Soil Field Study

This Soil Field Study Guide is a collection of activities that we share with students in Benton County as part of our Making Ripples Program: Community Building for Water Quality. All activities can be adapted for K-12 students. ***Please find the Oregon Department of Education standards for grades 5 - 12 listed by activity in Appendix B.***

The study of Earth Science and Ecology would be incomplete without considering the wonders of Soil. Soil is related to many aspects of nature and vital to life on Earth.
Consider the five factors of soil formation listed below to help you understand how soils differ from place to place:
1) Climate – moisture and temperature are the primary drivers in soil development
2) Organisms –plants and animals contribute organic materials and move soil particles
3) Relief or topography – a soil's position in the landscape, for example, hill top or valley floor, will influence the length of time and environmental inputs in soil development
4) Parent material –rock provides most of the mineral elements of soil
5) Time – Soils develop very slowly over time. Ancient soils are more weathered. Young soils, such as a sandy river bed, are constantly disrupted.

Soil Field Study - Vocabulary List:

bedrock
biodiversity
biome
compaction
ecology
erosion
humus
infiltration
mineral nutrients
organic matter
population density
pores
porosity
runoff
saprolite soil
horizon soil
particles
soil structure
subsoil topsoil

Soil: What is it?

Soil is everywhere. Soil is not the same in every place. For example, soil on a hill slope will be thin because the soil particles move downhill as they form. Soil at the bottom of the hill will be thick because the soil particles collect there.
Soil is very important:

- Plants grow in soil.
- We build houses on soil and bricks are made of soil.
- Some animals live in soil.
- Soil provides food for plants and animals through the break down of wastes and nutrient cycling.
- Soil cleans and stores water.

Because soil is important to us, we need to take care of it. If we treat our soil poorly, it can be washed or blown away. It can also be compacted or drained of its nutrients.

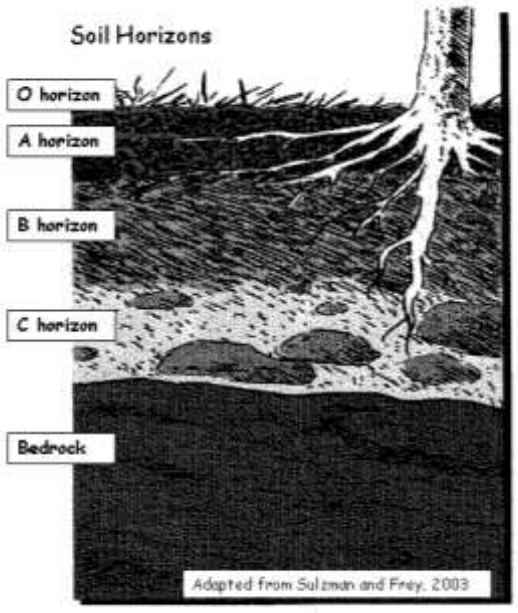
Soil Questions & Answers
Q: What are some things that might make soil wash or blow away?
A: Wind, water, rain and floods can cause soil erosion.
Q: What are some things that might help keep soil where it is?
A: Plant roots hold soil in place. Good soil structure is created when organic matter and soil organisms help soil particles stick together. Protecting soil organisms and adding organic matter to soil helps prevent erosion. Tilling soil destroys the soil structure and increases the chance of soil erosion. Farming practices that reduce tilling and preserve organic matter in the soil will reduce erosion.
Compaction occurs when soil particles are squished too tightly together, like where cars park or drive. Compaction decreases the space between soil particles where water can enter, also called infiltrate. After compaction, water cannot infiltrate the soil so it runs off. Water runoff may carry away topsoil, causing erosion. Therefore, activities which cause compaction increase soil erosion.
In addition, nutrients, fertilizer and pesticides may be carried off with the eroded soil, all expensive losses.

The Soil Profile

Soil is made out of many things. When you look at soil from above, you see only the very top layer. There are other layers, called horizons, in the soil. Each horizon does something different. Let' s take a look at a soil profile!

If you dig a deep hole or travel on a road through the hills you will see a soil profile. There you can see soil horizons, like the layers of a cake.

Soil horizons have special names that denote their location in the profile and contents. The list below describes the basic horizons found in a soil profile.



O HORIZON: Over the actual soil can be a humus layer. This horizon is sometimes called the " litt er layer." This layer is made up of decaying leaves, sticks, insect bodies, and other **O**rganic matter. Soil nutrients come from the O Horizon.

A HORIZON: is the upper layer of soil. It is also called " TOPSOIL." This layer, too, has lots of organic matter and is rich in nutrients. You can think of this layer as where the plants get their food.

B HORIZON: is below the A horizon. It is also the top layer of what is called " SUBSOIL." The B horizon usually has more clay than the A horizon, and it may contain more rocks. The B horizon is also usually thicker than the A horizon and may contain more water. You can think of the B horizon as where plants get their water.

C HORIZON: is the next horizon below B. This is the raw material that the soil is made from. It contains old rocks that are breaking down. Geologists call this rotten rock " SAPROLITE." This is often the deepest soil layer.

BEDROCK: underlies the soil. The bedrock layer is also called the R HORIZON. This is truly the raw material that makes up the mineral content of our soil. This horizon is hard rock.

Soil Texture

An important soil property is soil texture. Soil texture is the proportion of sand, silt and clay present in a given soil sample. Soil texture influences many soil properties, such as 1) water holding capacity – sand drains quickly; clay holds water very long and tightly, and 2) water infiltration – water infiltrates quickly in sandy soil and slower into soils with higher silt or clay content.

Name of soil separate	*Diameter limits (mm) (USDA classification)*
Clay	less than 0.002
Silt	0.002–0.05
Very fine sand	0.05–0.10
Fine sand	0.10–0.25
Medium sand	0.25–0.50
Coarse sand	0.50–1.00
Very coarse sand	1.00–2.00

The lesson below will introduce students to the concept of soil texture and teach them a method for texturing soil with their hands.

Activity Title: Feel Soil Texture with Your Hands
Author: Teresa Matteson, Benton SWCD
Grade level: Corvallis Outdoor School, grade 6
Concepts: soil texture, sand, silt, clay, particle size
Processes: soil texture classification by feel **Objectives:**
Students will

- Feel examples for the texture of sand (sand), silt (corn starch) and clay (modeling clay)
- Use the Soil Texture by Feel Method
- Learn to follow a flow chart
- Report soil texture
- Understand the relationship between water drainage and soil texture

Background: Fingers are very sensitive and are capable of determining the difference between soil particle sizes: sand (largest), silt (medium), and clay (very small). In this activity, students will follow a flow chart to determine soil texture by feel.

