

CURRICULUM GUIDE FOR

Land and Water

(Based on the STC Land and Water Science Kit)

*Additional Resources for this unit can be found on Wallingford's W drive
(W:\SCIENCE - ELEMENTARY\Land and Water gr 4)*

Wallingford Public Schools
4th Grade
Science

*Based on the K-5 Science Scope and Sequence approved the
Wallingford Board of Education July 17, 2006*

Approved by Science Management Team January 8, 2008

Table of Contents

Unit Summary	3
Stage 1: Standards/Goals	3
<i>Stage one identifies the desired results of the unit including the related state science content standards and expected performances, enduring understandings, essential questions, knowledge and skills. What should students understand, know, and be able to do?</i>	
The knowledge and skills in this section have been extracted from Wallingford’s K-5 Science Scope and Sequence.	
Stage 2: Determine Acceptable Evidence	7
<i>Stage two identifies the acceptable evidence that students have acquired the understandings, knowledge, and skills identified in stage one. How will we know if students have achieved the desired results and met the content standards? How will we know that students really understand?</i>	
Stage 3: Lesson Activities	15
<i>What will need to be taught and coached, and how should it best be taught, in light of the performance goals in stage one? How will we make learning both engaging and effective, given the goals (stage 1) and needed evidence (stage 2)? Stage 3 helps teachers plan learning experiences that align with stage one and enables students to be successful in stage two. Lesson activities are suggested, however, teachers are encouraged to customize this stage to their own students, maintaining alignment with stages one and two.</i>	
Slope and Flow Inquiry	19
Human Interactions on Land and Water Inquiry	39
Literature Resources	52
<i>These literature resources have been purchased to supplement the kit and are housed in each elementary school library.</i>	
Materials List	53
<i>This list identifies the list of materials found in the kit. In many cases, the original kit material list has been modified from the manufacturers list.</i>	
Appendix A: Exploratorium’s Description of Inquiry	54
Appendix B: Map of IFI Inquiry Structure (3 Phases of Inquiry Diagram)	55

UNIT SUMMARY

Students investigate the interactions between land and water. Using a stream table as their model, students observe how runoff causes stream formation; how groundwater forms; how soil is eroded, transported, and deposited; and how water shapes land. Students use inquiry investigations to discover the effects of human interaction with land and water such as pollution, dams, landscapes, etc. They connect the models to real-world examples and apply the concepts they have learned to photographs of land and water on earth. Through these applications, students are encouraged to observe land and water each day and search for evidence of interactions between land and water in the world around them.

STAGE 1- STANDARDS/GOALS

<p style="text-align: center;">Enduring Understandings</p> <p style="text-align: center;"><i>Insights earned from exploring generalizations via the essential questions (Students will understand THAT...)</i> <i>K-12 enduring understandings are those understandings that should be developed over time, they are not expected to be mastered over one unit or one year.</i></p>	<p style="text-align: center;">Essential Questions</p> <p style="text-align: center;"><i>Inquiry used to explore generalizations</i></p>
<p><u>Overarching Enduring Understandings:</u></p> <ul style="list-style-type: none"> • Science is the method of observation and investigation used to understand our world. (K-12) • Inquiry is the integration of process skills, the application of scientific content, and critical thinking to solve problems. (K-12) <p><u>Unit Specific Enduring Understandings:</u></p> <ul style="list-style-type: none"> • Sun energy drives the water cycle. • Water has an important role in shaping the land on earth. • Land forms may change the direction and flow of water. • Earth's materials (rocks and minerals) are formed and may undergo change by certain conditions, such as erosion or metamorphism, and can occur over various amounts of time. • The landscape is a result of natural and man-made processes that interact with the Earth. Land and water have an impact on 	<ul style="list-style-type: none"> • How does water move above, below, and on land? • How does water change forms as it moves through the water cycle? • How do river and streams shape the surface of the Earth? • How do man-made and natural land features affect the flow and direction of water, influencing erosion? • How does nature and human activity affect the flow of water and the landscape? • Why and how do we change the flow of water? • How do soil properties affect the ways in which soil is eroded and deposited by water? • How does the Earth's surface affect the flow of rivers and streams? • What role does the water cycle play in shaping the landscape?

<p>each other.</p> <ul style="list-style-type: none"> Human activities impact the landscape sometimes resulting in changes in erosion and changes to water flow. 	
<p style="text-align: center;">Knowledge and Skills <i>What students are expected to know and be able to do.</i> The knowledge and skills in this section have been extracted from Wallingford's K-5 Science Scope and Sequence.</p>	
<p><u>Knowledge</u></p> <p>K1. Describe how the sun's energy impacts the water cycle.</p> <p>K2. Identify different properties used to describe earth materials (soil, gravel, etc.).</p> <p>K3. Describe the role of water in erosion and river formation.</p> <p>K4. Describe the physical changes that occur in rocks and minerals as a result of weathering and erosion.</p> <p>K5. Investigate the effect of water on erosion and deposition with different water flows and slopes (stream tables).</p> <p>K6. Explain how the slope and flow affect erosion and deposition.</p> <p>K7. Identify the relationship between pore space (porosity) and water runoff and their impact on earth materials.</p> <p>K8. Understand how humans (landscape, dams, houses, grass, etc.) and nature (force and frequency of river flow) may impact the direction and flow of rivers.</p> <p><u>Skills</u></p> <p>S1. Generate testable questions that need to be answered with print resources.</p> <p>S2. Identify testable questions.</p> <p>S3. Observe objects and describe commonalities and differences.</p> <p>S4. Classify, based on observations of properties.</p> <p>S5. Predict what might happen.</p> <p>S6. Design an investigation to help answer an investigable question.</p> <p>S7. Conduct simple investigations.</p> <p>S8. Employ simple equipment and measuring tools.</p> <p>S9. Organize appropriate and accurate measurements and observations using:</p> <ul style="list-style-type: none"> Graphic organizers Charts and graphs Illustrations or diagrams Journaling <p>S10. Draw conclusions based on data, charts, graphs or observations.</p> <p>S11. Communicate results or information in an appropriate manner using:</p> <ul style="list-style-type: none"> Presentations Visuals Simple reports 	

Content Standard(s) <i>Generalizations about what students should know and be able to do.</i>	
CSDE Content Standards (CSDE Science Framework 2004)	CSDE Primary Expected Performances (CSDE Science Framework 2004)
<p><i>Earth's Systems – How do eternal and internal sources of energy affect the Earth's systems?</i></p> <p>4.3 Water has a major role in shaping the Earth's surface.</p> <ul style="list-style-type: none"> Water circulates through the Earth's crust, oceans and atmospheres. <p><i>The Changing Earth – How do materials cycle through the Earth's systems?</i></p> <p>2.3 Earth materials have varied physical properties which make them useful in different ways.</p> <ul style="list-style-type: none"> Soils can be described by their color, texture, and capacity to retain water. Soils support the growth of many kinds of plants, including those in our food supply. 	<p>B12. Describe how the sun's energy impacts the water cycle.</p> <p>B13. Describe the role of water in erosion and river formation.</p> <p>A21. Sort different soils by properties, such as particle size, color and composition.</p> <p>A22. Relate the properties of different soils to their capacity to retain water and support the growth of certain plants.</p>
<p><i>Scientific Inquiry</i></p>	<p>B INQ.1 Make observations and ask questions about objects, organisms and the environment.</p> <p>B INQ.2 Seek relevant information in books, magazines and electronic media.</p> <p>B INQ.3 Design and conduct simple investigations.</p> <p>B INQ.4 Employ simple equipment and measuring tools to gather data and extend the senses.</p>
<p><i>Scientific Literacy</i></p>	<p>B INQ.5 Use data to construct reasonable explanations.</p> <p>B INQ.6 Analyze, critique and communicate investigations using words, graphs and drawings.</p> <p>B INQ.7 Read and write a variety of science-related fiction and nonfiction texts.</p>

<p><i>Scientific Numeracy</i></p>	<p>B INQ.8 Search the Web and locate relevant science information.</p> <p>B INQ.9 Use measurement tools and standard units (e.g., cm, m, g, kg) to describe objects and materials.</p> <p>B INQ.10 Use mathematics to analyze, interpret and present data.</p>
<p style="text-align: center;">Common Misconceptions Children Have</p> <p style="text-align: center;"><i>By identifying misconceptions early, teachers can design appropriate lessons to address and change student misconceptions.</i></p>	
<ul style="list-style-type: none"> • Water can be made. • Water is an endless supply. • Water is only found in bodies of water. • Water is not recycled. • Polluted water is contained. • Pollution only affects water. • Drinking water comes directly from bodies of water. 	

STAGE 2 – DETERMINE ACCEPTABLE EVIDENCE

How will we know if students have achieved the desired results and met the content standards? How will we know that students really understand? Stage two identifies the acceptable evidence that students have acquired the understandings, knowledge, and skills identified in stage one.

