

Not just down the drain!

Healthy soil acts like a:



SPONGE
It soaks up excess rainwater and slows runoff.



SPIGOT
It releases water to plants as they need it, even between rainfalls.



FILTER
It traps urban pollutants like oil, metals, and pesticides as water percolates through it.



SUPERMARKET
It supplies valuable nutrients to plants.

Once upon a time, our untreated sewage, or wastewater, flowed right into our oceans, lakes and streams. Since we couldn't see it anymore, we assumed it just went away, but it came back to haunt us as polluted lakes, rivers and streams. To protect the environment and public health, we now collect and clean your dirty water before it reaches our waterways.

What are biosolids and where do they come from?
Biosolids are a natural product made from wastewater. Wastewater travels from homes and businesses through underground pipes to the treatment plant. During the process of cleaning the wastewater, the solid part of this waste, including food scraps and poop, is removed from the water and sent to big tanks called digesters. In the heated digesters, good bacteria eat (decompose) the solids, turning them into biosolids. The digestion process reduces odor and kills up to 95% of pathogens that were in the raw solids. After digestion, biosolids are "spun" in a centrifuge to remove water, making a semi-solid product rich in nutrients and organic matter. These biosolids will be used as a fertilizer and soil amendment.

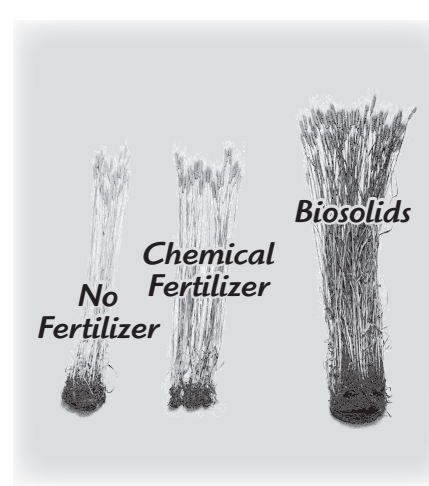
Where do biosolids go?
King County's biosolids are used as a fertilizer on farms in eastern Washington to grow healthier crops, and on tree plantations in King County to make trees grow faster. Some biosolids are also composted with sawdust to make GroCo, which is available to the public to improve soils in their gardens.

Soil: the basics
Biosolids are a nutrient-rich fertilizer and soil amendment, helping plants grow larger and healthier. How does soil do all that? First we need to understand a few things about soil.

Soil is much more than a mix of sand, silt, clay and rocks on the ground. Find a shovel, go outside and dig around a bit in soil! You will find that it also has a lot of organic matter from decomposed plants. It also includes air, and though it may seem dry, it has water in it too. If you were to look at it under a microscope, you'd see a wealth of bacteria, fungi and other organisms. These organisms convert decomposing plant material and rock into energy and essential nutrients for plants. It takes a very long time for soil organisms to break down all the ingredients to make good soil. In fact, it can take 500 years to form just one inch of soil!

Building healthy soil and growing healthier plants
Healthy soil grows healthy plants. Plants need air, water, light and nutrients like nitrogen, phosphorus and potassium to grow. Soil organisms break down rock and dead plant material, releasing nutrients into the water in the soil. When a plant takes up water through its roots, the nutrients get absorbed into the plant too.

Not just down the drain! (continued)



Sometimes plants don't grow as well as we'd like because the soil they are growing in isn't providing everything they need. Often, over years of cultivation, the soil has become depleted of nutrients. Sometimes the soils are too young to have all the nutrients available for plants. Other times the soil is too dense to let water in or the soil is too sandy or rocky to hold water long enough for plants to absorb it. Soil amendments can be used to fix some of these problems, but different soil amendments help the soil in different ways.