Materials: Each group of students will need the following items:

- 3 examples of sand, silt (corn starch), and clay
- 3 soil samples (two given and one collected)
- Soil spiral augers –
- Guide to Soil Texture by Feel Appendix A at the end of these activities
- Water bottle
- Towel

Procedure:

1. Instructor will introduce soil texture by describing soil particle size. Diagrams will be provided.
2. Instructor will talk about characteristics of various soils (properties of sand and clay are mentioned specifically in Extension Questions later).
3. Pass sand (coarse sand), silt (corn starch), and clay (modeling clay) samples so each student can feel the texture of the different soil particles.
4. The instructor will walk the students through the Guide to Soil Texture by Feel flow chart.
5. Student will use the Feel method to determine the texture of two unknown soil samples.
6. Student will record each soil sample texture on the Soil Physical Properties data card.
7. As a group, discuss how texture influences important soil properties such as porosity, water infiltration, and nutrient and water holding capacity.

Soil Color

Activity Title: Describing Soil Color
Author: Teresa Matteson, Benton SWCD
Grade level: Corvallis Outdoor School grade 6
Concepts: soil color, Munsell Color Charts, subjective observations, objective observations
Processes: sample comparison to color charts, scientific reporting

Objectives: Students will

- Hear Lewis and Clark quotes about soil color
- Use Munsell color charts to report soil color
- Learn what soil color may tell us and why soil color is important

Background:
Soil color tells important things about the soil:

- Dark soils are often high in organic matter
- Red soils are high in iron
- Yellow soils are high in aluminum
- White soils can be high in calcium
- Green or dark gray soils are saturated with water (hydric soils)

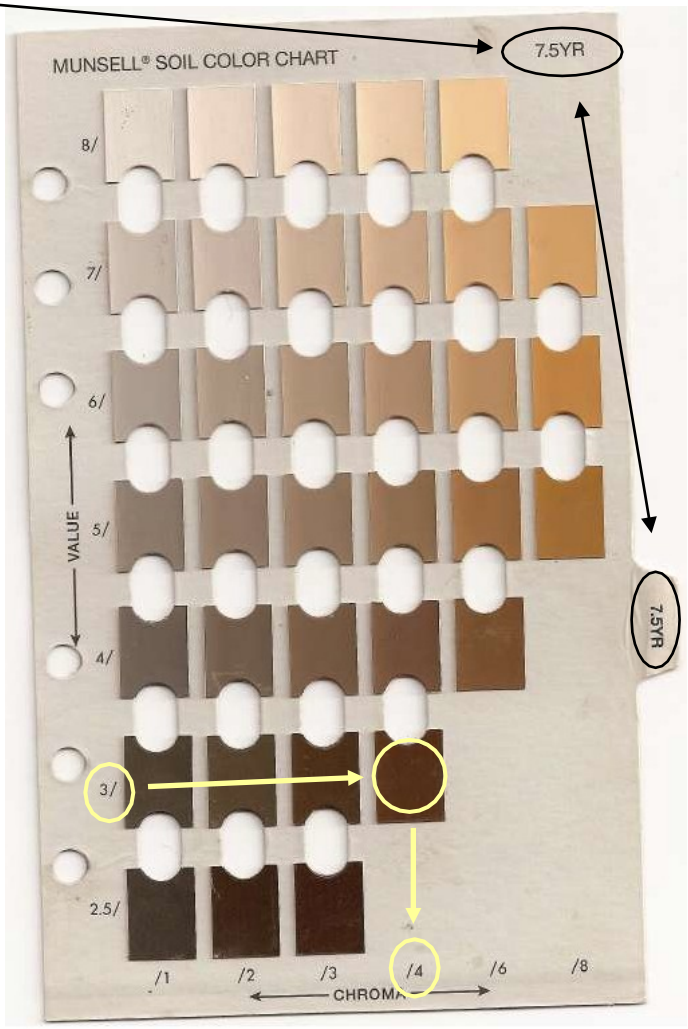
Using Munsell Color Charts to describe soil color allows scientists across the world to communicate colors without language barriers. In this activity, students will learn to use the Munsell Color Charts to describe soil color.

Materials: Each group of students will need the following items:

- 2 unknown soil samples
- Munsell color chart
- Pencils
- Data sheet sets (cards)
- Spiral soil auger or shovel

Procedure:

1. Introduce soil color. Talk about the importance of using the Munsell system for accurate color descriptions.
2. Introduce the Munsell color charts.
3. Demonstrate how the Munsell charts are used to determine soil colors. Standing with your back to the sun and letting it shine over your left shoulder, hold the soil ped next to the chips on the color chart until you find the closest match.
4. For this example, your soil color matched the color chip circled below. Read and record the soil color number. Example: 7.5YR 3/ 4. The soil color name starts with the page. In this case, it's 7.5YR.
5. For the second part of the soil color, read the chart across and down. This example would be 3/ 4. See ovals on the diagram.
6. Put the two parts together to get 7.5YR 3/4.
7. Students describe the two unknown soil colors using the Munsell system, for example forest and field soils.
8. Students record the Munsell colors on data card.



To complete the soil physical properties data card shown on page 8, the students will use a soil spiral auger or shovel to collect a sample of local soil. They will determine the Color and Texture for the local soil and record both results on the data card.

The Soil Physical Properties data card looks like the following chart:

Soil Physical Properties			
	Soil Samples		
Property	Location 1: _____	Location 2: _____	Location 3: _____
Munsell color			
Soil texture			

Soil Texture Extension: Answer the following questions as a group.

Q: Why is it important for a farmer or gardener to know soil texture?
A: Meeting the needs of plants will change according to soil texture. Management practices, such as watering, fertilizer use and pesticide application vary with regard to soil texture.
Q: How would you water a garden with sandy soil?
A: Frequent short watering sessions will be needed to provide water to plants in quickly draining sandy soil.
Q: How will watering be different in a garden with clay soil?
A: Water infiltration into clay soil is much slower than sandy soil, so you will want to water in short sessions to prevent runoff. Clay soil holds water tightly so water can be applied less often than for sandy soils.

A discussion of how soil texture relates to the other Soil Field Activities is located at the end of this guide.

Useful Web pages for Soil Profile

- NRCS Soil profile web site (retrieved November 2010) http:/ /www.mo15.nrcs.usda.gov/ features/ gallery/ gallery.html
- **Discovery Education: The Dirt on Soil: Learning Adventures (retrieved November 2010)** http:/ /school.discoveryeducation.com/ schooladventures/ soil/ teacher_tips.html

Soil Conservation

An introduction to Soil Conservation concepts is important to give students an overall picture for the Soil Compaction, Infiltration and Water activity that follows. This Conservation text will define soil erosion and discuss problems related to soil erosion. This guide does not include a specific Soil Conservation activity.

