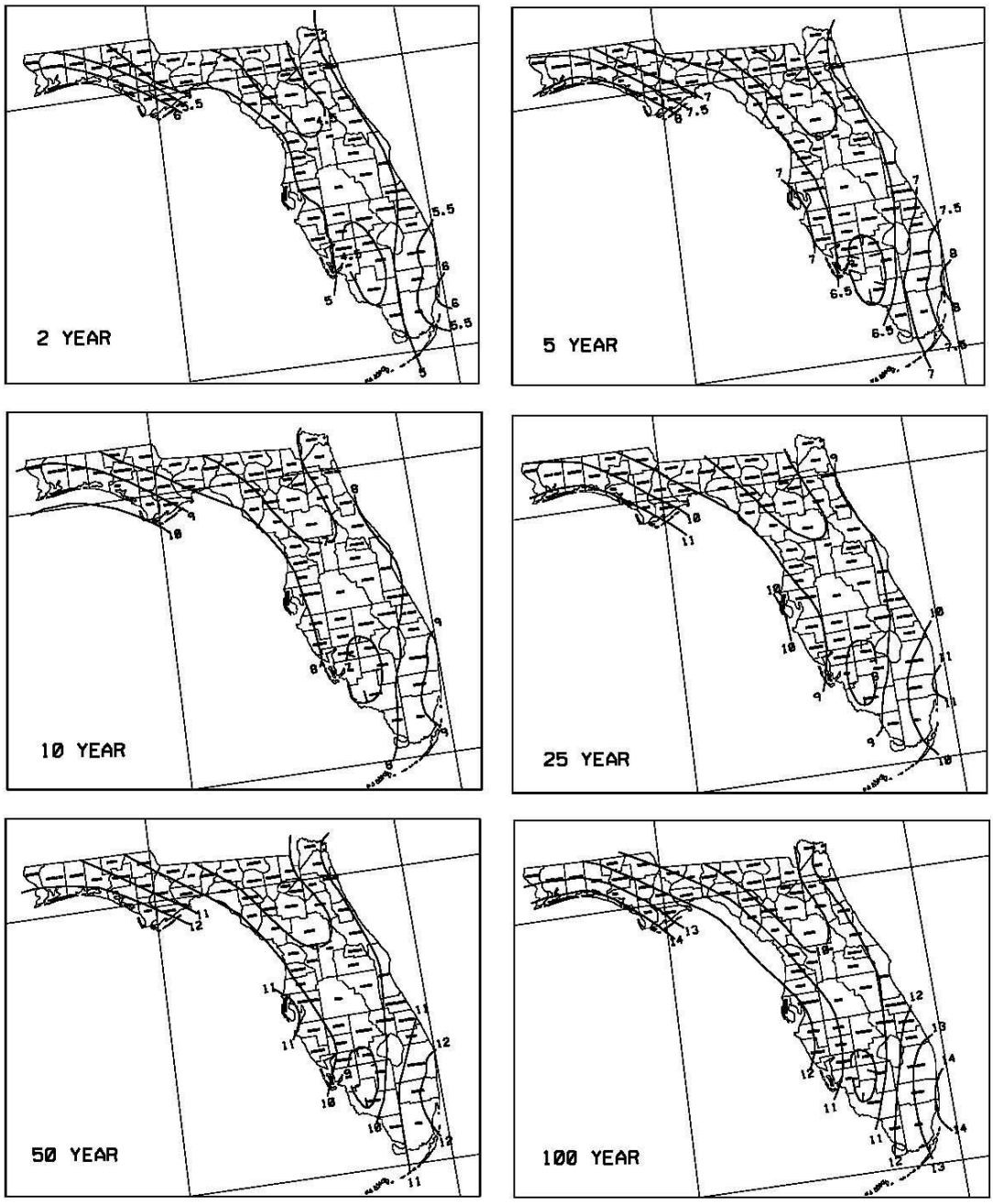
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=50

http://www.dca.state.ga.us/development/environmentalmanagement/programs/downloads/dcabackyardbuffers.pdf