Performance Task(s) <i>Authentic application in new context to evaluate student achievement of desired results designed according to GRASPS. (Goal, Role, Audience, Setting Performance, Standards)</i>	Other Evidence <i>Other methods to evaluate student achievement of desired results.</i>
<ol style="list-style-type: none"> 1. You are a homeowner. You are choosing a building site from another classmate's previously built landscape (stream table). Based on the characteristics of the site, prepare and share a detailed plan for where you would place your home. After testing your site, give a demonstration to your contractor, providing recommendations for where to place the house and necessary changes (conducted after all learning activities only). 2. The Main Street Mountain has excessive water runoff that is damaging the roads. You work for the Wallingford Landscaping Company and have been hired to design a hillside landscape that will prevent the water runoff from destroying the roads. Based on the characteristics of the hillside, prepare and share a detailed plan that includes illustrations, and at least 4 steps that identify the relationship between soil and water runoff and their impact on erosion. 3. You have been asked by Channel 8 News to demonstrate the effects of pollution on the environment. Your demonstration needs to include ways that pollutants can enter the land and waterways. You may use a replica of the land (stream table) or a poster with illustrations and labels to show the damaging effects of pollution. Your presentation should also include ways people can help reduce pollution. 	<p>Maintain a science notebook of investigations (sample rubric below)</p> <p>Teacher observations</p> <p>Teacher generated quizzes</p> <p>Pre and post written assessment (see next few pages)</p> <ul style="list-style-type: none"> • Can also use picture cards with questions on back (refer to lesson 1) <p>STC Land & Water binder p. 21~ Assessment 2 "Investigating Pollution in Land and Water"</p> <p>Illustrating and labeling stream tables</p> <p>Vocabulary assessment</p> <p>Writing prompts (below for sample prompts)</p>

Rubric for Science Notebook

*2	<ul style="list-style-type: none"> <input type="checkbox"/> Response provides a <u>complete</u> explanation to the question. <input type="checkbox"/> Includes <u>accurate details.</u> <input type="checkbox"/> <u>Correctly uses sciences words</u> in writing. <input type="checkbox"/> <u>Conclusions</u> are <u>thorough & supported by specific observations.</u> <input type="checkbox"/> Drawing is <u>labeled</u> and <u>accurate.</u>
1	<ul style="list-style-type: none"> <input type="checkbox"/> Response provides a PARTIAL explanation to the question. <input type="checkbox"/> Includes SOME accurate details. <input type="checkbox"/> Correctly uses science words in writing MOST of the time. <input type="checkbox"/> Conclusions are NOT thorough & are NOT supported by specific observations. <input type="checkbox"/> Drawing is PARTIALLY labeled and MOSTLY accurate.
0	<ul style="list-style-type: none"> <input type="checkbox"/> Response does NOT answer the question. <input type="checkbox"/> FEW of the details are accurate. <input type="checkbox"/> Uses little to no science words. <input type="checkbox"/> Conclusions are NOT related to the observations. <input type="checkbox"/> No drawing or INACCURATE drawing.

Land and Water Pre and Post Assessment

Approximately, what percentage of the Earth is covered by water?

- a. 10 %
- b. 30 %
- c. 70 %
- d. 100 %

Which of the following can prevent erosion?

- a. plants
- b. wind
- c. water
- d. waves

Water droplets clinging to the outside of a cold glass of iced tea are caused by

- a. evaporation
- b. precipitation
- c. condensation
- d. boiling



Which type of soil was once part of a living thing?

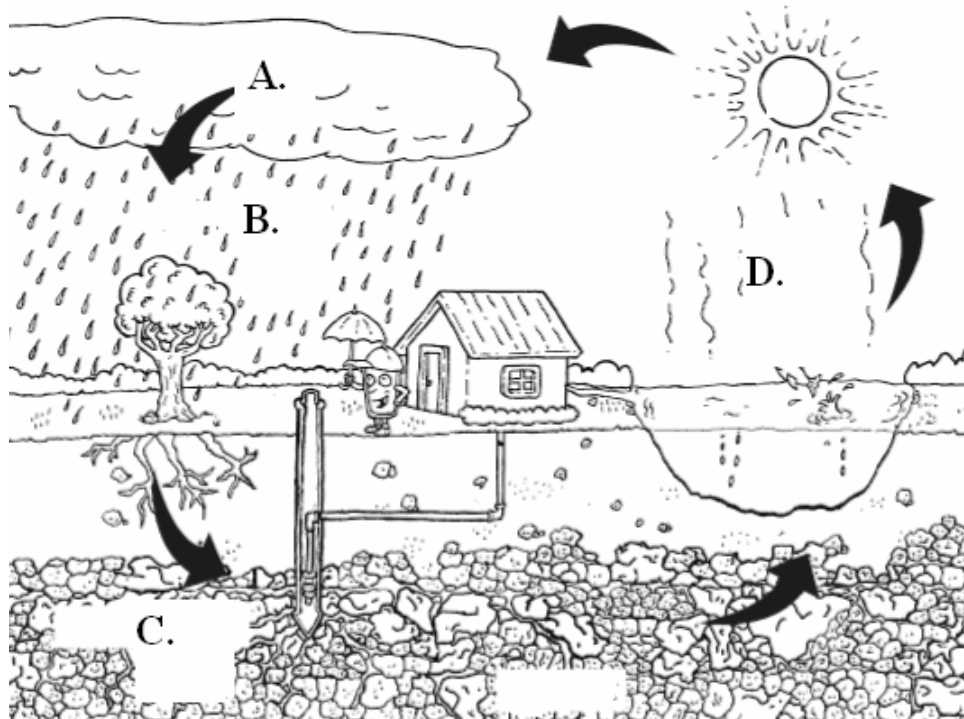
- a. humus
- b. gravel
- c. clay
- d. sand

Two liters of water was poured onto a stream table and only 1.5 liters of water was collected as runoff. What happened to the missing one half liter of water?

- a. All the extra water evaporated
- b. The water was filling in the pore spaces between the soil
- c. The extra water was at the bottom of the stream table
- d. The runoff was measured incorrectly

Under what conditions can water cause the most erosion and carry the largest amount of soil?

- a. fast moving water, steep slope
- b. fast moving water, no slope
- c. slow moving water, steep slope
- d. slow moving water, no slope



Which letter in the diagram above shows where ground water is found?

- a. A
- b. B
- c. C
- d. D

Which letter in the diagram above shows where evaporation is taking place?

- a. A
- b. B
- c. C
- d. D

Which letter in the diagram above shows where precipitation is taking place?

- a. A
- b. B
- c. C
- d. D

In a stream model, sprinkling with water very hard and fast will cause which of the following?

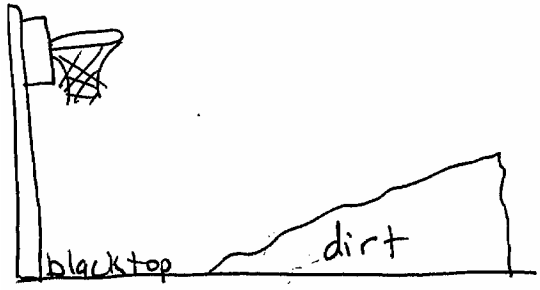
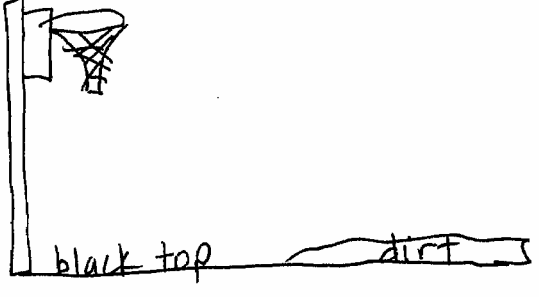
- a. gentle rain, a lot of erosion
- b. gentle rain, very little erosion
- c. hard rain, a lot of erosion
- d. hard rain, very little erosion

If plastic wrap or the lid is not placed back on the stream model, what will most likely be seen the next day?

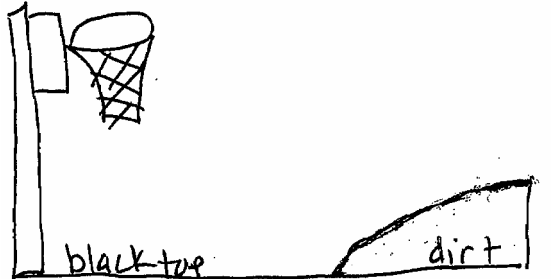
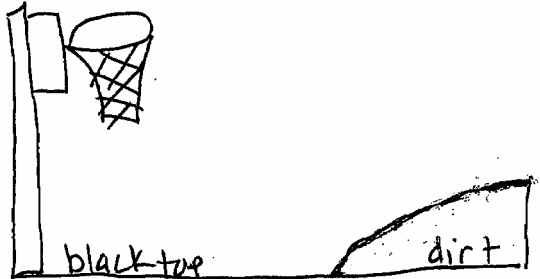
- a. The soil will be dry; some of the water will be gone
- b. The soil will be wet; all the water will still be there
- c. More water will be collected in the container
- d. There will be no change at all

Investigating Flow and Slope

1. Part of the playground at two schools is just a hill of bare soil. Compare what will happen at each school if there is a **light rain fall**.