Human activities often degrade the natural environment. Through observations and trials, humans can reduce the impact of their activities on the environment. Soil Conservation balances human needs, like food production, with responsible land use practices, such as no-till farming or contour planting patt erns.

Soil Erosion

EROSION is the movement of soil away from where it developed. Both water and wind can cause erosion. Some erosion is natural. The Willamette Valley has very good soil for agriculture because over 10,000 years ago eastern Washington upland soils were eroded by massive floods and deposited here in rich, deep layers.

Some erosion is accelerated by human activity, and once soil is gone, it takes a long, long time to get it back. Soil develops slowly. Under optimal conditions, it takes about 500 years for an inch of soil to form. If soil gets into water bodies like streams and lakes, it can also cause problems for fish, animals, and people living downstream. Fertilizer or chemicals applied to plants or soil can travel with eroding soil and create a hazard downstream or in an adjacent field. It makes sense to keep soil where it is by preventing erosion.

Erosion can be caused by too much RUNOFF, or water that doesn't INFILTRATE into the soil. Excess runoff means that water that should be stored in the B horizon for future plant use is lost downstream.

Background: Erosion is the movement of soil by wind and water. Erosion causes the loss of valuable topsoil that holds organic matter and nutrients, and subsoil is exposed. The subsoil holds less water and is nutrient poor. Therefore, eroded soils produce lower crop yields.

Bare soil is easily eroded by wind and water. Vegetation reduces erosion by trapping wind- and water-carried soil particles keeping topsoil in place. Some planting patt erns are more effective at preventing erosion than others. Planting rows that go down a slope can prevent erosion at each plant but inter-row areas continue to erode. With contour planting, vegetation grows across the slope. The plants catch soil particles that are moved by wind and water, thus reducing erosion.

Soil Conservation Extension: Answer the following questions as a group.

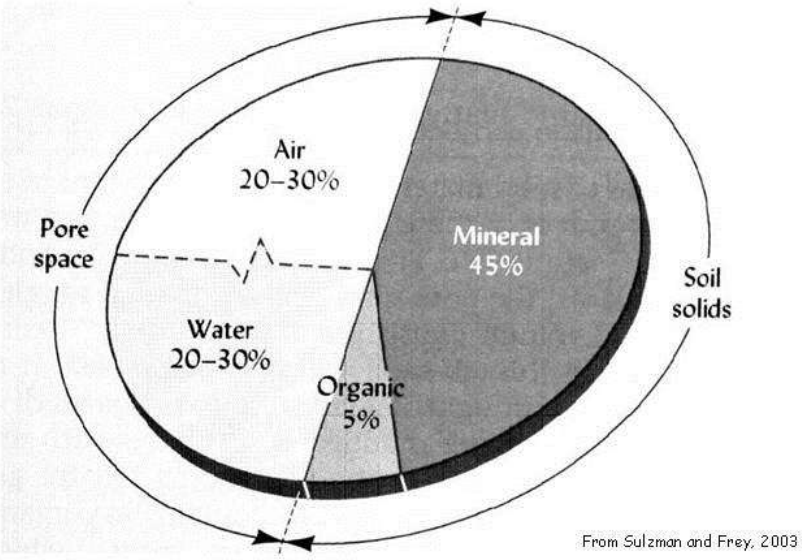
Q: Why is soil conservation important?
A: Humans used to believe that our natural resources were unlimited. Today we realize that we must use natural resources responsibly so future generations will have the soil, water, air and wildlife that are important for quality of life.

Useful websites for Soil Conservation:

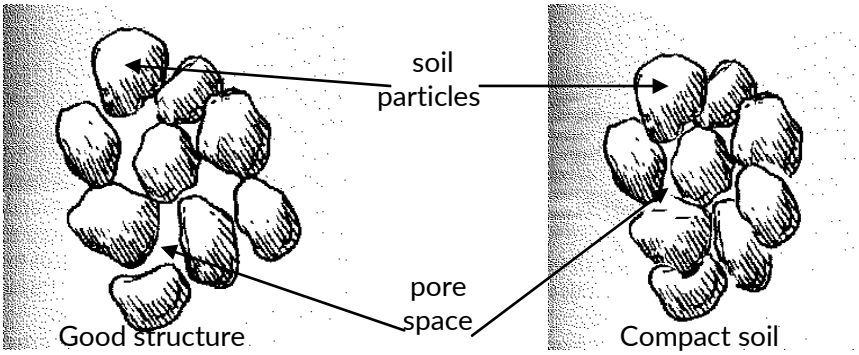
- NRCS – What is soil conservation? (retrieved November 2010) http:/ /www.nrcs.usda.gov/ feature/education/squirm/skQ13.html
- NRCS – Contour farming (retrieved November 2010) http:/ /www.or.nrcs.usda.gov/ technical/conservation-planning-and-conservation-records/contourfarming.html

Soil Compaction, Infiltration and Water

Soil is made of organic matter, mineral particles, and pores filled with either air or water. The following pie chart shows the proportions of the four components in a fertile loam soil.
In a healthy soil, approximately 45% will be mineral, 5% will be organic matter and 50% of the soil will be pore spaces filled with water or air. SOIL POROSITY is the amount of small pores or spaces in the soil that are filled with air or water. Sometimes human activity on the soil surface can compact soil and change porosity.
The following diagram shows what happens to soil particles during compaction.



Pores spaces are important because that is where plant roots get air, water, and nutrients. Soil compaction decreases valuable pore space between soil particles.



Adapted from Sulzman and Frey, 2003

Q: What are some activities that can cause soil compaction?
A: Soil is compacted by many activities including the following: driving, walking, parking, dragging trees or other heavy objects, and dropping heavy objects. The soil at a camping site is more compacted than the forest around the site, simply from the activities of campers.
When we construct buildings and highways, we want to compact the soil to make a strong and stable soil foundation for the construction. When we grow plants, we **DO NOT** want to compact the soil because the pore space for plant roots is decreased and air, water and nutrient space is lost.

Compaction also changes the way that water will flow into or infiltrate the soil at the surface. Infiltration is important to prevent soil erosion, reduce sedimentation in waterways, and is part of the soil's function to reduce flooding. We can use a soil infiltration exercise to demonstrate how compaction changes the water / soil relationship.

Activity Title: Soil Infiltration
Author: Teresa Matteson, Benton SWCD
Grade level: Corvallis Outdoor School, grade 6
Concepts: soil porosity, compaction, infiltration, land use impacts soil porosity, land use impacts water infiltration
Processes: Two infiltration tests help student assess how driving on soil changes the soil / water relationship.