Appendix B: Precipitation Data

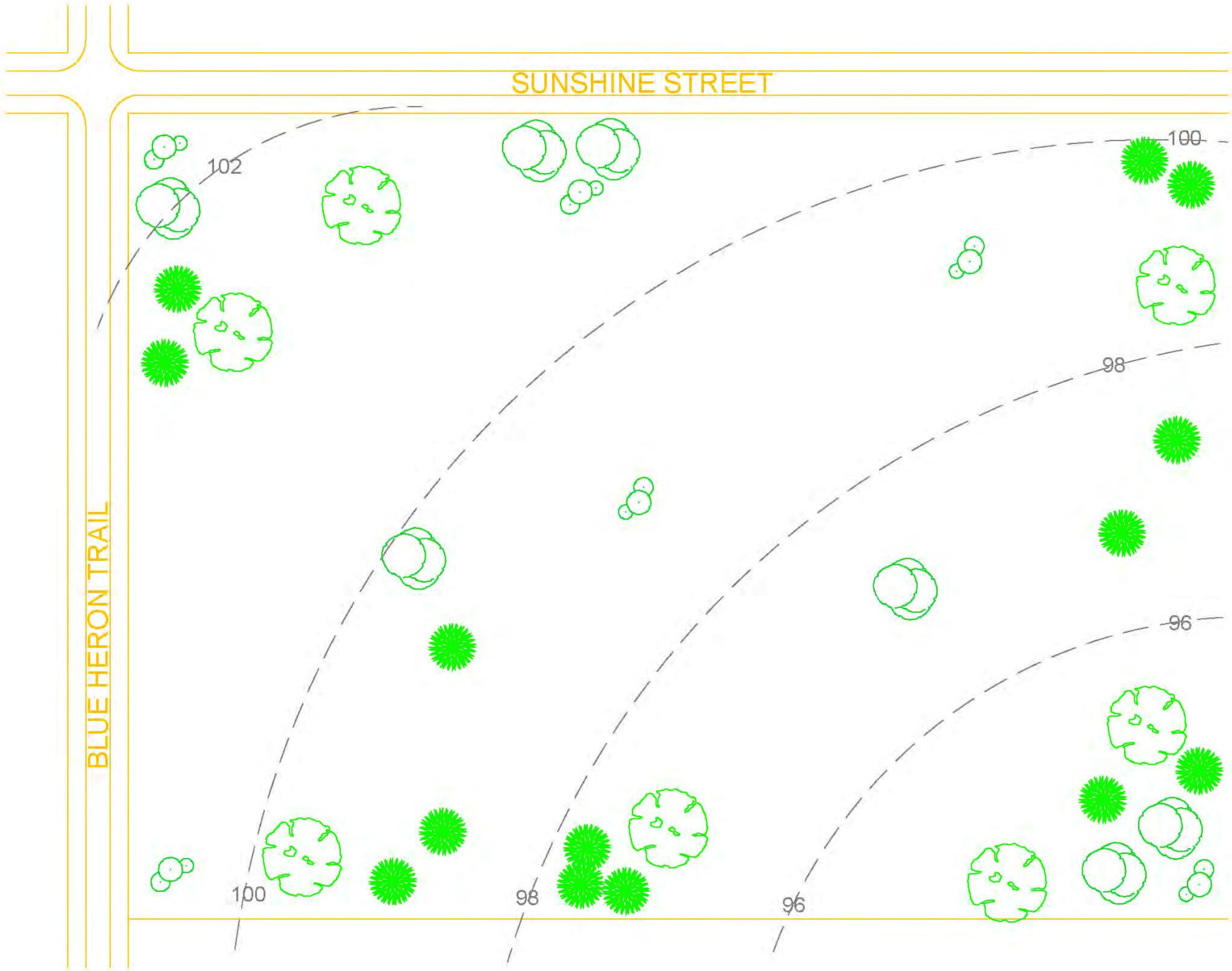
PRECIPITATION DEPTH DATA FOR 2-,5-,10-,25-, 50-, AND 100-YEAR FREQUENCIES