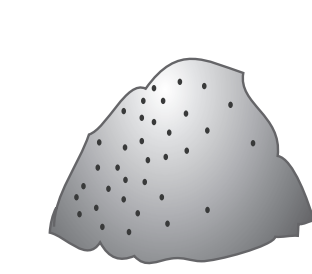
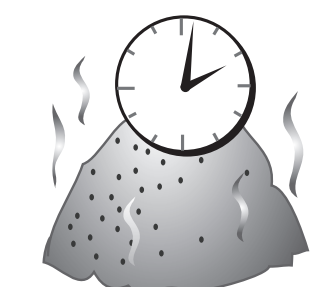
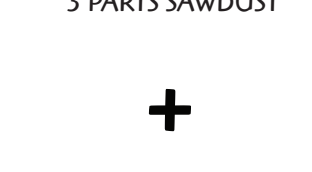
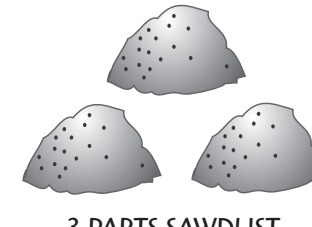
If the plant needs more nutrients than the soil can provide, fertilizers are the soil amendment of choice. Inorganic chemical fertilizers can be used as a quick fix for this problem, releasing all their nutrients right away. However, chemical fertilizers need to be used often and usually provide only one or two nutrients. Because they dissolve easily in water, chemical fertilizers can leach away from plant roots into streams and groundwater, where they cause algae blooms and other problems.

Biosolids, manures and other organic fertilizers also contain nutrients to feed plants, but they release nutrients slowly as they decompose, and are considered slow-release fertilizers. Because nutrients in organic fertilizers are not available all at once as they are in chemical fertilizers, they are less likely to leach away. Also, organic fertilizers usually provide more than just one or two types of nutrients. In fact, biosolids contain all the essential nutrients that plants need for healthy growth.



BENEFITS	CHEMICAL FERTILIZER	BIOSOLIDS AND MANURES	COMPOSTS
Provides nitrogen	★	★	some
Provides all plant nutrients		★	★
Slowly releases nutrients	sometimes	★	★
Contains organic matter		★	★
Holds water in soil		★	★
Prevents erosion		★	★
Resists leaching		★	★
Breaks up heavy soil		★	★

Not just down the drain! (continued)



GROCO

Biosolids, composts and other organic soil amendments have another advantage over chemical fertilizers: they are high in organic matter. If a soil is too dense (clayey) for plant roots and water to move through, mixing in a soil amendment high in organic matter will help break it up. If a soil is too loose (sandy or gravelly), water drains through too fast, and the soil dries up quickly. The organic matter found in biosolids, biosolids compost and other organic amendments acts like a sponge, holding water in the soil where plants can get to it. Organic matter improves soil structure and plant growth, helping to reduce erosion and protect water quality.

Biosolids vs. GroCo biosolids compost
Biosolids and GroCo biosolids compost are not the same thing. Biosolids are the product of wastewater treatment. Biosolids are rich in nutrients and organic matter, and are used as a soil amendment to improve soil and fertilize plants. King County's biosolids are treated to reduce pathogens, but not eliminate them completely so they cannot be used in home gardens.

GroCo biosolids compost is made from a blend of one part biosolids and three parts sawdust. This means that biosolids compost is mostly organic matter, and has only small amounts of the nutrients that are commonly missing from soil. It is available to the public, is safe to use in home gardens, and has been composted for a year to kill all pathogens. It is used primarily as a soil amendment to improve the overall health of soil, while supplying enough nutrients for one growing season.

Biosolids compost is available for community projects. Call 206-684-1280 or visit the link to the Biosolids Program on www.kingcounty.gov/WTD for more information.