Objectives: Students will
- Predict the infiltration rate of water in forest and road soils
- Measure water infiltration in two areas: road and forest
- Relate results of the infiltration test to land use practices and soil health

Background: Soil infiltration is the time it takes for a given amount of water to seep into a defined area of soil surface. Compaction of soil during land use decreases soil porosity and slows water infiltration. Thus soil infiltration is an indirect measure of soil compaction.

Materials: Each group of students will need the following items:
- Dead blow hammer
- Wood block
- 2 infiltration rings or large cans without ends (coffee cansare good; protect students from sharp edges duct tape may work)
- 2 Timers many students have watches with second hands or digital timers 2 Water containers filled with equal amounts of water

Procedure:
1. Instructor will introduce soil infiltration and how it is changed by land use. Diagram of compaction provided.
2. Students should describe the land use impact in the road and forest areas on data sheet. **Road** – impact is compaction from driving. The results are decreased soil quality, and decreased infiltration. **Forest** – impact is maintenance of soil structure and quality due to input of organic matter and activity of soil organisms. The result is good infiltration.

3. Ask students to predict how long it will take for the water to infiltrate the soil in each area. Answers will vary.
4. Road Area: Using the rubber mallet and wood block pound the infiltration ring into the soil up to the mark indicated on the ring.
5. All at once, pour the measured water into the ring and start the timer. This infiltration takes quite a long time – usually you can move to the forest area, do infiltration there, and get back to the road site before it is finished.
6. After the students realize that this is very slow (few minutes) move to the forest area and pound in the second infiltration ring.
7. Pour the measured water into the forest ring and start the timer. Watch until the water has completely infiltrated and record it on the infiltration data card.
8. Return to the road infiltration site and watch until all the water infiltrates. Record the time on the infiltration data card.
9. As a group, discuss how the actual times were different than the students' predictions.
10. Discuss how the land use practices in the forest and road areas changed the infiltration.
11. Discuss how infiltration is an indirect measurement of compaction.
12. Discuss how compaction can degrade wildlife habitat.

The Soil Infiltration data card looks like the following chart:

Soil Infiltration			
	Infiltration Time (minutes : seconds)	**Infiltration Time** (minutes : seconds)	**Conclusions**
land use	prediction	actual	How did each land use affect the infiltration time?
road			
forest			

Soil Infiltration Extension: Answer the following questions as a group.

Q: Why is water infiltration into soil important?
A: Collecting water where it falls is the best use of our water resource. Infiltration reduces erosion

and moderates surface water levels, preventing or reducing flooding. The reduction of erosion keeps topsoil in place along with fertilizers and chemicals that have been applied to the soil. Topsoil (upper 8 inches) is the most fertile soil in a profile and land use practices should be used to keep topsoil in place (prevent erosion).

A discussion of how soil compaction and infiltration relates to the other Soil Field Study Activities is located at the end of this guide.

Useful Web pages for Soil Infiltration and Compaction:

- Soil Quality Test Kit: Infiltration test – Chapter 3 (retrieved August 2008) http://soils.usda.gov/sqi/assessment/files/test_kit_complete.pdf
- NRCS Soil Quality – Infiltration (retrieved August 2008) http:/ /efotg.nrcs.usda.gov/references/ public/CO/COATN_91_Infiltration.pdf

Soil Wildlife

One cup of healthy soil contains billions of soil organisms, many of which are too small to see without a microscope. In this exercise we will explore the world of soil "wildlife" or bugs that we can see with our eyes or a hand lens. Students will use soil biodiversity (how many different types of organisms are found?) and density (how many of each type of organism are found?) studies to compare two different habitats and discuss the impacts of land use on soil organisms.

Activity Title: Soil Bugs: Who and How Many?
Author: Teresa Matteson, Benton SWCD
Grade level: Corvallis Outdoor School, grade 6
Concepts: Biodiversity, population density, pit fall traps, hula hoop study plots, statistics - average, soil biology assessment of soil quality,

Processes: Scientific inquiry, insect identification, sampling, statistics (average), decision making based on research

Objectives: Students will

- Count and compare soil organisms in two hula-hoop plots, forest vs. field
- Count and compare soil organisms in two pit fall traps, forest vs. field
- Pool group data to calculate the following statistics:
    - average number of each organism
    - average number of types of organisms
    - average total number of organisms counted
- Use group data to compare forest vs. field habitats
- Use group data to create a conclusion about land use and soil organisms
- Discuss management strategy for restoration and preservation of soil health
- Discuss the importance of soil biology related to water infiltration

Background: There is a direct relationship between soil organisms and soil quality. Microscopic organisms improve soil structure by creating "glues" and "nets" that hold soil particles together. When soil particles stick together, there are more soil spaces. The tunnels of larger burrowing organisms, such as moles and worms, create large spaces in soil. Water on the soil surface infiltrates through both small and large soil spaces. Forest areas have less human impact compared to areas where the soil is compacted by foot or vehicle traffic.

Organic matter creates the foundation of the soil food web – a highly interactive network of organisms that live in the soil. Forest trees and shrubs drop large amounts of organic matter, such as leaves, needles and branches, on to the forest soil. Organic matter decomposes on the soil surface and is carried under ground by soil organisms. This acts as a food source for soil organisms and improves the soil quality.

Pressure on soil causes compaction. Compaction reduces soil porosity making less space for water and air. This degrades the soil environment for plant roots. Less air and water space in the soil also degrades the habitat for small and large soil dwelling organisms.

Conditions that maintain or improve the habitat for soil organisms and plant roots, in turn improves

soil porosity, which leads to increased water infiltration. Improving water infiltration reduces soil erosion and regulates water levels in the environment. Looking at the soil organisms will help students predict what land use decisions will improve soil health and soil function in an ecosystem. Three comparisons can be considered in this activity: 1) count soil organisms to provide baseline biodiversity and population density data. This data can serve as a baseline for monitoring the impact of human activity on soil organisms and soil quality in the study area; 2) compare Forest vs. Field soil organism data; 3) compare and contrast the two methods for collecting soil organism data using hula-hoop plots versus pit fall traps.

Materials: Each group of students will need the following items:

- 2 Hula-hoops (forest and field)
- 2 Pit fall traps (forest and field) 2 Hand lens
- 2 Pencils
- 2 Data cards Calculator

Procedure:

Hula-hoop plot counts:

1. Randomly select area of study in forest biome and place a hula-hoop on ground.
2. Using a hand lens, identify all the soil organisms on the soil surface in the plot. Draw or describe each organism.
3. Record the number of each organism found on the data card.
4. Record the number of different organisms on the data card.
5. Repeat the study in the field biome.