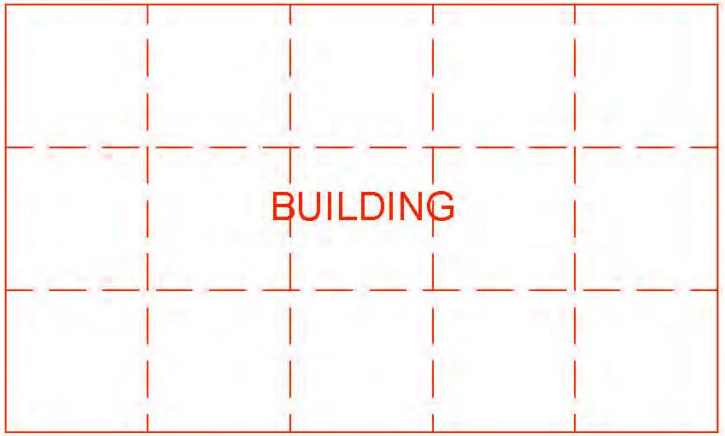
1 DAY

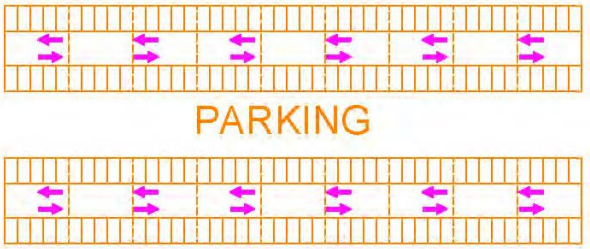


ALL DEPTH CONTOURS IN INCHES

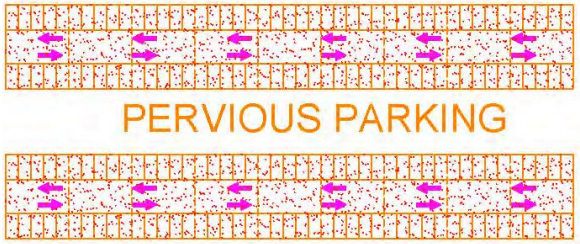
Appendix C: Site Plans


SUNSHINE STREET
BLUE HERON TRAIL
102
100
98
96
100
98
96



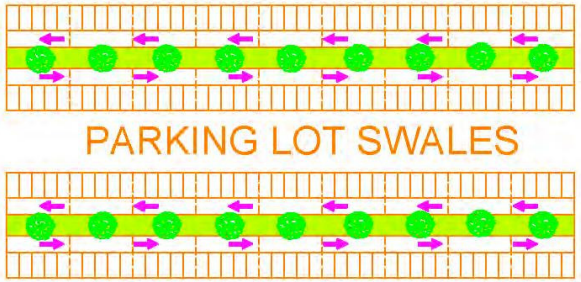


Basic Building Components



USE TANK FOR
RAINWATER
HARVESTING

STORAGE
TANK



BMPs

VEGETATIVE BUFFER

VEGETATIVE BUFFER

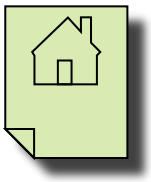
VEGETATIVE BUFFER

Appendix D: Comprehension Instructional Sequence

STEPS	LITERACY ACTIVITIES
1	**Hook Question**: The teacher poses a question that engages the students in the key ideas presented in the text.
2	**Predictive Writing from Essential Question**: This question encourage students to reflect on what they currently know about the subject presented in the text
3	**Vocabulary Instruction:** The teacher directs students to key vocabulary in the text, focusing on word parts, word origins, etymology, and/or context clues from words and phrases in sentences. Words should be selected from the following three categories: content-specific, general academic vocabulary and words frequently used in intellectual discussion.
4	**First Reading/Text Coding**: Teacher reads text aloud while students mark text using codes provided by the teacher; the teacher demonstrates process in first few paragraphs.
5	**Second Writing in Response to Text Coding**: Students respond in writing to essential question using evidence collected from text coding.
6	**Second Reading/Directed Note-taking**: students read text on their own and record evidence on graphic organizer.
7	**Third Reading/Question Generation:** In this third and final reading, the teacher demonstrates the process of generating high level questions in response to text followed by student generation of questions.
8	**Collaborative Inquiry**: Students work in partners to review questions to determine those with the greatest potential to generate high level discussion.
9	**Extended Text Discussion**: The teacher facilitates a discussion of the text based on the questions generated by students.
10	**Final Writing**: Students write a final response to essential question using evidence reviewed in the Comprehension Instructional Sequence.

Appendix E: Student Copy of the Model Eliciting Activity Planning for a Rainy Day

Reading Passage 1



REQUEST FOR PROPOSALS

Rainy School District

The school board of Rainy, Florida is seeking cost-effective, environmentally friendly proposals for designing the storm water management plan for a new middle school. A tract of land has been selected as the proposed site. The total construction budget for the project is $29,000,000, although sufficient bids that come in under this amount will receive first preference.

In an effort to control flooding and remove pollutants from stormwater runoff, the school board requires that each proposal include plans for a stormwater pond as well as one or more of the Best Management Practices (BMPs) recommended by the local water management district.

