King County

Wastewater Engineers

4-6th grade virtual curriculum

Developed in 2020

Table of Contents:

Overview:

How do we impact the water in our communities? What are we doing to clean it up and what could we do differently? Students will learn how the choices they make daily impact the water cycle. Sessions are designed for students and families to use the engineering design process to understand the process of cleaning wastewater. Students will explore King County's wastewater treatment plant and learn how they can become stewards of their water system.

Goals

- Explain and understand the process of cleaning wastewater.
- Explain how personal choices impact our water systems.
- Understand the engineering design process and how to apply it to wastewater problems.

Objectives:

- Describe the engineered solutions involved in cleaning wastewater.
- List the inputs from humans which make our water dirty
- Using the engineering design process, create and test water cleaning methods.
- Identify ways that the students can change their behaviors and take a pledge to minimize negative impacts on water systems.

King County

Lesson 1- What is Wastewater?

Overview: Have you ever wondered what happens to the water you use every day? In this lesson, students will be introduced to this hidden system running beneath our school, streets and homes. Students will trace the "human water cycle" and learn how they are connected to the Puget Sound. They will be introduced to the concept of "Wastewater" and learn why wastewater treatment is important.

Grade Level: 4th-6th grade

Time: 45 minutes

Supplies:

- Lesson 1 Visuals Aids
- Marker/Pencil
- Blank paper or printed Wastewater Engineers journal
- Gallon jug of water

Virtual Teaching:
There are many ways to interact with students on virtual teaching platforms; each class has their own norms and expectations. Some classes rely entirely on the chat box to communicate, which means that you will need to read the chat box as you teach and interact with the answers. You may need to remind students to type their answers into the chat box every time you ask a question. We've found that accepting answers verbally (calling on students with raised physical or virtual hands) AND through the chat box is a good way to engage all the students. We've also found success asking the classroom teacher to moderate the chat box and read aloud answers to us.

Curriculum Outline:

Overall goal: students know the basics of our urban water system, and consider how and where they interact with wastewater (and why that might matter)			
Topic & Goal	**What's happening in lesson/on screen?** **What will students/viewers be doing?**	**Materials Needed? Or People? (what will be needed to do this?)**	**Time: 55 minutes**
Virtual teaching Expectations/ Housekeeping	Teacher establishes virtual classroom expectations and does quick tech intro	Teacher onscreen, students listening	3
Attention getter- How have you used water today?	Students share out, connect their use of water to the bigger water system	Teacher onscreen, calling on students, students share verbally and chat box	5
Tracing the Human Water Cycle	Teacher walks through human water cycle with student input	Teacher: PowerPoint share screen, Students: printed journal pages or blank paper	15
Where does wastewater come from? What is in wastewater?	Students contribute to lists of drains and pollutants in water system	Teacher: PowerPoint with drain table, organics/trash/bacteria/chemicals table Students: printed journal pages or blank paper	15
Conclusion/ Prepare for Lesson 2	Students share out one thing they learned, will share with family		5

Intro-

- Welcome the group and introduce yourself.
- Program introduction: *"Today, I'm going to talk about where water comes from, how it gets to your house, and how we are really good at making water dirty. We'll also talk about where it goes afterwards to be cleaned up."*

- **Tech:** (adapt depending on audience) Verbally review classroom norms for interacting such as:
    - Students should stay muted unless they have been called on
    - Students should have video on if possible
    - To answer a question, students can raise their hand physically, use the raised hand button, or type an answer in the chat box
    - Students should be engaged and answering teacher questions throughout the program

- Student first names should be displayed
- Note: some teachers encourage typing instructions into the chatbox as well, in this case we recommend preparing a separate document of items to copy into chat box during the program.

Attention Getter- How have you used water today?

- Start off the lesson by bringing the concept of wastewater back to them at individual level by discussing water in student's everyday lives

- *"I'd like to start off by asking you all- how have you used water today? Please type your answer in the chat box."*

- *"How many gallons of water do you think you use per day? Type you answer in that chat box."*

- Hold up an empty gallon of milk if you have it or explain how much a gallon is/ looks like. Address student answers out loud from chat box
- *"Did you know the average American uses about 100 gallons of water a day? That's two and a half bath tubs full of water! How did your guess compare?"* Hold a full gallon jug of water up to help students conceptualize that volume.

Water Cycle Map- Page 2 of Student Journal

- "*Did you know that water that you used today came from the water cycle? Other people have used that water before you. That water came from nature and is going to be put back into the water cycle-in the Puget Sound- after you use it!"*

(Begin screen sharing- Bring up the Water Cycle worksheet on the screen.)