<p>A.</p>  <p>Diagram A shows a playground layout. On the left, there is a basketball hoop on a pole. To its right is a rectangular area labeled 'blacktop'. Further right is a large, sloping hill labeled 'dirt'.</p>	<p>B.</p>  <p>Diagram B shows a playground layout. On the left, there is a basketball hoop on a pole. To its right is a rectangular area labeled 'black top'. Further right is a flat, rectangular area labeled 'dirt'.</p>

2. Compare what will happen at each school.

A. Torrential Rain	B. Light Rain Fall
	

Writing Prompts

After lesson 1

- Tell me what you know about the water cycle?

After lesson 2

- What will happen to the land after it rains? Where will the water go?

After lesson 4

- What does this experiment tell you about where water goes when it meets land?

After lesson 9 or inquiry on slope

- Describe how rocks and hills affect the direction and flow of water.

After lesson 14

- You have seen kids at the beach pulling out the beach grass in the sand dunes. You decide to write to the Department of Environmental Protection and ask them to post a sign telling people not to pull the beach grass. Write a letter explaining why and design a sign to help stop this problem.
 - Word wall – erosion, ground cover, soil, soil conservation, root system, flood, flood control

After lesson 16

- Your Uncle pours paint and oil into the ground. Explain what you would tell him to teach him that this is not a good practice. Also, draw a diagram and label the parts showing him how the water table works.
 - word wall – filter, ground water, runoff, pore space, water table, pollution

After lesson 10 or inquiry on human impacts

- How do you think building a dam will affect how towns and cities are protected?

Essential Questions

How does water move above, below, and on land?

How does water change forms as it moves through the water cycle?

How do river and streams shape the surface of the Earth?

How do man-made and natural land features affect the flow and direction of water, influencing erosion?

How does nature and human activity affect the flow of water and the landscape?

Why and how do we change the flow of water?

How do soil properties affect the ways in which soil is eroded and deposited by water?

How does the Earth's surface affect the flow of rivers and streams?

What role does the water cycle play in shaping the landscape?

STAGE 3 – LESSON ACTIVITIES

What will need to be taught and coached, and how should it best be taught, in light of the performance goals in stage one? How will we make learning both engaging and effective, given the goals (stage 1) and needed evidence (stage 2)? Stage 3 helps teachers plan learning experiences that align with stage one and enables students to be successful in stage two. Lesson activities are suggested, however, teachers are encouraged to customize these activities, maintaining alignment with stages one and two.

The suggested lesson activities are not sequenced in any particular order. Teachers may select which lesson activities will best meet the needs of their students and the unit objectives. Each lesson activity is coded with the corresponding knowledge (K) and/or skill (S) objectives that are found in stage one.

The following unit sequence is recommended. Additional information about each lesson/inquiry can be found below and/or in the teacher's manual.

Land and Water Unit Overview

1. Pre-assessment and elicit prior knowledge (lesson 1 or another strategy)
2. Water cycle (lesson 2 and additional teaching)
3. Investigate rain and streams (combine concepts in lessons 3 & 4)
4. Properties of Earth materials (lesson 5)
5. Slope and flow inquiry (combine concepts in lessons 10 & 13 using inquiry template provided)
6. Human interactions on land and water inquiry (combine lessons 12-16 using inquiry template provided). Integrate nonfiction literature into this inquiry.
7. Post assessment

Note: Before beginning kit, you may ask students to bring in additional water bottles. One liter or 2 liter bottles work best. Try to plan longer blocks of time to allow for set up and clean up. There is no Saran Wrap in the kit, instead, use large plastic sheets. In addition to elastic bands, secure with masking tape.

Essential Questions

Post the essential questions in your classroom to refer back to throughout the unit. Use these questions as pre-assessments, journal prompts, and/or assessment questions. You can easily write these questions on chart paper and track which questions you are addressing (for each lesson) with clothespins or sticky notes.

Integrating Nonfiction

Integrate reading strategies throughout this unit. Nonfiction texts can be found in the library. Students can investigate the essential questions for the unit using hands on experiments and further their understanding with the nonfiction.

1. PRE-ASSESSMENT AND ELICIT PRIOR KNOWLEDGE

It is suggested that you use the supplied pre-assessment (**SEE STAGE 2**) or the picture cards with questions for pre-assessment.

Some suggested strategies to elicit prior knowledge include:

- Have students browse the science literature books and complete an FQR (Fact, Question, Response Chart) in their notebooks. Teacher may need to model FQR strategy before beginning.
- Brain Drain- Students write for 10 minutes listing all the facts they think they know about land and water movement, and then take 5 minutes to write questions they have. Students can share their facts and questions with the class.
- Modified version of Lesson 1, STC Land and Water Teacher's Guide. Use the cards to help elicit prior knowledge and formatively assess what the students know about erosion and land and water interactions. You may also want to use the nonfiction literature and identify additional pictures related to the objectives (man's impact on land, erosion; including wave, wind, water, dams, large/small water fall, Grand Canyon, etc.)

Note: You need to put freezer packs in the freezer in preparation for Lesson 2: Water Cycle. Also, teacher should quickly measure soil materials into stream table prior to lesson.

2. THE WATER CYCLE: MODELING LAND AND WATER

Note: Additional literature for the Water Cycle can be found in the third grade science resources in the library. You might also need to do some re-teaching of the water cycle prior to the beginning of this lesson (Water Cycle is a third grade kit).

STC Land and Water Lesson 2: The Water Cycle: Modeling Land and Water combined with Lesson 3: Modeling Rain on Land. **Before beginning lesson, remind students that slope, bulldozing, amount of water, the way in which they shake the bottle, are all factors that need to be constant in order to conduct a fair test throughout the use of the stream tables.** Students build a model of land and water to investigate the water cycle. Students should focus on how rain affects the landforms. They do this through the use of the water bottles to represent rain. (See Lesson 3). Students should use and record their observations in their science notebook. They could also refer to literature to learn more about the water cycle and to enhance their vocabulary. Optional: At end of the lesson, have students share out their observations. Focus on students' ability to recognize what happened when the rain met the land (what landforms were created).

Some Water Cycle graphics can be found on the W drive.

- *How does water move above, below, and on land?*
- *How does water change forms as it moves through the water cycle?*
- *How do river and streams shape the surface of the Earth?*
- *Why and how do we change the flow of water?*
- *How do soil properties affect the ways in which soil is eroded and deposited by water?*
- *How does the Earth's surface affect the flow of river and streams?*
- *What role does the water cycle play in shaping the landscape?*

Time: 90 minutes (including set up)

Knowledge and Skills: K2, K3, K4, K5, K6, K7, K8, S3, S5, S7, S8, S9, S10, S11

Note: Keep the stream tables from today's lesson for the remainder of the kit.

3. INVESTIGATING RAIN AND STREAMS

Note: Lessons 3 and 4 can be combined.

STC Land and Water Lesson 4: Investigating Streams. Students will observe how runoff from rain changes the land through stream formation. (Today a stream source is being added to the model). Since Lesson 6 is being omitted, it is important for students to understand the concept of pore space. Where does the water go? Teacher should reinforce how different soil components affect ground water, runoff, and stream formation. Students will investigate and record observations about what happens when water from a single source flows over and through land. Students should walk around other stream tables to discuss differences and similarities. Be sure to connect this lesson with real world streams.

- *How does water move above, below and on land?*
- *How do rivers and streams shape the surface of the Earth?*
- *Why and how do we change the flow of water?*
- *How do soil properties affect the ways in which soil is eroded and deposited by water?*
- *How does the Earth's surface affect the flow of river and streams?*
- *What role does the water cycle play in shaping the landscape?*

Time: 75 minutes

Knowledge and Skills: K3, K4, K5, K6, K7, K8, S3, S4, S5, S7, S8, S9, S10, S11

4. PROPERTIES OF EARTH MATERIALS

STC Land and Water Lesson 5: Examining Earth Materials. In Lessons 5, students observe and record the properties of soil and examine the processes by which water flows over and through land. Lesson 5: focuses on appearance, texture, size of particles, and what happens when added to water. You can use water record sheet 5-A on page 59 or have students incorporate their data into their science notebooks.

Note: You can incorporate the sedimentators (clear tube with soil samples with various particle sizes and water) into this lesson.

- *How does water move above, below, and on land?*
- *How do soil properties affect the ways in which soil is eroded and deposited by water?*
- *How does the Earth's surface affect the flow of river and streams?*

Time: 60 minutes

Knowledge and Skills: K2, K3, K7, S3, S4, S5, S7, S8, S9, S10, S11

Skip Lesson 7-9 and 11. (complete these lessons if there is additional time)

5. SLOPE AND FLOW

Combine STC Land and Water Lessons 10 and 13 into Slope and Flow Inquiry.