Fact sheets on five of these BMPs are attached for your review.

All proposals should include the following:

- A stormwater management plan that includes details of a stormwater pond in addition to a description of which BMP(s) should be built at the site.
- A stormwater management site plan that includes a complete visual display of the proposed site.
- A budget that includes total construction costs, along with a general equation that can be used to calculate total construction costs if modifications are requested. Also include an equation showing how you computed the maintenance costs for the BMP(s) for the next 20 years as well as the final total maintenance costs for each BMP used. These maintenance costs do not have to be included in the construction budget of $29,000,000. (A calculation table is included in the attached proposal template.)
- A justification of why your plan is environmentally responsible and cost-effective. It is possible that your proposal may serve as a model for future school sites, so it should also provide a step-by-step explanation of the procedure you used to determine what to build and an explanation of your decisions.

Additional data, information, and instructions are included in the following pages and attachments. The Fact Sheets provide additional important information that might be helpful in your planning.

Thank you and we look forward to seeing your proposal.

Sincerely,

The School Board of Rainy, Florida

Table 1 – Building Construction Data

ITEM	AREA, SQUARE FEET (IMPERVIOUS AREA)	COST PER SQUARE FOOT
Building:	150,000 ft^2	$130 (Costs based on single story building. Two story buildings cost an additional $10 per sq. ft.)
Parking Lot:	48,000 ft^2	$75 (includes driveways needed to connect parking areas and roads)

- Determine the total cost of the building and the total cost of the parking lot and add these two quantities together to calculate the net construction costs.

Table 2 – Stormwater Pond Data

Treatment Volume:	The pond must capture 1-1/4 inches of runoff from the impervious areas (including the building and the parking lot) to provide the required pollutant removal.
Flood Control Volume:	In addition to the treatment volume, the pond must capture 75% of the rain that falls on the impervious areas during a 25-year, 24-hour storm. Rainfall data has been obtained from the Florida Dept. of Transportation and is attached for your use.
Pond Cost Data:	The construction cost of the pond is $5 per cubic foot.

- Use the attached precipitation depth data map (Appendix B) to determine the total rainfall for a storm that lasts 24 hours and occurs once every 25-years (the 25-year, 24-hour storm). Assume this school will be built where you live.

- Use the information in Table 2 to determine both the treatment and flood control volumes required for the detention pond and add these together to determine the total treatment pond volume that is required for this site.

- Using the Stormwater Pond Data, determine the construction cost of the stormwater pond.

