Inquiring About Erosion

UVLEL 2012-2013

Jenny Hewitt
Pomfret Fourth Grade

Essential Question: What is erosion and how can it be controlled?

1. "Going, Going, Gone" pgs. 95-100 (Dig In! NSTA)– students simulate rain and wind using a hair dryer and watering can to observe the effects of water erosion and wind erosion on soil
2. "Messy Farms" pgs. 46-47 Amazing Dirt Book – Students set up two "fields" using cookie sheets. The first has straight furrows for planting; the second has curved furrows. Which field has the most erosion?
3. Follow – up – "Disappearing Dirt" pgs. 44-45 Amazing Dirt Book
4. Read aloud – Grand Canyon: A Trail Through Time by Linda Viera

Resources:

- Growlab
- Project Seasons
- Magic Schoolbus Inside the Earth
- Down the Mountain: A Book About Ever-Changing Soil
- Dig In! NSTA
- Soil Science – Delta Science Readers
- The Amazing Dirt Book by Paulette Bourgeois
- Grand Canyon: A Trail Through Time by Linda Viera
- Living in Harmony with Streams: A Citizen's Handbook of How Streams Work – Friends of Winooski River, White River and Winooski River Natural Resources Conservation Districts http://www.winooskiriver.org/
- Riparia's River by Michael J. Caduto and Olga Pastuchiv
- YouTube videos on River Flume http://www.youtube.com/watch?v=EQ9xkLd6QxA
- Wow Express Lesson Plan: Station #1 The River Table
- The Wrath of Irene: Vermont's Imperfect Storm of 2011 by M. Dickey Drysdale

Essential Question: What are the basics of stream dynamics?

1. Introduction to stream dynamics using vocabulary from the WOW Express lesson plan. Prepare index cards with term on the front and definition on the back. For the initial lesson, have students take turns reading the term

and the definition. Make note of which words are familiar and which are confusing. Refer to this list in Lesson #3.

2. Stream Table Basics – This session is designed to familiarize students with the stream table. Important ideas to include are:
    - dynamics of how the table works – 25 gallons of water being circulated through the table using a pump
    - 150 pounds of sediment – repurposed plastic lunch trays
    - velocity of water can be adjusted by using the dial to increase or decrease flow
    - water enters table through headwaters
    - depth of mouth can be adjusted to simulate different elevations/grades
    - various manipulatives can be used to add to the simulation – toy cars, animals, houses, roads, etc
    - Protocol of using wash bucket to rinse hands and manipulatives to minimize loss of sediment and clogging of sink drain

3. Stream Table Dynamics – This session allows students time to observe the stream table at work, make predictions, record observations and wonderings in science notebooks, and link the vocabulary cards from lesson 1 with what they see on the table. Concepts such as meanders, cutbanks, floodplains, and "hungry water" can be observed and discussed. Teacher background information is available in Living in Harmony with Streams: A Citizen's Handbook of How Streams Work. The YouTube video http://www.youtube.com/watch?v=EQ9xkLd6QxA gives a great introduction by watershed educators to stream dynamics using a stream table.

Essential Question: What causes erosion?

Students read background information from the handout "What causes lakeshore and streambank erosion?"

Essential Question: How can erosion be prevented?

Students read background information from the handout "Three Basic Types of Erosion Control Methods". Over the course of the next three sessions, students work with each type of erosion control method individually on the stream table.

1. Vegetative – planting growing materials such as trees, shrubs, grass, and aquatic plants. Students use materials such as plastic

trees with steel wool roots to simulate trees and shrubs and strips of felt and/or washcloths to simulate grass. A cycle of observation, recording in science notebooks, noting wonderings, making changes and predictions, and then starting over again with observing is used. Throughout these sessions, emphasis is placed on using vocabulary as well as observation to solidify understanding of both stream dynamics and erosion control.

2. Structural – using protective structures such as rip-rap, culverts, sandbags, and railroad ties to protect the streambanks. The same process as described above is used. Students are encouraged to watch how rip-rap and other structural changes affect the land downstream and change the meanders of the water. Connections can be made to the reconstruction to river and stream banks following Tropical Storm Irene. Use The Wrath of Irene: Vermont's Imperfect Storm of 2011 as a resource for info and photographs.