Pit fall trap counts:

1. Find a pit fall trap in the forest biome.
2. Remove the funnel
6. Remove the collection cup without disrupting the support basin.
7. Using a hand lens, identify all the soil organisms in the trap. Draw or describe each organism.
8. Replace the organisms, collection cup and funnel in the trap.
9. Record the number of each organism found on the data card.
10. Record the number of different organisms on the data card.
11. Repeat the study in the field biome.

The Soil Biodiversity and Density data card looks like the following chart:

Soil Wildlife Data									
	How many of each organism did you find?							**Population Size**	
organism	Ant	Spider	Beetle	Worm	Caterpillar	Mite	Other	How many types of organisms did you find?	What is the total number of all organisms?
Hula-hoop Plot									
Forest									
Field									
Pit Fall Trap									
Forest									
Field									

Statistics

To calculate an average, divide the total number of all samples by the number of sample sets. Example: To calculate the average number of ants collected by each group, divide the sum of all ants counted by all groups by the number of groups counting ants.

For the hula-hoop and pit fall methods, calculate:

1. The average number of each organism found in the forest and field biomes.
2. The average number of different species found in each biome (biodiversity).
3. The average number of total organisms in each biome (population density).
4. Compare the biodiversity and population density of the two biomes.

Soil Wildlife Statistics									
	What is the average number of organisms? Total number counted by all groups / number of groups							Population Size	
organism	Ant	Spider	Beetle	Worm	Cater-pillar	Mite	Other	Average number of types **biodiversity**	Total number of organisms **density**
Hula-hoop Plot									
Forest Average									
Field Average									
Pit Fall Trap									
Forest Average									
Field Average									

How does land use impact soil wildlife? The studies of OSU entomologist, Dr. Andy Moldenke, show that natural forest communities have more than 19 species of arthropods per square foot of soil and more than 18,600 individual bugs! People change land use from natural forest to farming practices that may include tilling the soil and adding chemicals. Dr. Moldenke's work shows that this can impact soil wildlife, causing arthropods to drop to 2 species, with less than 2,780 individual bugs per square foot. This shows that land use changes can greatly alter soil biodiversity and population density.

Soil Wildlife Extension: Answer the following questions as a group.

Compare the results for the two methods of assessment; hula-hoop plot and pit fall trap. Do they agree? If not, suggest why there may be differences in the two results?
Q: Discuss the strong and weak points of each method.
A: Pit fall traps collect and kill organisms over a period of time. The organisms move into the study area. A gentle scientist will not harm soil organisms while observing in a small hula-hoop space over a short time period.

Q: List two things that soil organisms do that are good for soil quality.
A: They make burrows, tunnels or holes. As they move through the soil, they push soil particles together to form structure. Glues and nets made by soil organisms hold soil particles together. This creates soil spaces that allow water infiltration.

Q: List one important function that will change in the future if there is a decrease in populations of soil organisms.
A: There could be a decline in soil structure and reduced porosity. This will reduce water infiltration. Since water is stored and purified in the soil, decreased infiltration could result in flooding, lack of water in dry seasons, less ground water, lower water levels in streams, rivers and lakes, and cause dry wells in the area.

Q: Write about a land use practice that will help preserve and restore important populations of soil organisms.
A: Organisms need organic matter as the base of the soil food web. Leaving leaves, wood, and grass on the ground gives soil wildlife food and habitat. Preserving wild space, or protecting some areas to remain natural, provides soil organism habitat. Reduce tillage and chemical use in farming practices helps soil wildlife survive in agricultural soils.

A discussion of how these soil wildlife activities are related to the other Soil Field Study Activities is located at the end of this guide.

Useful Web pages for Soil Wildlife

- Soil Biology Primer -Arthropods (retrieved November 2010)
  http:/ /soils.usda.gov/sqi/concepts/soil_biology/arthropods.html
- NRCS – Soil Biology Primer (retrieved November 2010)
  http:/ /soils.usda.gov/sqi/concepts/soil_biology/ biology.html
- City Bugs online identification key (retrieved November 2010)
  http:// www.cnr.berkeley.edu/citybugs/
- Entomologists Society (retrieved November 2010)
  http:// www.entfdn.org/ education_links.php
- Smithsonian Biodiversity Web site (retrieved November 2010)
  http:/ /www.nrcs.usda.gov/ technical/ECS/wildlife/ primermedres.pdf

Soil Cleans and Stores Water

Soil performs many services that we take for granted. Soil interacts closely with the water in our environment. It stores water for plants to use during dry seasons and prevents floods during normal rain events. It also cleans water – this activity will help students understand how that works!

Activity Title: Soil Cleans and Stores Water

Author: Teresa Matteson, Benton SWCD **Grade level:** Corvallis Outdoor School, grade 6

Concepts: contamination, pollution, gravity, magnets, opposites attract.

Processes: Colored water is filtered through soil and comes out clear.

Objectives: Students will

- Set up experiment apparatus
- Observe how soil texture influences water infiltration
- Predict what will happen to colored water as it passes through the soil.

Background: Have you ever held two opposite magnets together? They attract, right? A similar attraction helps soil clean water. Most soils have a negative charge. Many water contaminants have a positive charge. As polluted water infiltrates through soil, the contaminants are attracted to the soil particles, namely clay, and are trapped in the soil. Cleaner water moves downward through the soil profile. This activity will demonstrate the ability of soil to clean water.

Materials: Each group will use the following items:

- Dried, crushed soil samplesprepare in advance. Collect soil and spread it on newspaper until dry.
- Put the dry soil in a bag and crush to a powder with a roller or hammer. Wear protective eye goggles.
- Water bottle with top cut off top becomes funnel; bottom is the catch basin Rubber band
- Coffee filter, paper towel or napkin, cut to size that will cover water bottle neck Colored Water methylene blue works well available at OSU Chemistry store Waste bucket

Procedure:

1. Explain the soil drying process to the students. They can do this exercise at home with soil from their yard and some help from an adult.
2. Show the students how a water bottle was made into a scientific tool. An adult can help them cut plastic water bottles at home
3. Place the filter paper over the funnel mouth and secure it with a rubber band so there are no holes.
4. Set the funnel with filter paper on the catch basin.
5. Using a spoon, fill the short funnel neck with dried, crushed soil.
6. Fill the small cup with colored water.
7. Have the students predict what will happen when the water is poured on the soil.
8. Pour the colored water on the soil and let it set until all the water has drained through.
9. Repeat this exercise with a different soil texture.
10. Discuss the difference in infiltration rates of the two soil textures.