Table 3 – BMP Data

BMP:	Green Roof System	Rainwater Harvesting System	Pervious Pavements	Parking Lot Swales (Dry Retention)	Vegetated Buffers
*Construction cost per square foot :	$20 per ft^2 of building	$18 per ft^2 of building	$15 per ft^2 of parking	$12 per ft^2 of parking**	$250,000 per acre (3 acres required)

*Annual maintenance costs are 5% of initial construction costs.
** The cost for parking lot swales is based on the original area of 48,000 ft^2 and includes the extra length of driveway needed for this option.

Additional Instructions:

- Use the attached site plan to lay out your site (Appendix C). The site plan shows the locations of large live oaks and other large trees. It also has topographic contours which show the land slope. Remember, stormwater runoff always runs perpendicular to the topographic contours.

- Cut out the building and parking lots and lay them out on the site plan, along with your BMPs. You can cut the building and parking lots on the dotted lines to form them into different shapes. Your team must decide the layout. Questions to consider:
    - What will be the layout for the school building? Will it be one large building or will it consist of separate buildings connected by walkways? Will any trees need to be removed to accommodate your plan?

    - Don't forget to put the stormwater pond on your site as well. What is the best location for the pond?

- Select your BMP(s) from the attached Fact Sheets (Appendix A). Include the reasons for your selections in your proposal using the Template on the following page.

- Determine the annual maintenance cost of your BMP(s)? The maintenance cost for 20 years? Include this cost in your proposal.

Extra Credit:

Look up the location of your school using the online Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Is it a sand, sandy loam, sandy clay loam, or other type of soil? Is this soil normally wet or dry? Is it good for farming or other uses? Is it suitable for septic tank systems?

Proposal Template 1

Dear _____,

Our Team, _____, has selected the following BMP(s) for your project:

_____

_____

_____

Please refer to our site plan, attached. Reasons for our selection are:

_____

_____

_____

_____

_____

Cost of Project:

Building Cost (including Parking)	$
Stormwater Pond Cost	$
BMP(s) Cost	$
Total Cost	**$**

BMP(s) 20-year maintenance cost: $_____

Sincerely,

_____

Reading Passage 2

REQUEST FOR PROPOSALS

Rainy, Florida School District

Dear Team,

Thank you very much for your proposed plan. However, shortly after we received your proposal, our school board was made aware of a wetland that lies down slope from the school. It is a sensitive environmental habitat that is used for feeding and nesting by an endangered species of bird, the Florida Sandhill Crane (*Grus canadensis pratensis*). Disruption of the normal wetlands could adversely affect survival of this species as well as other types of wildlife in the area.

The Rainy Water Management District has determined that 85% removal of nitrogen from the school's stormwater runoff is needed to protect the wetlands. The stormwater pond removes 45% of the nitrogen. Graduate students from Rainy University tested the BMPs and determined that they will remove the following percentages of total nitrogen from the runoff:

BMP:	Green Roof System	Rainwater Harvesting System	Pervious Pavements	Parking Lot Swales (Dry Retention)	Vegetated Buffers
Percent removal of Total Nitrogen from stormwater runoff:	40%	45%	20%	22%	25%

Unfortunately, we still only have $29,000,000 total budget and would like the proposal to remain as cost-effective as possible.

Please determine if your procedure still works taking this new information into account. Write us a revised proposal saying whether your procedure for selecting your BMP(s) changed or not; if so, describe and explain these changes. Make sure that your proposal still includes a step-by-step explanation of the process you used to determine what to build and an explanation of your decisions. We look forward to seeing your updated proposal.

Sincerely,

The School Board of Rainy, Florida

Proposal Template 2

Dear _____,

Our Team, _____, has selected the following BMP(s) for your project:

_____

_____

_____

We did / did not make the following changes to our procedure for selecting the best management practices. Our changes are:

_____

_____

_____

_____

_____

We think you should select our system because:

_____

_____

_____

_____

_____

_____

Sincerely,

_____