3. Manipulative – changing the stream or streambank. Students explore how changing the course of the stream, grading the banks, and/or removing gravel or other impediments affects erosion. This is a great time to reinforce the idea of "hungry water". The following video clip illustrates this beautifully: http://www.youtube.com/watch?v=0tb5may-Ghw&playnext=1&list=PL6C8BB9FB0B8CC4D6&feature=results_video

Assessment Tasks

4. Stream Table Erosion Prevention Performance Task
    a) Review criteria for performance task.
    b) Review rubric for scoring.
    c) Students sign up for either 15 minutes at the stream table by themselves or 30 minutes as a pair.
    d) Students sign up to be photographer/videographer for their partner or another student.
    e) Students are given approximately 30 minutes to think about their plan for the performance task – how they will address the 6 criteria, what they want to test at the stream table, and what materials they will need.
    f) Students use the schedule to rotate through their time at the table and their time as photographer/videographer.

g) Additional sessions are provided for time to write up plan and self-assess using rubric.

5. Technology Integration – Over the course of several computer sessions, students create a one-page Word document synthesizing their learning and integrating multi-media. The "Happy Valley Tech Integration Checklist" is used as assessment.

Essential Question: What can be done to help conserve areas affected by erosion?

6. Citizen Science Component – this portion of the unit is designed to integrate all that students have learned about erosion, water quality, watersheds, and the impact of human actions on a riparian habitat over the course of two years of integrated curriculum.
    a. Read students the book Riparia's River. Talk about what a riparian zone is and how it protects rivers and streams from non-point source pollution by acting as a buffer zone. Make connections to benthic macroinvertebrates as indicators of water quality and low dissolved oxygen levels leading to poor habitat for aquatic life. Reinforce that this book shows one example of non-point source pollution – agriculture. Have students recall other sources of watershed pollution such as pesticides, fertilizers, herbicides, thermal pollution, etc.
    b. Guest Speaker - Greg Russ from the White River Partnership shared information about a Tropical Storm Irene flood restoration project at Hurricane Flats Farm in South Royalton. This was an "out of the box" plan using scour logs, root wads, and other flood debris to stabilize the Farm's streambank along the White River. A conscious decision was made to use this method in conjunction with vegetative erosion control as opposed to structural erosion control in the form of rip-rap. There was significant cost savings as well as the chosen method allows the stream to erode at a natural rate and is aesthetically pleasing from both the river and from the road. Greg also made reference to a riparian management plan at Fat Rooster Farm (our Farm to School collaborator for Trek to Taste). In this case, the WRP bought the management rights to a 50' riparian zone at the Farm so that the White River would be free to meander as it would naturally without being impeded by the farmers' actions. The farmers were financially compensated as well as they benefit from the stability of their streambank.

c. Riparian Tree Planting – Students planted 130 trees – willow, birch, box, elder, and dogwood - along the White River at Hurricane Flats Farm. They learned how to identify the collar of a sapling, how to dig the correct size hole for each tree, how to backfill the hole up to the collar, how to tamp down the soil around the tree, and how to give the tug test to make sure the newly planted tree is secure. Students also participated in a bucket brigade to water the trees. While at the site, we saw evidence of Irene damage, the reconstructed streambank, and the preparations for the next section waiting to be repaired. We also got a chance to ID some BMIs along the water's edge.

Assessment/Synthesis of Learning

d. Written Reflection- Students were asked to reflect on both Greg's visit and the tree planting as a way to synthesize their learning about erosion and all the inter-related components of our water studies.

River Dynamics Vocabulary

(Adapted by Jenna Guarino from the Watershed on Wheels [WoW] Express of the Silvio O. Conte National Fish and Wildlife Refuge)

Directions: Laminate this sheet and the next sheet (so they can get wet). Cut out the cards on each sheet and tape each one to a Popsicle stick. Discuss each term with the students and post each "sign" in an appropriate place in the river table.