Resources

Gardening, soils and compost:
Washington State University Stewardship Gardening
<http://gardening.wsu.edu/Stewardship/index.htm>

Soils Information:
www.soils.org/lesson_OR/www.soils.usda.gov/education

Seattle Tilth:
(206) 633-0224
www.seattletilth.org

Master Gardener phone clinic:
(206) 296-3440
www.gardening.wsu.edu

University of Washington Center for Urban Horticulture:
(206) 897-5268
www.depts.washington.edu/hortlib/index.shtml

King County Wastewater Treatment Division
201 S. Jackson Street, Suite 500, Seattle, WA 98104
(206) 684-1280
Link to Biosolids Program at: www.kingcounty.gov/wtd

California Foundation for Agriculture in the Classroom:
www.cfaic.org
www.sandiego.gov/mwwd/kids/index.shtml

Tacoma Enviro Challenger Web site:
www.cityoftacoma.org/Page.aspx?hid=241
This also has lessons, etc. pre and post activities.

Environmental volunteer opportunities:
YMCA Youth Development
909 4th Avenue, Seattle, WA 98104
Interest Area: Teen/Young Adult Programs, Environment and biosolids
www.seattleyymca.org

Washington Environmental Council
615 2nd Avenue, Suite 380, Seattle, WA 98104
Interest Area: Environment
www.wecprotects.org

Mountains to Sound Greenway Trust
911 Western Avenue, Suite 523, Seattle, WA 98104
(206) 382-5565
www.mtsgreenway.org

United Way of King County
www.uwkc.org

Volunteer Match
www.volunteermatch.com

General information:
Ecological footprint resources
www.footprintnetwork.org

Facing the Future
Seattle office: 811 First Avenue, Suite 454, Seattle, WA
www.facingthefuture.org

Fill'er up with 114,859 tons!

Outcome
Students will develop an understanding of the quantity of biosolids produced daily and the importance of recycling.

Grade level
6th to 8th
EALR Math 1.2, 2.1, 3.1, 3.2, 4.1, 4.2, 5.3
Science 1.3, 2.1, 3.1, 3.2

Time:
15 - 30 minutes

Materials:
Pencil and paper
20' measuring tape

Facts
2000 pounds = 1 ton
One truck carries 33 tons of biosolids.

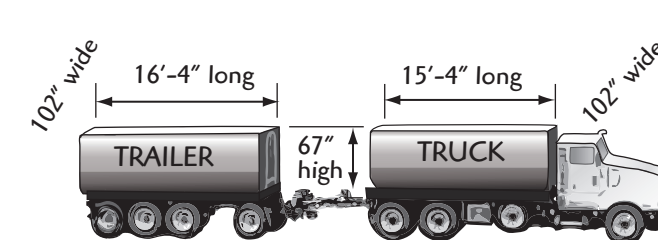
King County produces 114,859 tons of biosolids in one year.

King County Wastewater Treatment Plant serves 1.4 million (1,400,000) people.

Procedure

The people of King County who manage your biosolids know that it is smart to recycle biosolids on the land to help grow trees, crops and gardens. Using biosolids improves the health of the soil by reducing erosion, adding nutrients, and increasing the soil's ability to hold water. King County produces enough biosolids to fill 9.5 tractor-trailer trucks carrying 33 tons apiece every day of the year. Imagine all of those truckloads full of biosolids! If we didn't recycle biosolids what would we do with them? To help you get an idea of just how much biosolids we produce in one day and how big ten truckloads of biosolids really are do the following problem.

Biosolids are transported to fields and farms in tractor trailers that look like this:



Measure the width, height and length of the truck. Figure out the carrying capacity of the truck or how many cubic feet of biosolids the truck can hold. Figure out the carrying capacity of one tractor trailer that transports biosolids. Now measure the height, width and length of your classroom to figure out its carrying capacity. How many truckloads of biosolids fit inside your classroom? How many classrooms would be needed to hold all of the biosolids produced in one year?

Bonus questions

- How many classrooms would be needed to hold all of the biosolids produced in one day?
- How much do YOU contribute to biosolids production in one year? King County's (where you live) wastewater treatment plants receive wastewater from 1.4 million customers and they produce 114,859 tons of biosolids a year. Figure it out! How much is yours?

Discussion questions

- If we don't recycle biosolids what will we do with them?
- Why do farmers and gardeners like to have their soil retain water?
- Can you make up another math problem using the statistics on biosolids?