11. Have the students observe the filtered water – it should be clear.
12. Discuss what happened to the color in the water.

The Soil Cleans Water data card looks like the following chart:

Soil Filters Water

	Predict infiltration rate (fast or slow)	Actual infiltration rate (fast or slow)	Color of water before infiltration	Color of water after infiltration
Clay soil				
Sandy soil				

Soil Filters Water Extension: Answer the following questions as agroup.

Q: Now that the water is clear is it safe to drink?
A: NO! Just because water is clear does not mean that it is safe to drink.

Q: Where did the color go?
A: Most soils, especially those with clay, have a negative charge. Many pollutants have a positive charge. Just like opposite charged magnets, the negative soil and positive pollutants are attracted to each other. As the water passes through the soil the contaminants stick to the soil particles and the water is cleaned.

Q: Consider how this has impacted the soil
A: Now the soil is contaminated. It is important not to contaminant soil because it may decrease the ability for plants to grow.

A discussion of how soil's ability to filter water is related to the other Soil Field Study Activities is located at the end of this guide.

Useful web sites for Soil's Ability to Filter Water:

- Soil as a Filter by Dr. Dirt (retrieved August 2008) http:/ /www.wtamu.edu/ ~crobinson/DrDirt/ filter.html
- The Water Cycle Game (retrieved August 2008) http:/ /response.restoration.noaa.gov/ book_shelf/1064_Watercycle_instructions.pdf

How do these Soil Field Study Activities relate to each other?

Please read below…

Discuss how soil texture relates to the other Soil Field Study Activities:

- Soil Infiltration Texture influences the rate that water infiltrates soil and how long water is held in the soil.
- Soil Wildlife different soil textures are found in different locations and climates. The soil wildlife will change from one location to another due to soil texture and the relative moisture and organic matter content.
- How Soil Cleans Water soil texture influences how quickly water will enter and drain through soil.
- Forestry Soil texture determines how easily soil is eroded. Clay soil is sticky, sandy soil does not cling together.
- Vegetation & Wildlife the close relationship between soil texture and water will influence vegetation growth and wildlife habitat.

Discuss how soil conservation relates to the other Soil Field Study activities:

- Soil Texture Because texture influences water holding capacity and drainage, conservation practices will vary based on texture. All soil textures benefit from vegetation cover.
- Soil Wildlife Increasing soil wildlife biodiversity and population density improves soil quality and infiltration, and reduces erosion.
- Soil Infiltration infiltration is an indirect measure of compaction. Compacted soils have less infiltration, which makes erosion, especially by water, more likely.

Discuss how soil infiltration is related to the other Soil Field Study activities:

- Soil Texture texture influences infiltration. Sandy soils infiltrate quickly. Clay soils infiltrate more slowly.
- Soil Wildlife soil moisture influences wildlife, soil organisms need different amounts of water to survive.
- Forestry Forest conservation practices include leaving vegetation buffers along waterways. The vegetation filters sediments that are carried in runoff and reduces the impact of timber harvest on water quality. Also, plant roots help hold the soil in place.
- Vegetation water erosion is mostly caused by rain drops hitting bare soil. Vegetation softens or prevents rain hitting directly on the soil and reduces erosion.
- Wildlife wildlife habitat is degraded when soil erosion increases sediments in soil which is measured by water turbidity.
- Water water quality is protected or enhanced by preventing compaction and erosion.

Discuss how the soil wildlife activities relate to the other Soil Field Study activities:

- Soil Color dark soils usually contain more organic matter, which is the base of the soil food web
- Soil Texture the texture of soil influences the amount of water it holds and what organisms will live in it.
- Soil Infiltration soil organisms need water in the soil. Runoff erodes soil that is important to soil organisms.
- Soil Conservation good land use practices, such as reduced tillage and leaving plant residue on the soil, maintain and restore soil organisms.

Discuss how the Soil Cleans Water activity relates to the other Soil Activities:

- Soil Texture and Soil infiltration: Water drains through sandy soil quickly. Color may not be removed. Water drains through clay soil more slowly. The clay particles have the negative charge that attracts the pollutants.
- Soil Wildlife and Pollutants held in soil can degrade the soil wildlife habitat.

If you have questions or comments about this curriculum, please contact us:

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Appendix A – Soil Texture by Feel flowchart

Background

The ability to determine soil texture by feel is very useful, both to professional soil scientists and others. While the texture by feel method is not as accurate as laboratory methods, experienced people can make remarkably accurate determinations of soil texture in the field. This has the advantage of requiring litt le equipment and litt le time. It requires a lot of practice. Now is your chance to start practicing.

Use the steps below to determine the texture of your soil by the feel method.

1. Take a small sample of the soil in your hand. Use a water bottle to moisten it to the correct moisture content. Moisture content is critical--your sample must be as wet as it possibly can be without sticking to your fingers. If you get your sample too wet, it will stick to clean fingers. You will be unable to form a ribbon and it will feel sticky, which might lead you to overestimate clay content. If you allow your sample to be too dry, litt le cracks form when you try to shape it. A too-dry sample will exhibit what is known as *plasticity*, the ribbon will be too long, and you will again overestimate clay content.

2. Squeeze the soil, pushing it over your index finger knuckle with your thumb, to form a ribbon. This is a tricky process. Your ribbon should be about ¼" thick and no more than 1" wide. As you extend the ribbon, make it go straight up into the air. When it falls over, approximate the length of it and compare it with the guidelines below. This will give you an estimate of the clay content of your sample.

- **Clay content:**
  - -Ribbons up to 1 ½ inches long - clay content <27%
  - -Ribbons from 1 ½ to 3 inches long - clay content 27-40%
  - -Ribbons > 3 inches long - clay content >40%

3. Next, wash the soil between your thumb and forefinger. Rinse; rub your fingers together; then rinse again. Repeat this until you feel you have rinsed away almost everything but the sand. Rub your thumb and forefinger together. You are trying to detect the presence of a gritty feeling caused by sand. Use the guidelines below to determine the sand content of your soil.