- We are going to work together and talk out how water flows through where you live. "*Go ahead and take a minute, use your finger to trace out how you think water flows through our system."*
- Ok now let's add some arrows to our watershed to show how water moves- follow along with me.
- "Since the water cycle is a big circle, you can really start anywhere". Ask students to think back to when they studied the water cycle in school. Ask for students to share how they think the water moves through the picture. Add arrows on screen as they share. Map out the typical water cycle (snow in the mountains, snow melt, rivers, out to the Puget Sound, then up into the clouds through evaporation).
- Using water cycle vocabulary (evaporation, precipitation, and condensation) isn't necessary but encouraged.
- *"But wait, what is missing from this water cycle? People! We need to add in how people take water from the water cycle."*
- *"Does anyone know where are drinking water comes from?"* This question might help student noticing the water tower
- *"We get our drinking water from a beautiful lake in the mountains-it's called the Cedar River Watershed. The snow melts into the lake, and we pipe it from there down into the cities. The rest*

of the water keeps going, along the Cedar River, and eventually out in Lake Washington."
"Where does the water from the reservoir go next on it's journey to where you live?"

- (Water tower!) Yep, it goes in these! The beautiful mountain water is piped into these things- putting the water up high in the water towers makes it much easier for us to pipe the water to your house.

- *"On to the next stop- that beautiful mountain water gets piped to where you live. Your toilet, shower, sink water-it's all the same*!" Draw an arrow to the houses.
- *"Now that the water has been used, what happens to it next?"*
- *"Yes, we must clean it! The water gets sent to the wastewater treatment plant."*
- *"At this point, we use some incredible machines to do our best to remove the icky stuff that you put in the water. After our second lesson together, you'll get to watch a virtual tour video and see all of our cool machines and the treatment process."*

- *"After we do things to clean the water, does anyone know where it goes next?* "The Puget Sound

- *"So, believe it or not - you are part of the water cycle when you get water from your faucet, and when you go to the bathroom."*

(Screen Sharing- King County's reginal Wastewater Map)

- *"Looking at this map- where do you live?"* Find it on the map. *"What color is the area where your house is? "*
- *"If you live in the yellow area your wastewater goes to the South Treatment Plant in Renton. If you live in the brown area on the paper your wastewater goes to the Brightwater Treatment in Woodinville. If you live in the pink area on the map your water goes to the West Point Treatment Plant located in Discovery park. "*

<u>Where does Wastewater Come from? Page 3 of Student journal</u>

- *"I'd like you to start thinking about all the places wastewater comes from and all stuff that you put down with the water every day."*

- Have students turn to the other side of the worksheet. If you don't they don't have the journal page paper, they can draw this out on a blank page or white board.

(Screen Sharing- Wastewater Table)

- *"Take a few minutes to think- what are the drains that are inside of a building where dirty water disappears? Try to come up with at least three. I'll give you a minute."* Raise hands/ type some of your ideas into the chat box!

- Now go ahead and fill in the journal with these drains- Shower/tub, sink, toilet, washing machine.

(Turn to slide with chart, drains column filled in)

What is in Wastewater - Page 3 of Student Journal

- *"Now we are going to start thinking about what goes down these drains. What are some other things that could be in it?"* Make a list on the left column next to each drain. Note, we know water is going down, so we don't need to write that.
- Give students time to independently write down a list, then share out with the class.

(Turn slide to the categories table)

- *"Alright class I have reorganized the list of think we can up into a slightly different format."*
- *"Looking at these 4 categories what do they have in common?" We want to come up with word title for each of these 4 categories.*
    - Trash- these things really do not belong in the pipes, instead you should be putting them in the trash can
    - Organics- All the thing in this category come from a living thing or were once living
    - Chemicals- Everything in this category has chemicals in the ingredients
    - Bacteria- All the tiny microscopic organisms that are on our hands and in our bodies, that are washed down the drain when we wash our hands, shower, and use the toilet

(End screen sharing.)

Conclusion

- I am so glad that the treatment plant exists, so all this icky stuff isn't going out in Puget Sound.
- Next time we will be together we will be doing an engineering lesson with fake wastewater! You'll need to gather supplies from your kitchen, we'll send out a list to your teacher.
- *Before I leave, I want you to think of one thing you just learned that you are going to share with the people you live with. When you have your answer, put your finger on your nose. Not in your nose!* Have students share out verbally or in the chat box.
- Thanks again so much for having me join your class today.

Lesson 2: Engineering Challenge

Overview: In this hands-on and interactive lesson, students will to learn about the engineering design process behind cleaning water. Students will practice being wastewater engineers themselves and will engineer their own wastewater filter using household supplies.