Ms. Goodearth's dilemma

Outcome
Students will develop an understanding of the pros and cons of different crop fertilization methods. Information on fertilizer cost, environmental impact, availability, composition, and ease of use will be gathered by small groups and then presented to the class.

Grade level
8th to 12th
EALR Communication 1.1, 1.2, 2.2 to 2.5, 3.1 to 3.3, Reading 1.3, 3.1, 3.2, Math 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.3
Science 1.3, 3.1, 3.2

Time
30-45 minutes to introduce the activity; time during class or outside of class to research the topic; one full class period to present all the reports.

Materials
Library, phone, computer to research topics

Note to teachers

Please review the *Not just down the drain* section about soil, slow and fast release fertilizer, manures, soil amendments and soil nutrients to assist with your conversations with the students.

Procedure

Present this scenario to your students:
Ms. Goodearth lives in your neighborhood and loves to garden. She knows you are studying fertilizer, crops and soil health and asks you for advice because she has developed some problems with her garden. She tells you that her soil is hard to dig in and that when she waters her plants, the water runs off onto the sidewalk and into the creek. It does not soak into the soil. The plants that do grow are tiny and yellow. Lastly, she has noticed that the once beautiful creek next to her yard appears slimy and choked with green plants and algae.

What can Ms. Goodearth do to improve the health of her soil and plants?

In order to answer this question, divide the class into five groups. Each group researches a different substance: biosolids compost (GroCo), chemical fertilizer, animal manure, organic/natural fertilizers sold in boxes and home compost/worm bins. Each group studies the following areas: cost, effect on the environment, availability (how/where do you get it?), composition (what is in it?), ease of use (helicopter, shovel, tractor?) and results (how has it performed?).

After the students have completed their research, set aside one period for them to present their results to the entire class. Make a chart on an overhead so that students can compare the different products. Discuss the pros/cons of each fertilizer with the class and the potential cause of the polluted stream.

Resources

- King County Wastewater Treatment Division: www.kingcounty.gov/wtd
- Mountains to Sound Greenway Education Program: (206) 524-1665, www.mtsgreenway.org
- Northwest Biosolids Management Association: (206) 684-1145, www.nwbiosolids.org
- Master Gardener phone clinic, (206) 296-3440
- Seattle Tilth: (206) 633-0224, www.seattletilth.org
- Washington Toxics Coalition: www.watoxics.org
- Choosing Fertilizers for the Lawn and Garden: www.lnw.org
- UW Urban Horticulture Plant Answer Line: (206) 897-5268, hortlib@u.washington.edu
- WSU Cooperative Extension: www.gardening.wsu.edu/Stewardship/index.htm
- City of San Diego: www.sandiego.gov/mwwd/kids/index.shtml
- City of Tacoma: www.cityoftacoma.org/Page.aspx?hid=184

Discussion questions

- Why do people have the "yuck" reaction when discussing biosolids or GroCo?
- What have you learned about biosolids or GroCo that has convinced you that it is useful?
- If we don't recycle biosolids on crops and tree farms, what else can we do with this valuable resource?
- Find out if it is OK to put biosolids in landfills in Washington State.
- What do other countries do with their sewage? Why don't we do the same?