***SEE PAGE 19 FOR SLOPE AND FLOW INQUIRY)**

- *How do man-made and natural land features affect the flow and direction of water, influencing erosion?*

- *How does nature and human activity affect the flow of water and the landscape?*
- *How and why do we change the flow of water?*
- *How do soil properties affect the ways in which soil is eroded and deposited by water?*
- *How does the flow of river and streams affect the Earth's surface?*

Time: 3 days or 4 ½ hours

Knowledge and Skills: K2, K3, K4, K4, K6, K7, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11

6. HUMAN INTERACTION WITH LAND AND WATER INQUIRY (Investigate dams, plants, landscapes, pollution, etc.)

Combine STC Land and Water Lessons 12-16 into the Human Impact on Land and Water Inquiry

***SEE PAGE 41 FOR HUMAN INTERACTIONS WITH LAND AND WATER INQUIRY)**

Suggested time: 5-7 lessons

(K2, K3, K4, K5, K7, K8, K9, K10, K11, S1-10)

- *How does water move above, below, and on land?*
- *How do man-made and natural land features affect the flow and direction of water, influencing erosion?*
- *How does nature and human activity affect the flow of water and the landscape?*
- *Why and how do we change the flow of water to make the landscape a safer place to live?*
- *How do soil properties affect the ways in which soil is eroded and deposited by water?*

7. POST ASSESSMENT

Share inquiry investigations through oral presentations, posters, diagrams, and science notebooks.
(Revisit pre-assessment)

Slope and Flow Inquiry

(Concepts related to Land & Water Lesson 10 & 13)

Classroom Stream Table Inquiry Vignette

SLOPE and FLOW Inquiry

(Inquiry that can result by combining STC *Land and Water* Lessons 10 & 13)

Materials Needed:

- Stream tables with Earth materials
- Cups with large and small holes
- Cups with multiple holes
- Rulers
- Books (to increase slope)
- Additional materials for student inquiry might include: toothpicks (change flow), rocks, string, etc.

“Draft - Adapted with permission from Exploratorium Institute for Inquiry copyright protected materials distributed at the 2005 Classroom Strategies for Teaching Inquiry Workshop. For more Institute for Inquiry resources, see www.exploratorium.edu/IFI.” - Modified by Wallingford Public Schools

This resource is designed to give teachers an image of inquiry in the classroom and an understanding of the main issues a teacher must consider when implementing classroom inquiry. This document helps teachers plan for a similar inquiry in their classroom.

This is a description of an inquiry on stream flow and erosion that was done in an elementary classroom over a 3 day period for a total of 4.5 hours. There were 28 students, many of whom were bilingual second language learners.

The content goal for the inquiry was for students to understand how different variables affect the amount of erosion, including the steepness of the slope, the amount of water flow, and the size of the sediment particles. The process goals were for students to be able to ask investigation questions, to plan and do an investigation, and to interpret and report their investigation results.

Day 1:

Schedule: 90 min

- Introduction 10 min
- Inquiry starter I 15 min
- Eliciting observations/questions 15 min
- Inquiry starter II 15 min
- Eliciting more questions 10 min
- Forming groups/plan investigations 15 min
- Clean-up and closure 10 min

Introduction

Before the students came in, the teacher covered the tables with plastic/newspaper and prepared a streamtable set up for each table group of four. Then, the teacher explained to the class that they were going to do an investigation on streams and erosion over a three-day period. Today, they would explore streams and erosion by pouring water through stream tables full of earth materials and raising questions. Tomorrow, they would investigate a question in small groups which they would then present to the class the next day.

Inquiry Starter I

Note: Direction cards for Inquiry Starter 1 can be found on Wallingford's W drive.

The teacher demonstrated how to set up and run a stream table, using a water container with a small hole. He told them to do one or two runs and then experiment with the larger hole. As the students worked, he circulated and reminded them to remember their questions. He gave a 2 minute warning and then asked the groups to stop.

Eliciting observations and questions

He asked the students to put down their materials, write down something interesting they had noticed, and be prepared to share this with the class. After a minute, he asked for people to share their observations, which he repeated out loud, including:

- It pushed a big pile of sand down
- It makes its own path in the sand.
- The bigger hole makes a puncture where the water drips.
- The bigger hole makes bigger lanes for the water to go through.
- The smaller hole did a lot less damage.

After sharing these observations, he asked people to share their questions, particularly ones that they would want to investigate further tomorrow.

As the students asked questions (or sometimes, stated more observations), the teacher asked clarifying questions in order to make sure he understood what they were curious about, so that he could rephrase their statements if necessary to help everyone understand them. Then, he charted them.

For example, a student said he noticed that water seeped from under the sand rather than flowing over it, but this only happened with the 1/8" hole. The teacher asked him if what he was curious about was "why does the middle size hole make underground streams?" He agreed and the teacher charted it.

Here are some examples of their questions related to **flow** (and more observations):

- Why does the large sized hole make underground streams?
- How does the water have the strength to move the sand?
- How do the different holes make the streams more or less squiggly?

- How does the sand hold so much water?
- How come the sand turned the water yellowish brown?
- Why didn't the water make it all the way down with the small hole?
- Why does the water keep flowing after the land has absorbed some of it?
- How does the water make deep paths in the soil?
- How did the water travel through the soil?

Inquiry Starter II

Note: Direction cards for Inquiry Starter 1 can be found on Wallingford's W drive.

The teacher passed 4 books (or wooden blocks) to each group and asked the class to continue exploring by changing number of books under the pan (the slope) while using only the small hole. Some groups tried very steep slopes and found that the water had dug down to the bottom of the pan.

As the teacher circulated, he asked the students what they were noticing and encouraged them to compare one situation to another. For instance, one group deviated from the directions by pouring water straight from the pitcher rather than using the drip containers and the teacher asked the group if using the whole pitcher had a different effect on the sand than using one of the containers with holes?

More questions

Again, the teacher stopped the class and asked for more questions that they might want to work on further tomorrow.

Here is a list of additional questions related to slope.

- Why did the water go faster with more books?
- With four books, it pushed all the sand away.
- With lots of water and no slope, it pushed lots of sand away.
- With four books, the water went straight even though there was a squiggly channel.
- When you use four books under the pan, does the water make more lanes to flow through?
- Why did the higher slope absorb more water?

The teacher should remove questions not related to the content goals of the unit.

Forming groups

The teacher complimented the groups on all their questions and told them that they could choose a partner or two to work with for the rest of the investigation. He said that they could work with a friend, but if they started to get silly, they might have to split up.

Making plans

Then, the teacher passed out a “planning sheet” and asked the groups to take 10 minutes to make a plan for the next day.

Planning and Investigating with Streamtables

Pick a partner or two, choose a question to investigate, and make a plan.

On your plan below, record the materials you might need and the steps you think you need to help answer your question.

Consider the following questions:

- What will you observe or measure to answer your question? (such as: how deep the stream gets, how much sand is moved, etc.)
- What parts of the streamtable set-up will stay the same? What things will you change?

Investigation Question:

Materials Needed for Investigation:

My first step will be to ...

My next step(s) will be ...

The teacher said that the first thing they should do was to pick a question to investigate. They could pick anything from the question chart, whether it was their question or someone else's. The most important thing to think about was whether it was “do-able”. They would need to decide in advance what they could do that might help answer their question and what materials they would need. If their group needed materials which weren't in the classroom, the students would either have to bring them from home or would have to choose a different question.

Then, the teacher introduced the available materials for tomorrow. There were more stream tables and set-ups if they needed to do comparisons. They could also use uniformly fine or

coarse sand in addition to the mixed size sand they had been using. Finally, there were “cubes or toothpicks” they could use if they wanted to keep track of a “place” on their sandscape.

The groups wrote down their plans while the teacher circulated. His major facilitation strategy was to ask the groups what they thought they would need to do in order to answer their question and what materials they would require. One student asked to work alone and, after finding that he had a solid plan, the teacher consented. After 10 minutes, the teacher collected the plans and organized the class to clear the materials onto an empty table where they would be ready for the next day.

Formative assessment after school

That evening, the teacher looked over the plans the students had come up with to decide how to prepare for the next day.

Here are examples of two student planning sheets.

Chad, David, Aaron, and Grant

Investigation question:

Why does the middle sized hole make underground streams?

Materials needed for investigation:

Cup with small hole, scraper, water, mixed dry sand

My first step will be to ...

Smooth the sand

My next step(s) will be ...

Put the cup where we want it, pour the water in the cup. Then, examine it for underground streams.

Nicole, Chelsea, and Michelle

Investigation question:

How does water go through two different kinds of sand?

Materials needed for investigation:

Small and medium particle dirt, 2 stream tables, 6 books, 2 small hole cups, 2 large hole cups, 2 cups with 3 holes, 2 pitchers, 1 scraper, 1 rag

My first step will be ...

Put the sand over the hole of the stream table

My next step(s) will be ...