Bank The land alongside or sloping down to a river.	**Point Bar** A low, curved bank of sediment along the inside bend of a meandering stream, formed when water slows down and drops its load as it rounds the bend.
Channel An area that contains flowing water confined by banks	**Point Source Pollution** Pollution that comes from known location and one person or group can be held responsible for its entry into the watershed
Condensation A physical change in water from the *gas* state to the *liquid* state	**Precipitation** Water in the atmosphere that falls to Earth, including rain, snow, sleet or hail.
Cut bank An eroded, concave, often very steep bank formed at a bend of a river or stream by the flow of water around the bend.	**Riparian Area** The vegetated areas along a river or stream.
Delta A sediment deposit where the mouth of a river spreads out as it meets the ocean.	**Riverbed** A channel occupied, or formerly occupied, by a river.
Evaporation A physical change in water from a *liquid* state to *gas* state.	**River Erosion** The gradual removal of rock material from riverbanks and riverbeds.

Flood plain A strip of flat land bordering a stream or river that receives the overflow of floodwaters.	**Runoff** Water coming off the land into rivers, streams and ponds that often carries pollution and nutrients with it.
Groundwater Water that collects underground and sometimes flows beneath the surface.	**Surface Water** Water that is visible on the Earth's surface (lakes, streams, oceans, etc.)
Headwaters The high-elevation places from which the water in a river or stream originates.	**Tributary** A river or stream that flows into another stream, river or lake.
Meander A winding curve or bend of a river.	**Water Cycle** The loop that water takes through the atmosphere, down to the Earth, and back up into the atmosphere.
Mouth The place where a river empties into another body of water.	**Watershed** A basin of land in which all water flows down and collects in a common water body.
Non-point Source Pollution Pollution that comes from many different sources throughout the watershed.	

.

Lakeshore and Streambank Erosion

(Adapted by Jenny Hewitt, Pomfret School, from lakeshoreerosioncntrl.com)

What Causes It?

Lakeshores and streambanks are areas of dynamic energy. The powerful forces of waves, currents, and ice move soil particles toward, away from, and along the shoreline.

Streams are continually downcutting into their valley, carrying sediments downstream particle by particle. The current moves from side to side, undercutting banks and causing the stream channel to meander.

The ice of frozen lakes can expand shoreward with a force of many tons per square foot, moving most obstacles in its path (including shoreline soil). Masses of ice put in motion by winds or currents can scour the banks of lakes and streams.

Even in small inland lakes, breaking waves and currents can loosen sediments. Headlands (points) usually have high erosion rates because the waves, currents, and ice attack from all sides and move the sediments to bays, where they are deposited. Bays are usually the most erosion resistant areas.

Erosion and the transport and deposition of sediments are natural processes along shorelines. Typically, erosion happens very slowly, and the plants and animals that live along the shoreline can adjust to these slow changes, maintaining a stable, healthy, productive ecosystem. When some catastrophic natural or human disturbance causes this equilibrium or balance to be upset, increased erosion can happen. Examples of natural disturbances include large trees uprooted by a windstorm, or a flood resulting from a torrential rainstorm. Human disturbances include vegetation removal, dredging, filling, or construction on or near the shoreline.

Three Basic Types of Erosion Control Methods:

1. Vegetative: This method involves planting live plants.
    a. trees or woody shrubs are used for the soil holding properties of their large root systems
    b. grass and other plants are used to protect against the force of rain and prevent runoff
    c. aquatic plants are used to stabilize bottom sediments and lessen wave action

2. Structural: This method involves using protective structures.
    a. Placing rocks of various sizes along the streambank (referred to as rip-rap)
    b. bulkheads,
    c. gabions (rock filled baskets),
    d. sandbags filled with concrete,
    e. railroad ties.

    Rip-rap is the most common. Other methods are often considered "eyesores", require more heavy equipment and technical expertise, and may be more likely to fail in comparison to simple rip-rap.