Glossary

Biosolids	the nutrient-rich organic matter produced by the treatment of wastewater
Centrifuge	equipment that uses centrifugal force to remove water from the solids, much like the spin cycle in a washing machine
Compost	the process in which solid organic materials are decomposed in the presence of oxygen through the action of bacteria and other microorganisms; a natural organic material that is produced by the composting process
Commercial or synthetic fertilizer	a human-made chemical that supplies one or more nutrients to plants
Commercial wastewater	wastewater from businesses such as restaurants, laundromats, hair salons, and grocery stores
Digester tank	a large, heated tank where bacteria break down organic material, reduce odor and kill pathogens
Fertilizer	material (often manure or a chemical mixture) that provides nutrients to soil and plants
GroCo compost	a mix of 1 part biosolids to 3 parts sawdust that has been composted for at least a year to kill all pathogens. GroCo is available to the public, and can be used safely in home gardens.
Industrial wastewater	wastewater produced during manufacturing of products such as beverages or airplanes
Leach	the process by which materials on or in soil are dissolved and carried by water seeping through the soil
Manure	droppings from animals that may or may not be composted. In its non-composted form, the form of nitrogen in manure can "burn" the plants, by providing too many nutrients all at once.
Nutrients	a substance or ingredient that nourishes living things for growth and development (i.e. minerals and vitamins are nutrients; so is water)
Organic	a substance derived from living organisms; without chemical fertilizers or pesticides; in chemistry, any compound which contains carbon
Organic matter	plant and animal material in various stages of decomposition
Residential wastewater	wastewater from homes, such as from toilets, showers, washing machines and sinks
Pathogen	an organism capable of causing a susceptible host to develop disease or infection; germs
Soil	the inorganic and organic materials that form a layer on the surface of the earth in which plants sink their roots and from which they receive nutrients
Soil amendment	materials added to soil to improve plant growth and soil health
Vegetation	all plants, large or small
Wastewater	used water from homes, businesses, factories and other sources

Watch it grow!



Procedure

Divide the class into groups depending on how many planting containers you have. If you are using milk cartons, cut off the tops and poke holes in the bottom for drainage. Place at least four inches of soil in each container. For non-GroCo test samples use four inches of pure soil. For GroCo test sample, evenly mix 50% (2 inches) GroCo and 50% (2 inches) other soil. Label each container with the type of soil it contains. Plant four seeds in each pot and water each test sample. Ask the students to develop a hypothesis about the growth of the different plants.

Check the seeds every day, water when the soil is dry to the touch and note when they sprout. After sprouting, measure and record their growth every three days. After the plants have reached their full growth have each group make a chart of the growth and present it to the rest of the class. Engage the class with the discussion questions.

You may keep this experiment simple by: watering all the plants with the same amount of water, exposing the plants to the same amount of sunlight and using only biosolids and one other soil sample. You may increase the complexity by altering the amounts of water and sunlight and increasing the variety of soil samples you use.

Discussion questions

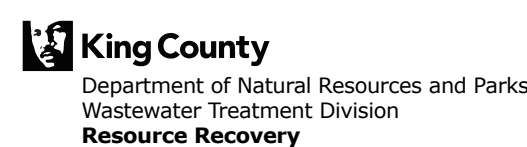
- Which plant grew the tallest? Why?
- What variables affected the growth of these plants?
- What are nutrients? What is fertilizer? What are biosolids?
- How do plants and trees absorb nutrients? Can you name any of the nutrients in the soil and in biosolids?
- Why do biosolids help the soil retain water? Why is that helpful to plants and trees?
- How do we recycle biosolids today? Why don't we put biosolids in the water?

Attention

Be sure to follow the safety guidelines of your school district when handling soil. Always wash your hands after handling soil, biosolids compost (GroCo), fertilizer and manures.

Note to teachers

Please review the *Biosolids vs. GroCo biosolids compost* section about the difference between biosolids and GroCo. Details about soil, slow and fast release fertilizer, manures, soil amendments and soil nutrients are also included in the *Not just down the drain* section and can assist in your conversations with the students.



For more than 30 years King County's wastewater treatment utility has been turning wastewater solids into a natural resource called biosolids. More than 40 years of research by university and government scientists has proven the safety of biosolids recycling. Biosolids recycling is a classic story of converting waste to resource.



From the shores of Puget Sound in Seattle, through the Cascade Mountains to the grasslands of Central Washington, Northwest nature and history are easily accessible and carefully preserved as the 100-mile Mountains to Sound Greenway along Interstate 90 in Washington State. The Greenway environmental education program, "Seeking Solutions to Sustain Forests," brings classroom lessons and field trips to 5th-10th grade students throughout King County, with science-based instruction about biosolids recycling, forests, salmon and soils.