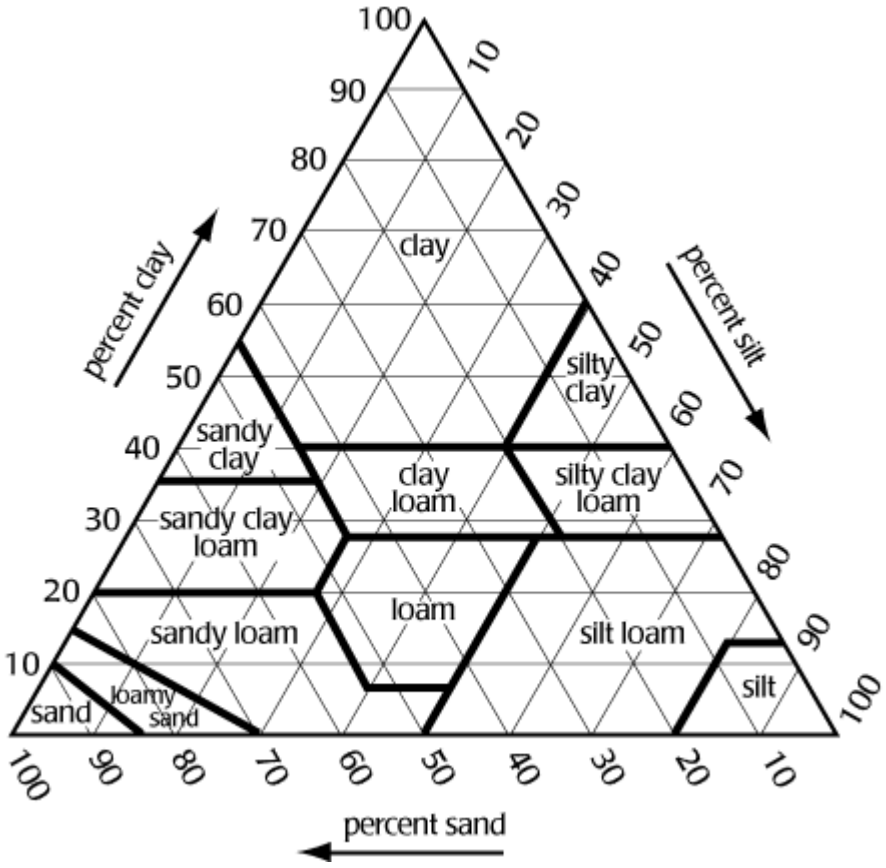
- **Sand content:**
  - -Grittiness absent or barely detectable in washed sample on fingers - sand <20%
  - -Grittiness easily detectable but not dominant - sand 20 - 50%
  - -Grittiness dominates - sand >50%

4. These two techniques will provide you with estimates for clay and sand contents. You could estimate silt content by totaling those numbers and subtracting from 100%:

100% – (%clay + %sand).

However, that is unnecessary. You can find the texture of a soil sample with only the sand and clay percentages by using the Textural Triangle on page 26.

5. How to use the Textural Triangle: Locate the percent sand value on the bottom side of the triangle. Locate the percent clay value on the left side of the triangle. Follow lines for those percent values that are parallel to the other lines for that soil component. The section label where the percent sand and clay lines cross will describe your soil texture.



Appendix B - Oregon Department of Education Standards – grades 5 - 12
Benton SWCD Soil Field Study Activities

updated August 2008

Feel Soil Texture with Your Hands

Summary of Concepts -

Mathematics:

- (2008) 6.2. Number and Operations and Probability: Connect ratio, rate, and percent to multiplication and division. 6.2.1.

- Physical Science
  - CCG: Matter: Understand structure and properties of matter. SC.03.PS.01, SC.05.PS.01, SC.05.PS.01.01, SC.05.PS.01.02, SC.08.PS.01, SC.08.PS.01.02, SC.08.PS.01.03,
  - CCG: Force: Understand fundamental forces, their forms, and their effects on motion. SC.05.PS.03, SC.05.03.01, SC.05.PS.04, SC.05.PS.04.01, SC.08.PS.03, SC.08.PS.03.01, SC.08.PS.03.02, SC.CM.PS.03, SC.CM.PS.03.03, SC.CM.PS.04, SC.CM.PS.04.01
- Earth and Space Science
  - The Dynamic Earth: Understand the properties and limited availability of the materials which make up the Earth. SC.05.ES.01, SC.05.ES.01.01, SC.05.ES.01.02.

Soil Compaction and Infiltration

Summary of Concepts – group work, soil porosity, compaction, infiltration, land use impacts soil porosity, land use impacts water infiltration, use of stopwatch, predictions, volume of water, comparison, discussion of results

Mathematics:

- (2008) 6.2. Number and Operations and Probability: Connect ratio, rate, and percent to multiplication and division. 6.2.1.
- (2008) 8.2 Data Analysis and Algebra: Analyze and summarize data sets. 8.2.8.

Physical Science:

- CCG: Force: Understand fundamental forces, their forms, and their effects on motion. SC.05.PS.03, SC.05.03.01, SC.05.PS.04, SC.05.PS.04.01, SC.08.PS.03, SC.08.PS.03.01, SC.08.PS.03.02, SC.08.PS.04.01.

Earth Science:

- CCG: The Dynamic Earth: Understand changes occurring within the lithosphere, hydrosphere, and atmosphere of the Earth. SC.05.ES.03, SC.05.ES.03.01, SC.08.ES.03.03.

Science Inquiry:

- CCG: Forming the Question/ Hypothesis: Formulate and express scientific questions or hypotheses to be investigated. SC.05.SI.01, SC.08.SI.01, SC.CM.SI.01.
- CCG: Designing the Investigation: Design safe and ethical investigations to address questions or hypotheses. SC.05.SI.02, SC.08.SI.02, SC.CM.SI.02.
- CCG: Collecting and Presenting Data: Conduct procedures to collect, organize and display scientific data. SC.05.SI.03, SC.08.SI.03, SC.CM.SI.03.
- CCG: Analyzing Data and Interpreting Results: Analyze scientific data to develop and present conclusions. SC.05.SI.04, SC.08.SI.04, SC.CM.SI.04.

Soil Bugs: Who and How Many?

Summary of Concepts – biodiversity, pop ulation density, pitfall traps, hula hoop study plots, statistics, average, soil biology assessment of soil quality, comparison of research methods, comparison study site properties (field vs. forest), count and compare organisms, pool group data, use of group data for discussion, discussion of the application of management strategy for restoration and preservation of soil health, discuss how soil organisms influence soil structure, discuss the importance of soil biology related to water infiltration, recording data in table

Mathematics:

- (2008) 8.2 Data Analysis and Algebra: Analyze and summarize data sets. 8.2.3, 8.2.4, 8.2.5, 8.2.6, 8.2.7, 8.2.8.

Life Science

- CGG: Organisms: Understand the characteristics, structure, and functions of organisms. SC.05.LS.01, SC.05.LS.01.01.
- CCG: Diversity/ Interdependence: Understand the relationships among living things and between living things and their environment. SC.05.LS.05, SC.05.LS.05.01, SC.05.LS.05.02, SC.05.LS.05.03, SC.05.LS.05.05, SC.08.LS.04, SC.08.LS.04.02, SC.08.LS.04.03, SC.CM.LS.03, SC.CM.LS.03.01, SC.CM.LS.03.02.