3. Manipulative: This method involves changing the stream or streambank.
    a. Removing obstructions,
    b. Grading the banks,
    c. Rerouting the stream channel

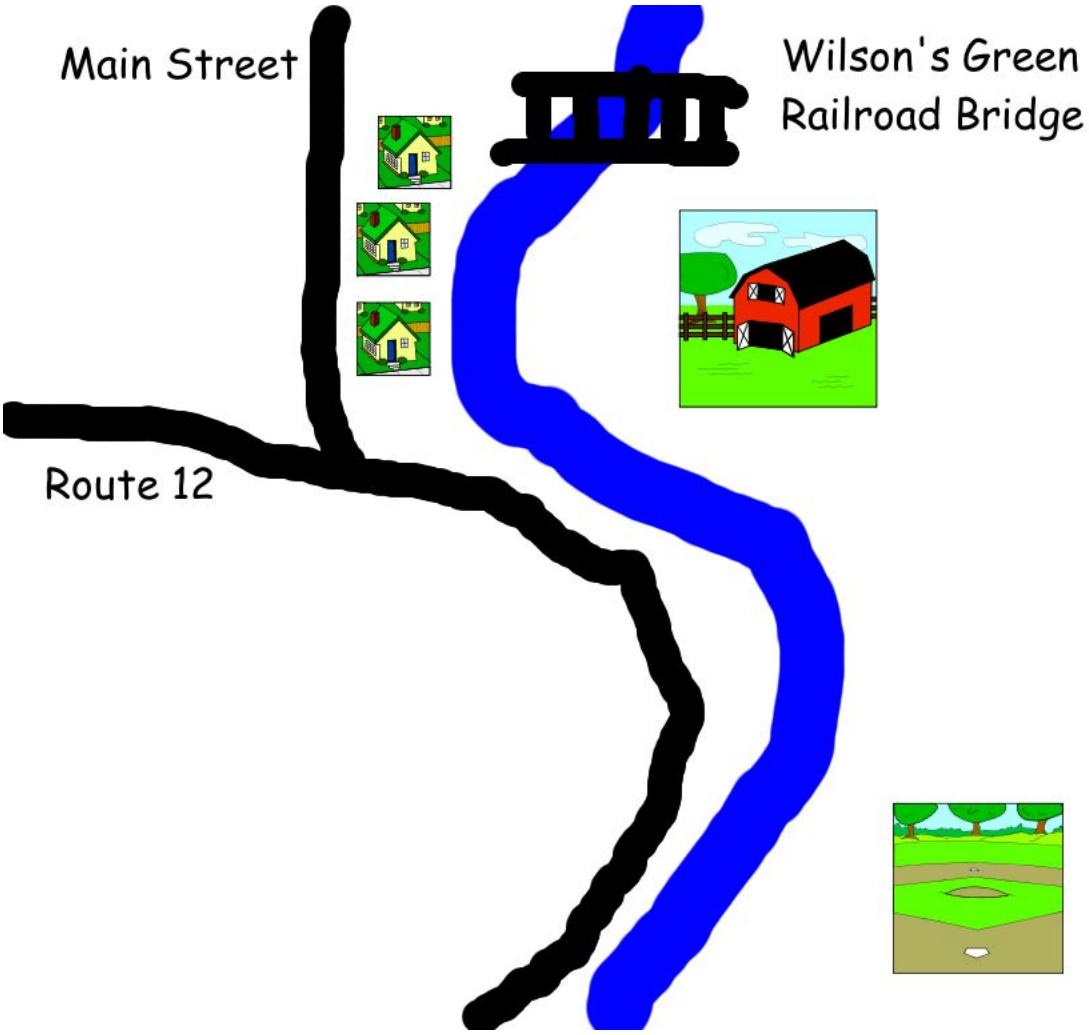
Soil bioengineering is a new method being used with good success. It combines many concepts to stop and prevent shoreline erosion. An example is the planting of willows with rip-rap. The rock provides immediate resistance to erosion. As the willows become established, roots invade and grow around the rocks and into underlying soil, binding them together into an erosion resistant mass. The willows also look more "natural" than plain rip-rap.

Happy Valley Erosion Prevention Performance Task

(Developed by Jenny Hewitt, Pomfret School, Pomfret, VT)

You have been asked by the town of Happy Valley to submit a plan to perform erosion control work along the Rambling River, which runs through the center of town. The Selectboard is looking for your expertise to help prevent damage to existing roads, railways, farms, and houses, as well as your recommendations as to areas best suited for future development.