Pour the water in the tray. Watch the water try to get through the sand

The teacher noticed that most of the plans had similar issues, such as not clearly identifying what the group wanted to observe or measure, that would help them answer their questions, or not setting up fair tests for their ideas, which included controlling variables. As a result, the teacher decided to model a plan to emphasize these things, and then give some time for every group to reflect on and refine their plans. He chose the following question which no one had chosen to do for modeling a plan.

“When you use more books under the pan, does the water make more lanes to flow through?”

Day 2

Schedule	90 min
Modeling a Plan/Refining Plans	20 min
Investigating	45 min
Clean up	10 min
Planning to Share Out	15 min

Modeling a plan/refining plans

The teacher told the class that before carrying out their investigations, they would refine their investigation plans. He also thought it would be helpful to practice making a plan as a whole group to model the process.

He showed the chart with the question “When you use more books under the pan, does the water make more lanes to flow through?” and asked the class to think about how they might make a plan for investigating this question. He waited for at least a few hands to go up and called on one person to start.

One student said that she would set up a stream table with 4 books and pour water through it. The teacher asked the student what she would be looking for after she poured the water. She said she would count the number of lanes.

The teacher said that was an important part of a plan – i.e., what you look for or measure. Then the teacher asked the student what she would do next to see if the number of books changed the number of lanes. The student replied that she’d take away a stick and do it again.

The teacher said that was well thought out because it would allow her to compare the effect of three and four books. But there were a few details that the student hadn’t mentioned, such as what size drip container she had used. She answered “small hole” and the teacher asked if it would matter if she used one size hole for the first run and another size hole for the next. She didn’t think it mattered, but other students thought it did. The teacher emphasized that if you are

interested in what happens when you change one thing, like the slope of the pan, then you should keep as many other things the same as possible.

The teacher charted this plan and called on someone else who shared a slightly different approach. The teacher said these were both good plans, illustrating that there can be many good plans for investigating the same question, though all good plans include certain elements such as:

- What you are going to observe or measure to try to answer the question
- Fair tests - which change one thing at a time and keep the rest the same

Then the teacher returned the students' plans and asked them to spend about 10 minutes refining them. The teacher circulated and asked questions to help students think through their own plan in the same way that he asked questions to help them think through the group plan. The refined plans were much more complete and systematic.

Beginning the investigations

The teacher pointed to the materials table and asked each group to choose a person to collect the groups' materials because "if everyone gets up all at once to get materials, it will be too crowded."

Once the groups started their investigations, everyone appeared thoroughly engaged. Some groups noticed that the fine sand was eroding more, while the coarse sand was staying in place with the water going underneath it. Others who were investigating clogging the drain hole noticed that the coarse sand let water pour out faster than the fine sand. Other groups compared the color of the water coming out of different kinds of sand, the amount of water that flowed all the way through the stream table, or the amount of sand moved using different sized drip containers.

As groups told the teacher what they were seeing, he would ask them questions to help them develop explanations, such as "Why do you think that's happening?", and questions to help them test their ideas, such as "Can you think of a way to test that out?".

One group noticed that the water flowed more quickly through the coarse sand than the fine sand. So the teacher asked if they had any ideas why this might be happening. They weren't sure at the time but came up with a thoughtful explanation later. Another group noticed that the coarse sand didn't seem to be moving as much as the fine sand. They thought this was because the water flowed through the holes between the coarse sand grains but had to push through the closely packed fine sand. The teacher asked them "If you had to choose a place to build a house, would it be on the coarse or fine sand? Or on the steep or flat places?" This was meant to help the students extend their ideas.

After about 30 minutes, the teacher stopped the students by ringing a bell. He then gave a brief demonstration that might help the students understand some of the investigations. It showed that finer particles of sand settle more slowly than coarse ones when shaken in water. Then, he told the class they had about 10 minutes to finish their investigation so they should begin to think about what they had found out so far and how they might communicate it to the other groups.

Finishing the investigations

In the last 10 minutes, he circulated and encouraged groups to think about what they'd found, or to try one more thing. One group had investigated whether a curved or straight dam would break first. However, they had put the straight dam behind the curved dams in the same pan. The teacher suggested that they might want to use the remaining time to try it with each dam in its own pan unless they had something else in mind. They said they had wanted to make a poster of their results, and the teacher encouraged them to do this, knowing that he could mention the idea of comparing the dams separately during their presentation as a way of reinforcing this idea for the whole group.

Planning to share out

After enlisting the students to help clean up the materials, the teacher passed out an "investigation presentation" sheet that asked groups to write their question, what they tested, what they found out, and why they thought this had happened. Each group was asked to choose a recorder and hand in their sheet before the end of the period. Also, they should consider who would present their findings the next day,

Formative assessment after school

When the teacher looked at their "investigation presentation" sheets there were a number of surprises. Some groups who didn't seem to be investigating very seriously had some thoughtful explanations for their results, and some groups who worked hard had very little written down. For example:

Lesley, Alejandra, Ten

What was your question?

Why does lots of water and no slope push a lot of sand away?

What did you test?

We tested how sand gets carried away by the water.

What did you find out?

We think this happened because ...

Chad Aaron, David and Grant

What was your question?

Why does the water create underground streams?

What did you test?

We tested what sand was better for underground streams.

What did you find out?

We found out that the medium sand makes better underground streams than the fine sand.

We think this happened because ...

We think this happens because the medium sand was bigger so that when they bundled up, it had bigger gaps than the fine sand.

Chelsea, Michelle and Nicole

What was your question?

How does the water go through 2 different kinds of sands?

What did you test?

We tested how the water goes through medium sized sand and small sized sand.

What did you find out?

We found out that the water goes under the medium sized sand and the water goes on top of the small size sand. When we mixed the sands together, the water goes on top of the sand and under the sand.

We think this happened because ...

The small sand was packed tighter and the medium sand was bigger and not as tight so the water went on top of the small sand and under the medium sand.

Most groups seemed to need a bit more time to figure out how to make a clear statement about what they had found that they could support with the evidence they had observed. As a result, the teacher made a poster to go over the main points he wanted each group to address, and gave them about 15 minutes for refining their presentations.

Share Your Investigation

- Your question:
- What you did to try to answer your question?
- What you found out and why you think so?
- What questions do you have now?

Finally, the teacher considered how he would synthesize what they had done in terms of his content goals on the effect of slope, flow, and particle size on erosion. Many groups' investigations addressed the idea of particle size, some through investigating underground streams or how well water gets through fine or coarse sand, and some through comparing the color of the water in the catchbasin (which is caused by the fine particles being carried all the way through the stream table). A few groups looked at the idea of the effect of flow by comparing pouring from a pitcher to pouring from the small holes in the containers. No group

had explicitly investigated the effect of slope, but 2 groups had included slope as smaller parts of their investigation.

If there had been other ideas besides slope, flow, and particle size that groups had addressed (such as the effect of saturation), the teacher would have made sure to honor them but there weren't at this time. As a result, he made a poster showing prompts to engage the students in a conversation about how the ideas of flow, slope, and particle size affected erosion.

Based on our investigations, how do you think these variables change how much erosion happens in the streamtables?

- Flow of water
- Slope of the streamtable
- Size of the sand particle

Day 3:

Schedule 90 min

Refining Plans for Sharing Out 20 min

Sharing Out 50 min

Synthesis of Idea 15 min

Closure 5 min

Refining plans for sharing out

The teacher reminded the students that today they were going to hear from each group about their investigations, and then, as a class, consider what they had learned about stream flow and erosion. He posted the chart of what to include in their presentations, went over it with them, and told the class to take about 15 more minutes prepare their presentations.

As the teacher circulated, he encouraged certain groups to present certain things. For example, he asked the groups investigating underground water to share their explanation that coarse particles left bigger holes for water to go through than fine particles, because this was an important idea that many groups could use to explain their results.

Some groups needed encouragement because they were nervous and didn't know what they should share. So the teacher "rehearsed" them saying, "just tell me what you think" and then encouraging them to repeat it to the class.

The teacher asked one group who seemed to be ready a bit before others if they would be willing to go first. This group had investigated underwater streams, so the teacher knew that other groups could expand on what the first group found.

Sharing out

The teacher said that one group had volunteered to go first, that everyone should listen very carefully and could ask questions at the end, and to volunteer to go next if your presentation was about a similar idea.

After the first presentation on underground streams, several groups volunteered to go next. It seemed that many people were eager to share. The teacher chose one group that he knew was related to the previous presentation.

After some groups presented, the teacher asked them to mention things they'd done or thought but hadn't mentioned which the teacher knew were related to the content. For example, one group who had investigated underground streams noticed but did not mention that houses put on coarse sand were destroyed less often than those on fine sand. So the teacher asked them to describe what they noticed about the houses, and based on their investigation, would they recommend people build houses on coarse or fine sand because it was more or less prone to erosion? There was also a group that had made a series of stream tables where one drained into the next. Although their investigation was meant to be on flow rates, the slopes of two stream tables were different. So the teacher asked them to comment on the effect of slope on erosion. This way, everyone could hear their results and the teacher could draw on it during the synthesis.