Science Inquiry:

- CCG: Forming the Question/ Hypothesis: Formulate and express scientific questions or hypotheses to be investigated. SC.05.SI.01, SC.08.SI.01, SC.CM.SI.01.
- CCG: Designing the Investigation: Design safe and ethical investigations to address questions or hypotheses. SC.05.SI.02, SC.08.SI.02, SC.CM.SI.02.
- CCG: Collecting and Presenting Data: Conduct procedures to collect, organize and display scientific data. SC.05.SI.03, SC.08.SI.03, SC.CM.SI.03.
- CCG: Analyzing Data and Interpreting Results: Analyze scientific data to develop and present conclusions. SC.05.SI.04, SC.08.SI.04, SC.CM.SI.04.

Soil Field Study Challenge

Summary of Concepts – ecological dynamics, how land use impacts nature, web of life, chain of events, cause and effect, how awareness results in behavior modification,

Earth Science:

- CCG: The Dynamic Earth: Understand changes occurring within the lithosphere, hydrosphere, and atmosphere of the Earth. SC.05.ES.03, SC.05.ES.03.01, SC.08.ES.03.03.

Social Science: Geography

- CCG: Understand how people and the environment are interrelated. SS.05.GE.07, SS.05.GE.07.01, SS.05.GE.07.02, SS.05.GE.08, SS.05.GE.08.01, SS.08.GE.07, SS.08.GE.07, SS.08.GE.07.01, SS.08.GE.07.02, SS.08.GE.08, SS.08.GE.08.01, SS.08.GE.08.03, SS.CM.GE.08, SS.CM.GE.08.

Social Science: History

- CCG: Historical Skills: Analyze cause and effect relationships, including multiple causalities. SS.05.HS.02, SS.08.HS.02,

Social Science: Analysis:

- CCG: Explain various perspectives on an event or issue and the reasoning behind them. SS.05.SA.03, SS.08.SA.03, SS.CM.SA.04.
- CCG: Identify and analyze an issue. SS.05.SA.04, SS.08.SA.04, SS.CM.SA.05.

- CCG: Select a course of action to resolve an issue. SS.05.SA.05, SS.08.SA.05, SS.CM.SA.06.

Soil Cleans and Stores Water

Summary of Concepts – contamination, pollution, gravity, magnets, opposites attract, soil texture and drainage, environmental impacts, reuse of bottles – resourcefulness, discussion of what happens to the color in the water, discuss if the water is clean to drink, discuss what happens to the contaminated soil, discuss how soil contamination impacts soil biology.

Physical Science

- CCG: Matter: Understand chemical and physical changes. SC.05.PS.02.02, SC.08.PS.02, SC.08.PS.02.01, SC.08.PS.02.02, SC.08.PS.02.03
- CCG: Force: Understand fundamental forces, their forms, and their effects on motion. SC.05.PS.03, SC.05.03.01, SC.05.PS.04, SC.05.PS.04.01, SC.08.PS.03, SC.08.PS.03.01, SC.08.PS.04.01, SC.CM.PS.03, SC.CM.PS.03.03, SC.CM.PS.04.

Earth and Space Science

- The Dynamic Earth: Understand the properties and limited availability of the materials which make up the Earth. SC.05.ES.01.03, SC.08.ES.01.01.

Science Inquiry:

- CCG: Forming the Question/ Hypothesis: Formulate and express scientific questions or hypotheses to be investigated. SC.05.SI.01, SC.08.SI.01, SC.CM.SI.01.
- CCG: Designing the Investigation: Design safe and ethical investigations to address questions or hypotheses. SC.05.SI.02, SC.08.SI.02, SC.CM.SI.02.
- CCG: Collecting and Presenting Data: Conduct procedures to collect, organize and display scientific data. SC.05.SI.03, SC.08.SI.03, SC.CM.SI.03.
- CCG: Analyzing Data and Interpreting Results: Analyze scientific data to develop and present conclusions. SC.05.SI.04, SC.08.SI.04, SC.CM.SI.04.

English Language Arts and Speaking & Listening learning standards are met through student discussions during the Benton SWCD Soil Field Study activities listed below. The specific standards for each category follow and apply to all of the Benton SWCD activities listed here.

Inventory of Life Experiences in the Natural World
Soil Field Study – Vocabulary List
Soil Texture
Soil Compaction and Infiltration
Soil Wildlife: Biodiversity and Population Density Soil
Field Study Challenge
Soil Cleans and Stores Water

English Language Arts

- CCG-Vocabulary-Increase word knowledge through systematic vocabulary development; determine the meaning of new words by applying knowledge of word origins, word relationships, and context clues; verify the meaning of new words; and use those new words accurately across the subject areas. EL.05.RE.09, EL.05.RE.11, EL.06.RE.09, EL.07.RE.08, EL.07.RE.10, EL.08.RE.08, EL.08.RE.10, EL.CM.RE.08, EL.CM.RE.10.
- CCG-Read to Perform a Task: Find, understand, and use specific information in a variety of texts across the subject areas to perform a task. EL.05.RE.20.

- Speaking and Listening
    - CCG: Speaking: Communicate supported ideas across the subject areas using oral, visual, and multi-media forms in ways appropriate to topic, context, audience, and purpose; organize oral, visual and multi-media presentations in clear sequence, making connections and transitions among ideas and elements; use language appropriate to topic, context, audience, and purpose; and demonstrate control of eye contact, speaking rate, volume, enunciation, inflection, gestures, and other non-verbal techniques. EL.05.SL.01, EL.05.SL.02, EL.05.SL.03, EL.05.SL.04, EL.05.SL.05, EL.06.SL.01, EL.06.SL.02, EL.06.SL.03, EL.06.SL.04, EL.06.SL.06, EL.06.SL.07, EL.07.SL.01, EL.07.SL.02, EL.07.SL.03, EL.07.SL.04, EL.07.SL.05, EL.08.SL.01, EL.08.SL.03, EL.08.SL.06, EL.CM.SL.03, EL.CM.SL.04, EL.CM.SL.05, EL.CM.SL.06.
      CCG: Listening: Listen critically and respond appropriately across the subject areas. EL.05.SL.07, EL.05.SL.08, EL.05.SL.09, EL.06.SL.09, EL.06.SL.10, EL.06.SL.11, EL.07.SL.07, EL.07.SL.08, EL.08.SL.09, EL.CM.SL.10, EL.CM.SL.11.