The Selectboard will choose the plan that provides the clearest explanations as to how each method will best prevent erosion and be suited for the area. As the Selectboard members are not experts on stream dynamics or erosion control, they will be looking for the most complete diagrams, explanations, and recommendations.



Your plan must include:

- A plan for road access to the ballfield from Route 12
- A way for Farmer Brown to get his milk and cheese to the houses across the Rambling River
- Ways to keep the Rambling River from causing damage to Route 12
- Recommendations for the best location for the new elementary school that will be built next year
- Areas that can be marketed as river view housing
- A way to address the crumbling pillars of the Wilson's Green Railroad Bridge

Happy Valley Performance Task Rubric

(Developed by Jenny Hewitt, Pomfret School, Pomfret, VT)

Student Name: _____

Category	3	2	1	Comments
Erosion Control Methods	The plan addresses all 6 areas indicated by the Selectboard as needing attention.	The plan addresses 3-5 areas indicated by the Selectboard as needing attention.	The plan addresses less than 3 areas indicated by the Selectboard as needing attention.	
Diagrams	Provided accurate, easy-to-follow diagrams with labels.	Some parts of the diagram were easy to follow and contained labels.	The diagrams were incomplete, missing, and/or hard to follow.	
Vocabulary	6 or more vocabulary words relating to streams and erosion are used accurately and appropriately.	3-5 vocabulary words relating to streams and erosion are used accurately and appropriately.	Less than 3 vocabulary words relating to streams and erosion are used accurately and appropriately.	
Elaboration	It is clear what methods of erosion control are being recommended and why they are suited to each area.	Some parts of the explanation as to what methods of erosion control are being recommended and why they are suited to each area are clear.	Explanations of what methods of erosion control are being recommended and why they are suited to each area are unclear.	
Points Earned				

Happy Valley Erosion Prevention Performance Task Schedule

(Developed by Jenny Hewitt, Pomfret School, Pomfret, VT)

Time	Erosion Engineer	Videographer/ Photographer
9:00-9:15		
9:15-9:30		
9:30-9:45		
9:45-10:00		
10:30-10:45		
10:45-11:00		
12:45-1:00		
1:00-1:15		
1:15-1:30		
1:30-1:45		
1:45-2:00		
2:00-2:30	Debrief as a class	

Name _____ Date_____

Happy Valley Tech Integration Checklist

Criteria	Points Earned	
	Student	Mrs. Hewitt
❑ Paragraph detailing learning		
❑ 2-3 photographs		
❑ caption for each photograph		
❑ video		
❑ caption for video		
❑ name		
❑ Word Art title		
❑ Neatness		
❑ G.U.M.		
❑ Overall impression		
Total Points	/20	/20

✓-	✓	✓+
0 points	1 point	2 points

River Table Glossary

The definitions below are from *Living in Harmony with Streams: A Citizen's Handbook to How Streams Work, by the Friends of the Winooski River, the White River Natural Resources Conservation District, and the Winooski Natural Resources Conservation District, 2012. Download the entire booklet at http://www.winooskiriver.org/.*

dynamic equilibrium – A stream system that has achieved a balance in transporting its water and sediment loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course). A stream in dynamic equilibrium resists flooding damage, resists erosion, and provides beneficial aquatic habitat.

erosion – The detachment and movement of soil or rock fragments by water, wind, ice, or other geological agents. In streams, erosion is a natural process that can be accelerated by poor stream management practices.

headcut – A marked change in the slope of a streambed, as in a "step" or waterfall, that is unprotected or of greater height than the stream can maintain. Increased potential for erosion at this location causes the headcut to move upstream, eventually reaching an equilibrium slope.

impervious – Those surfaces that cannot effectively infiltrate rainfall and snow melt (e.g., rooftops, pavement, sidewalks, driveways, etc.). Impervious cover causes an increase in the volume of surface runoff.

riprap – Broken rocks placed on a streambank or other surface to protect against scouring and erosion.

surface runoff – The portion of precipitation or snow melt that reaches the stream channel by flowing over the land surface.

velocity – In streams, the speed at which water is flowing, usually measured in feet per second.