The teacher also looked for places to reinforce points about planning investigations and ideas on erosion. For instance, during the presentation on the two dams, the group said that they found the straight dam held up longer than the curved, but that the conditions were different because one dam was in front of the other. The teacher helped them to consider that they could try it again side by side in two stream tables so it would be a fair test.

Each group seemed to enjoy presenting. The class applauded after each one.

During this time the teacher took notes about each group's presentation in terms of their relation to the big ideas of slope, flow, and particle size. That way, he could refer to them in the synthesis.

Synthesis

After the final group, the teacher thanked everyone for their work, and explained that they were going to discuss what they learned both from their own investigation and from each other. The teacher showed a chart to help focus the discussion, and started off by asking what was the effect of flow on erosion, then slope, then particle size.

Based on our investigations, how do you think these variables change how much erosion happens in the stream tables?

- Flow of water
- Slope of the stream table
- Size of the sand particle

As the groups added ideas about each of these variable's effect on erosion, the teacher charted their thoughts, asked questions to draw out additional information, and added some observations of his own.

Here is what the students said that the teachers charted:

Flow:

When the flow is greater,

- water goes faster and sand goes with it
- more sand is moved

When the hole is smaller, less sand is moved.

Slope:

Higher slope

Faster water

More sand moved

Lower slope

Water slower

Sand didn't move much

Particle size:

Bigger sand didn't break as fast

Fine sand held water longer

Small particles move further

In conclusion, the teacher posted the charts he'd just made about the effect of slope, flow, and particle size on erosion, and said that in summary, it seemed that the greater the slope, the more erosion takes place; the greater the flow, the more erosion takes place; and that finer particles erode more easily than coarser ones.

During a final conversation about what they'd found out, the teacher encouraged the students to be proud of themselves because they had just done real science, and that the things they had found out were the kinds of things that people make real decisions about, such as where to build a house, etc.

What these students had gone through was a process that answered some questions but also raised many additional ones. Their observations, questioning, planning, and thinking skills helped everyone learn together much more than any single student could have learned alone.

Teacher Notes on Synthesis:

This inquiry was designed with some science concepts in mind that could be learned through investigation. The intention was not that each student would arrive at all the science concepts, but that all the groups collectively would arrive at most, if not all, those ideas. When everyone shared their results, what they had learned became part of the entire group's understanding. Students should be learning from each other.

At the end of an inquiry, it is important to “synthesize,” to put all the information from your presentations together in a way that highlights a few central scientific ideas. Doing this can be helpful because people may have found out some fundamental and important ideas but don't know that they are important because there is so much information to digest.

The first idea is that the greater the flow, the more erosion takes place. This may seem like a simple idea but it's an important one, and the groups whose investigations supported this idea found that greater flows:

- moved more sand
- dug deeper or wider channels
- created longer or wider deltas

The next idea is that the greater the slope, the more erosion takes place. Again, this seems like a simple idea but it's an important one. Groups that supported this idea with their investigation found that greater slopes:

- moved more sand
- dug deeper or wider channels
- created longer or wider deltas

Next is the idea that, in general, the lighter the particles (typically the smaller ones), the further they move. Once particles are swept up into the flow of water, the lighter ones – typically the very fine particles, take longer to settle out. We saw this in the shake bottles – the fine baking soda took a lot longer than the coarser sand to settle out. People may have noticed that the water in your catchbasins contained some fine sediment which had been carried all the way through out the stream tables.

There are two kinds of special cases about particle size that often come up, and one is that there are very dense fine particles that can behave like coarser, less dense particles. It's really about how heavy the particle is that determines how far it is swept, so it's not really just about the “size” of the particle. For example, iron filings and baking soda would behave differently even though they are both very fine. The other exception that many people notice is that, after the water runs out, it appears that the streambeds contain only fine particles and that the larger particles have been swept away.

The next idea is called *Chaotic Systems*. This is a complex idea has to do with the interaction between the sediment and the flowing water. Some groups found that it was hard to get consistent results, no matter how hard they tried to make the starting conditions the same. The idea of Chaotic Systems is that there are feedback loops that cause behavior which does not appear to be very consistent. For example, in weather systems which are hard to predict, heat affects how windy it is, which in turn affects how hot it is, which continues to effect how windy it is, and so on, which can lead to gale winds on some days, gentle breezes on others, even though the days began with similar conditions. In the stream tables, the sediment affects how the water flows, which changes where the sediment is, which changes where the water flows. So even tiny differences in the initial starting set-ups can lead to drastically different results. It may have been hard for people to try to get consistent results, no matter how hard you tried to make the starting conditions the same.

One consistent pattern is that there are certain landforms, such as deltas, meanders, and islands frequently occur. Most people noticed that. Some may even have noticed that the islands had similar shapes – they are typically lentil shaped, or football shaped islands – because these shapes allow water to flow past them without being eroded away very quickly.

Note: Common examples of such ideas are:

- more saturated soils eroded more
- objects such as toothpicks or gravel pieces were effective in channeling the water in certain directions, thus preventing erosion in other places, or making water flow more in some places and thus erode more

<p style="text-align: center;">Inquiry Starter 1 – Student Directions <u>Flow</u> Starter Station Card</p>
--

1. Make sure your stream table is flat on the table.
2. Bulldoze the stream table and start with a flat surface.
3. Velcro the cup with the **one small hole** to the back of the stream table.
4. Fill the cup slowly with water. Use 1 liter of water. Keep the container topped up so it drains steadily.
5. Observe what happens to the water and to the sediment.
6. Repeat steps above using a cup with **one large hole**.
7. In your science notebook, complete a T-chart shown below.

FLOW Station	
I notice (also include illustrations)	I wonder.....

Inquiry Starter 2 – Student Directions

Slope Starter Station Card

1. Bulldoze the stream table and start with a flat surface.
2. Raise the back of the stream table on **two books**.
3. Velcro the cup with the one small hole to the back of the stream table.
4. Fill the cup slowly with water. Use 1 liter of water. Keep the container topped up so it drains steadily.
5. Observe what happens to the water and to the sediment.
6. Repeat steps above raising the back of the stream table using **four books**.
7. In your science notebook, complete a T-chart shown below.

SLOPE Station	
I notice (also include illustrations)	I wonder.....

Planning and Investigation

Group Members:

Investigation question:

Materials needed for investigation:

Our first step will be to

Our next step will be to

Also consider the following questions:

- What will you observe or measure to answer your question?
- When you do different runs in the setup, what parts of the stream table setup will stay the same? What variables will change?

Investigation Presentation Preparation

Group Members:

What was your question?

What did you test?

What did you find out?

We think this happened because....

What We Learned

Based on our investigations, how do you think these variables change how much erosion happens in the stream tables?

- Flow of water
- Slope of the stream table
- Size of sand particle

Human Interactions on Land and Water Inquiry

(Concepts Related to Land & Water Lessons 12-16)

HUMAN INTERACTION WITH LAND AND WATER

INQUIRY INVESTIGATION

GRADE 4 Land and Water

This guide is a tool for helping you plan an inquiry activity. The prime factor is that your students get the opportunity to practice choosing their own question and planning and carrying out an investigation to find out what they can learn from investigating that question.

Approx. Time: 5-7 days

Related State Content Standard(s):	Related State Expected Performance(s):
<p><i>Earth's Systems – How do eternal and internal sources of energy affect the Earth's systems?</i></p> <p>4.3 Water has a major role in shaping the Earth's surface.</p> <ul style="list-style-type: none"> Water circulates through the Earth's crust, oceans and atmospheres. <p><i>The Changing Earth – How do materials cycle through the Earth's systems?</i></p> <p>2.3 Earth materials have varied physical properties which make them useful in different ways.</p> <ul style="list-style-type: none"> Soils can be described by their color, texture, and capacity to retain water. Soils support the growth of many kinds of plants, including those in our food supply. 	<p>B12. Describe how the sun's energy impacts the water cycle.</p> <p>B13. Describe the role of water in erosion and river formation.</p> <p>A21. Sort different soils by properties, such as particle size, color and composition.</p> <p>A22. Relate the properties of different soils to their capacity to retain water and support the growth of certain plants.</p>
Related Enduring Understanding(s):	Related Essential Question(s):
<ul style="list-style-type: none"> Water has an important role in shaping the land on earth. Land forms may change the direction and flow of water. Earth's materials (rocks and minerals) are formed and may undergo <i>change</i> by certain conditions, such as erosion or metamorphism, and can occur over various amounts of time. The landscape is a result of the long-term integration of a variety of natural and man-made processes that act on the 	<ul style="list-style-type: none"> How does water move above, below, and on land? How does water change form as it moves through the water cycle? How do river and streams shape the surface of the Earth? How do man-made and natural land features affect the flow and direction of water, influencing erosion? How does nature and human activity affect the flow of water and the landscape? Why and how do we change the flow of

<p>surface of the Earth. Land and water have an impact on each other.</p> <ul style="list-style-type: none"> Human activities impact the landscape sometimes resulting in changes in erosion and changes to water flow. 	<p>water?</p> <ul style="list-style-type: none"> How do soil properties affect the ways in which soil is eroded and deposited by water? How does the Earth's surface affect the flow of rivers and streams? What role does the water cycle play in shaping the landscape?
<p>What simple content objectives/goals do you want to accomplish with this investigation? (see district curriculum documents)</p>	<p>What simple process skills do you want to improve with this investigation?</p>
<p>Students will:</p> <ul style="list-style-type: none"> Explore human interaction with natural elements to effect changes in landscape. Explore ways humans protect land from erosion. Learn about the damaging effects of pollution and ways in which to prevent it. Generate investigable and non-investigable questions. Design an investigation to answer and investigable question. Make predictions about how human activity affects flow of water and landscape. 	<ul style="list-style-type: none"> Predicting Observing Collecting data, organizing it, and communicating results
<p>What phase of this investigation will you provide the most modeling/templates/mini-lessons/scaffolding for better skill development?</p>	
<p>Phase 2- planning an investigation and collecting observations and data.</p>	
<p>Materials/Resources</p>	
<ul style="list-style-type: none"> Nonfiction texts (pictures from texts, video clips, etc.) All materials in the kits Students can bring in additional materials from home as needed. Pattern blocks or centimeter cubes (can be used for houses/buildings) Popsicle sticks (for making dams) Food coloring (to show pollution) If students are going to investigate how plants effect erosion you may want to grow plants in separate containers in advance (plant seeds early and/or use various small plants) 	

In order to guide students to raise questions for all categories, have these headings on sentence strips in the room.

Sample student investigation questions:

Dams:

- How do dams hold back water?
- How do humans build dams?
- Why do humans build dams?
- How do dams affect the environment?
- How do dams affect the flow of water?
- How can we prevent water from damaging land?

Plants:

- What roles do plants have in land and water interaction?
- How do plants reduce erosion?
- How do plants affect water flow?
- How do plants protect soil?
- How do certain plants affect erosion differently?
- How will plants handle a warmer environment (global warming)?

Landscape:

- How does landscape affect flow of water?
- How do landscapes affect soil erosion?
- How does the design of the landscape affect erosion?
- How do land features affect erosion?
- How do land features affect the flow of water?
- How do glaciers change the land?
- How does wind affect the land?

Pollution:

- Where does clean water come from?
- How do we prevent water pollution?
- How is water pollution treated?
- How does water pollution affect the environment?
- How is pollution spread by the water cycle?
- How does weathering affect the land (acid rain)?

PHASE 1 – Observing and Questioning

INQUIRY STARTERS

- What is the launching activity or **inquiry starter** for the investigation?
- What will be your **inquiry starter prompt**? How will you "invite" your audience to work with the materials?
- What **materials** will you use for the inquiry starters?
- How will you **elicit and collect or display student's questions**? Will they share questions orally? In writing?
- **Choosing investigation questions:** How will you help your students determine which questions they can choose from to investigate? How will you or the students form investigation groups?

Time	Task	Hints
5 min.	Teacher review of previous lessons focusing on stream tables, erosion, flow, and slope.	
30 min.	<ul style="list-style-type: none">• Teacher randomly divided class into four groups.• Students view pictures in nonfiction texts, picture cards, video clips, that will stimulate investigable questions.• All pictures relate to dams, plants, landscape, and pollution.• Students will rotate among the four centers.	<ul style="list-style-type: none">• Students should take notes or start to form wonderings in their journals.• Students can be encouraged to discuss their wonderings among their group members.• Assessment note: This is an opportunity for the teacher to formatively assess the ability of your students to write detailed observations and questions.
10 min.	<ul style="list-style-type: none">• Create a T-chart on the board with "I notice" and "I wonder". Chart the student's observations (I notice). These will naturally lead to questions (I wonder).• At this time teacher should introduce students to the additional materials that will be available for students' investigations. This will generate additional questions.	<ul style="list-style-type: none">• Guided Lesson/Thinking Tool: Try to help students rephrase their questions into investigable questions that can be investigated in the "here and now" with the materials that we have available. "XXXXXX" is a great question, but not investigable with our materials.• See page 2 of this inquiry

	<ul style="list-style-type: none"> Teacher may choose the most appropriate questions for investigation based on the content objectives of this lesson. 	investigation for some of the sample questions that students may generate.
--	---	--

Student Samples - I notice.... I wonder... I Notice.... (these are generated from photo cards in kit)	
<ul style="list-style-type: none"> The rocks are jagged. Water is flowing over the rocks. There are clouds in this picture. There is a big river and frozen ice/snow. There is different plant life. There are trees all over the river. There are little islands in the river. There are cracks in the snow (glacier). There are two mountains on either side. There is a whole in the rock. There are rocks balancing on other rocks. There are trees growing in water. Water flowing on different levels. There are trees with nothing around them, their roots are exposed and there is a canyon in the background. 	I Wonder <ul style="list-style-type: none"> How are there holes in rocks? Where did the water come from that is flowing over the rocks? Why does the water look like it is flowing down steps? Is the water clean? Drinkable? How did the clouds get in the mountains? How did the cracks form in the glacier? Why are the roots exposed? How did the canyon form? How many different kinds of plants live here? Why are there islands in the middle of the river? How does the water get polluted? Are the clouds polluted?
<p>Teacher can create groups for planning and investigating, (groups of 2-3 are recommended).</p> <ul style="list-style-type: none"> Things to consider: How will you help your students determine which questions they can choose from to investigate? How will you or students form investigation groups? 	<ul style="list-style-type: none"> The teacher may want to form groups based on student interest in a particular question. Assigning group roles such as materials manager, recorder, timer, etc. may be helpful. Note: This is the suggested end to Day 1 of the lesson.

PHASE 2 – Planning and Investigating

INVESTIGATION

- What **additional materials** will you introduce? How will you introduce additional materials participants can use to study the phenomena?
- How will you manage/organize materials, set up and clean up?
- How will you support the groups in **planning** their investigation? Will you provide criteria or planning sheets?
- How will you facilitate during the investigation?

Time	Task	Hints
15 min.	Teacher will review the materials available for the groups to use to investigate their questions.	
25 min.	<p>Class can brainstorm the elements of an effective plan while the teacher records on chart paper. Items discussed may include:</p> <ul style="list-style-type: none">○ Question○ Directions – numbered/sequenced steps○ Revise plans when changes are made○ List of materials w/ quantities○ Jobs – if assigned○ Must be reproducible (someone else should be able to duplicate the investigation and get same results)○ Labeled diagrams or drawings○ Prediction / hypothesis○ Type of results you will collect and how they might be <p>This can remain as a guide for students to refer to as they plan, or can be utilized to formulate a rubric.</p> <p>Teacher directs each group to develop a plan to use to investigate their question. This should be recorded by each group to share with the class in words or pictures.</p>	<ul style="list-style-type: none">• This can be done with minimal teacher input; in order for students to develop their own plans (mistakes are expected).• If teacher or students need additional guidance see STC <u>Land and Water Lesson 12</u>: Dams pp. 129-133, Lesson 14: Plants and Erosion pp. 153-162 Lesson 15: Landscape pp. 163-172• Assessment Note: This is an opportunity to formatively assess student planning.• Teachers may choose to use the “Investigation Plan Template” (find template at the end of this inquiry). This template can be taped into students’ journals for future reference.• Teacher may choose to model a plan using a question that students are not investigating.

3 min./group (15-20 min. total)	Students will then share their plans with the class (pair share, museum walk, chart paper, jigsaw, etc.), possibly modeling specific steps, using the materials.	<ul style="list-style-type: none"> Teacher should be adding key elements of an effective plan to the original list recorded on chart paper.
15 min.	Students should revisit their plans at this time, making the necessary revisions.	<ul style="list-style-type: none"> Teacher should reinforce the fact that most/all of the important plan elements were included in students' shared plans. <p><i>Note: This is the suggested end to Day 2.</i></p>
Time will vary among groups (if a group finishes their question, they can begin to investigate another question or deepen their understanding through literature) Approximate: 3-4 days	<p>Using their investigation plans and materials, students can conduct their investigations. Students will record their observations during the investigation in their student journals.</p> <p>Teacher will facilitate with reminders to record observations and measurements. Removing students from their materials for a few minutes will help them concentrate on recording observations and noting revisions they made to their plan.</p> <p>If students finish their investigation early they can continue to investigate a related question or start preparing for their presentation/sharing with the larger group. Students can also deepen understanding of investigation using various nonfiction texts and websites.</p> <p>Plan on ample time for clean-up procedures.</p>	<ul style="list-style-type: none"> Materials can be distributed to each group by the teacher, or a designated student may gather them for his/her group. Plastic café trays may be helpful to manage the materials. Teacher should circulate, questioning and guiding groups. Remind students that a good plan may still need to be revised once you begin your investigation. Remind groups that if they get stuck, they can: <ul style="list-style-type: none"> Walk around the room to see what other groups are doing Ask another group for advice Ask the teacher for advice Guided Lesson/Thinking Tools: Teacher may need to provide a mini-lesson on data collection and organization of this data. Some groups may need a template/chart to help with data collection. <p><i>Note: This is the suggested end to Day 3 of the lesson.</i></p>

Open Ended Questions and Comments to Help Guide Students during the Investigation

What do you know about...?	Tell me about it.
What will you need?	What's your plan for that?
What will you add?	What does this remind you of?
I wonder what will happen when...?	Tell me more about...
Why is that happening?	How are you going to use...?
Show me how that...	How will you use this today?
How do you know that?	What does it need?
What do you see, notice, hear about...?	What else can you do about...?
What does this do?	What will happen if...?
Where have you seen...?	How can we change that?
What's happening with this?	What happened when you did that?
What would you say about...?	What is different about that?
How can we find out about...?	What will you do to change that?
What other way can you try?	Show me...
What else can you do about...?	I'm noticing that..., how did that happen?
What can you use this for?	

PHASE 3 – Interpreting Results and Communicating

SHARING RESULTS AND PROCESSING FOR MEANING

- How will investigation groups present what they have learned from their investigations? (visual, oral presentation, combination, etc.) How will you decide the order of the presentations? (by similar questions, content goals, random, etc.)
- How will the facilitator synthesize the knowledge and findings of the participants for the group?

Time	Task	Hints
30 min. 3 min./group	<p>Prepare to share results.</p> <p>Things to consider: How will students visually share their results? (overheads, chart paper, poster, etc.)</p> <p>Teacher will allow an allotted time for each group to share their results (approx 3 minutes).</p>	<ul style="list-style-type: none"> • Guided Lesson/Thinking Tool: Discuss with students what would be in an “effective presentation” (question, hypothesis/prediction, overview of procedure, results, and conclusion). • Teachers may find it helpful to take notes as students present; documenting which groups had evidence of each big idea. • Teachers may choose to use the template, called “Preparing to Share Results,” to prepare for sharing (template can be found at the end of this inquiry) • Consider charting “findings/ conclusions” after each group presentation. This will be helpful later during the synthesis.
	<p>Synthesis – What have we learned about? Use specific examples from the class to support new learning/findings.</p> <p>Provide a copy (or have students copy into their journal) of the big ideas/summary of investigation findings.</p>	<ul style="list-style-type: none"> • Use the big ideas (see below) to question students to guide them toward the content goals of the inquiry investigation.
	<p>Follow up activity after synthesis. Students will be prompted to write in their science journals about why</p>	<ul style="list-style-type: none"> • What did they learn from revising their plans? • What did they notice about their plans as they investigated?

	Students will then Pair Share their journal entries with a student who was not in their investigation group.	<ul style="list-style-type: none"> • Was sequence important? • Did they develop/consider new questions during their investigation? • Did their partners notice the same things?
	Whole class discussion regarding student journal entries and Pair Share discussions.	<ul style="list-style-type: none"> • You might ask, “How was this different than how you have done science before?” • Assessment Note: Teacher will collect the student science notebooks for summative assessment.

Investigation Plan Template

Team member names: _____

Our **question** is: _____

Our **hypothesis/prediction** is: _____

Materials we will use: _____

PLAN

First, we will _____

Then we will _____

Next we will _____

Finally we will _____

What **changes/revisions** did you make to your original plan?

Preparing To Share Results

Question: _____

Hypothesis/Prediction: _____

Summary of what you did (plan) _____

We found out that (data or results) _____

Conclusion (WHY?) _____

Space for illustration/diagram of investigation plan and/or results.

LITERATURE RESOURCES

These literature resources are recommended to support integrated activities in the classroom.

Guided Reading Sets (6 copies in each school)

Water Cycle, Delta Science Readers (8 pack)

Erosion, Delta Science Readers (8 pack)

Water - theme series Shaping Earth's Surface, National Geographic, Nash Krames

Wind, Water, Ice, Newbridge, Susan Ring

Save our Earth, Pearson i-opener, Sharon Stewart

Explore Your World (Water, Air and Soil), Pearson i-opener, Jeffrey Fuerst

Erosion, Rebecca Olien (3 copies)

Land and Water, STC Books

Read Aloud (1 copy per school)

Rivers - Geography Starts 1-57572-606-2

Thundering Landslides 1-57572-606-2

Raging Floods 1-4034-3724-6

Soil (Rocks and Minerals Series), Melissa Stewart

Sedimentary Rocks (Rocks and Minerals Series), Melissa Stewart

Grand Canyon National Park - A True Book, David Petersen

Erosion: How Land Forms, How It Changes, Darlene Stille

Watery Earth, Science Companion Pearson

Earth's Changing Surface, Science Companion Pearson

Other Resources that may be found in your Library

The Water Hole, Graehm Base

The Day It Rained Forever – A Story of The Johnstown Flood, Virginia Gross

Rocks Tell Stories, Sidney Horesntein

Rocks and Minerals, Dr. R. F. Symes (part of Rocks and Mineral Kit)

Rocking and Rolling, Philip Steele (part of Earth Movement Kit)

Rocks and Soil, Science Projects, Robert Snedden (Raintree Steck-Vaughn)

See 3rd Grade Water Cycle Texts

Videos

The Living Sound, A Kids Video about Long Island Sound

Assorted Videos from United Streaming (membership required)

Other Helpful Resources

www.readingatoz.com Leveled Texts (membership required)

www.edhelper.com Leveled Texts (membership required)

Land and Water – Grade 4

Revised Dec. 2007

(Based on the STC Land and Water Kit)

INVENTORY LIST BY BIN NUMBER

Bin #1	Bin #2
4 clear boxes with hole in end w/lids	4 clear plastic boxes with hole in end /lids
2 gallon bags of gravel – 10 lbs each	15 student books
8 clear 9 oz cups	1 bucket or 4 qt bag of clay
8 clear 9 oz cups with 1 large hole (blue)	250 small craft sticks
8 clear 9 oz cups with 1 small hole (red)	32 - 1 oz (30 ml) graduated cups
8 clear 9 oz cups with 3 small holes (green)	16 jumbo straws
1 funnel	2 rolls of paper towels
1 large graduated beaker – plastic – 1 liter	8 pair chop sticks
1 teacher manual	1 lb marine sand – LABEL BAG
1 copy – Curriculum Guide	3 lb white fine grain sand – LABEL BAG
8 plastic spreaders	8 sets of photo cards
1 roll electrical tape	4 - 500 ml beakers - plastic
8 Rubbermaid Blue Ice Packs	8 plastic spoons
8 rubbers stoppers – size 00	1 box flat toothpicks
8 sprinkler heads	1 large bottle food coloring (or 2 small)
Up to 8 empty water/soda bottles	
1 spray bottle	
Bin #3	BIN #3
8 china markers	Velcro loop strips (30)
1 package of color dots-1/2" round	Velcro hook strips (12)
1 bottle brush to clean graduated cylinders	1 roll masking tape
16 hand lenses	5 – gallon bags all purpose sand
1 10 oz bag of rye seed	1 pack – 3 x 5 index cards
1 10 oz bag of mustard seed	
1 roll string	
48 plastic cm cubes	Bin #4
8 large rubber bands 17.5 x .3 cm 7 x 1/8 inch)	8 plastic gallon buckets
30-60 self stick labels – white – 78 x 31/4 or 3/4 x 1 1/2	40 50 ml graduated cylinders - plastic
8 sets of 6 crayons (orange, black, gold, brown, blue and green)	2 bags of humus – 11 lbs each
	16 Pieces of clear plastic to cover boxes
	4 sedimentators

INSTITUTE • FOR • INQUIRY

A DESCRIPTION OF INQUIRY

Appendix A

1998 The Exploratorium

At the *Exploratorium Institute for Inquiry* our work in science education is deeply rooted in the belief that human beings are natural inquirers and that inquiry is at the heart of all learning. The work that we do with educators is designed to give them an opportunity to personally experience the process of learning science through inquiry. Our hope is that this experience will stimulate their thinking about how to create classrooms that are supportive environments for children's inquiry.

Inquiry is an approach to learning that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search for new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.

The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem.

The process begins when the learner notices something that intrigues, surprises, or stimulates a question—something that is new, or something that may not make sense in relationship to the learner's previous experience or current understanding.

The next step is to take action—through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models.

The learner must find her or his own pathway through this process. It is rarely a linear progression, but rather more of a back and forth, or cyclical, series of events.

As the process unfolds, more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena—and greater potential for further development of understanding.

Along the way, the inquirer collects and records data, makes representations of results and explanations, and draws upon other resources such as books, videos and the expertise or insights of others.

Making meaning from the experience requires reflection, conversations and comparison of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts. All of this serves to help the learner construct new mental frameworks of the world.

Teaching science using the inquiry process requires a fundamental reexamination of the relationship between the teacher and the learner whereby the teacher becomes a facilitator or guide for the learner's own process of discovery and creating understanding of the world.

Map of IFI Inquiry Structure
(3 Phases of Inquiry Diagram)
Appendix B