Grade Level: 4-6th grade

Time: 45mins

Supplies:

- Lesson 2 Visual Aids
- Items for experiment (students gather at home before lesson):
    - **Props for Dirty Water**: 2 bowls, 2 cups of water, Paper towel (represent trash), 1 tbs dirt/soil/coffee grounds (Organics), Table salt (Bacteria), colorful Liquid Soap (Chemicals)
    - **Engineering challenge tools**: Colander/strainer, spoon, fork, sponge optional: rubber band/hair tie, coffee filter/paper towel

Platform: Live Zoom/Teams Lesson

Appendix: Alternate introduction if students have not received Wastewater Engineers lesson 1

Overall goal: Students will learn what is wastewater, why it is a health hazard for people and the environment, and that cleaning wastewater requires complex and interesting engineering. Students will gain exposure to engineering as an iterative process, an accessible and fun activity, and a possible career.			
Topic & Goal	**What's happening in lesson/on screen?** **What will students/viewers be doing?**	**Materials Needed? Or People? (what will be needed to do this?)**	**Time: 50 minutes**
Zoom Tech Housekeeping, intro	Teacher establishes virtual classroom expectations and does quick tech intro	Teacher onscreen, students listening	3
Review of Wastewater Lesson 1	Students share knowledge of wastewater and water systems	Teacher: PowerPoint share screen, Students: printed journal pages or blank paper	5
Engineering 101	Introduction to the engineering process, pose the engineering challenge for the day	Teacher: PowerPoint Engineering 101 Students: Pen and paper	10

Making Dirty Water	Teacher demonstrates then students follow along, making fake wastewater	Teacher and students: bowl, 2 cups water, 1 tbs dirt/ coffee grounds, paper towel, liquid dish soap, table salt, spoon	10
Engineering Challenge	Students attempt to design and then filter their water	Teacher and students: two bowls, colander, coffee filter/paper towel, rubber band, spoon, fork	12
Review designs, redesign	Students share designs and spend time adding steps to their original design. Share out redesign plans.	Students: Paper/pencil	5
Closing	Students share out one thing they learned; one question they would like answered		5

A note about virtual teaching- there are many ways to interact with students on virtual teaching platforms; each class has their own norms and expectations. Some classes rely entirely on the chatbox to communicate, which means that you will need to read the chatbox as you teach and interact with the answers. You may need to remind students to type their answers into the chat box every time you ask a question. We've found that accepting answers verbally (calling on students with raised physical or virtual hands) AND through the chatbox is a good way to engage all the students. We've also found success asking the classroom teacher to moderate the chatbox and read aloud answers to us.

Introductions and tech housekeeping-

- Introduce yourself and your role within your water agency
- Program introduction: *"Today, in our hour together, we are going to practice being wastewater engineers. Wastewater engineers use science and problem solving to clean our water after we are done using it. To give you an outline of our class today, we are going to start by talking about our water system. Then, we are going to make fake wastewater together, and try to clean it together. At the end, we'll study what real engineers do to clean the water at our facilities. If you were able to gather the supplies we requested before, you can do the experiments with us together, otherwise it's fine just to watch and follow along."*

- **Tech:** (adapt depending on audience) Verbally review classroom norms for interacting such as:
    - Students should stay muted unless they have been called on
    - Students should have video on if possible
    - To answer a question, students can raise their hand physically, use the raised hand button, or type an answer in the chat box
    - Students should be engaged and answering teacher questions throughout the program
    - Student first names should be displayed
    - Note: some teachers encourage typing instructions into the chatbox as well, in this case we recommend preparing a separate document of items to copy into chat box during the program.

Wastewater Review:

(If students have not done an introductory water systems lesson, use the introduction activity at the end of the document under "Additional Lesson Materials")

- *"Today we are going to be wastewater engineers. Thinking back to our last lesson, who can tell me what wastewater is?"*
- Listen to responses. Review the human water cycle. Where does drinking water come from, where does wastewater come from, where it goes.
- *What are some of the things that are in wastewater*?

  (Pull up on screen, table with ORGANICS, TRASH, CHEMICALS, and BACTERIA)

- *"Looking at this list, why do you think wastewater is dangerous?"*
- Take responses, come up with reasons that it's a health hazard to people and the environment.

Engineering 101

- *"It's so important that we have a system to clean the water and remove all those pollutants that humans put into it. Wastewater Engineers have designed these systems at our Wastewater Treatment Plants."*

- Ask students to define engineering, and list different types of engineers
  (Share screen, engineering definition slide)

- *"There are so many kinds of engineering specialties, but what they all have in common is that they are using since to design solutions to problems. Engineers do this using the engineering problem solving process"*

  (Slide with engineering process diagram)

- Using the pointer feature, describe each stage of the engineering process. *"This process is so cool because it's a giant circle! You identify your problem, research solutions, create a design and then test it out! Then, you look at how your design did, and go back to the drawing board to make it even better."*

- Identify dirty water as the engineering problem today. Go through the engineering cycle on the slide, describing how you'll follow the process to develop a water filter.

Make dirty water

(Water filter supply slide)

- *"Ok, now for the gross part- we are going to make our own fake wastewater. Don't worry, we are going to use things to represent things in the water, not actual human waste."*
- This is the best time for students to make sure that they have gathered all their supplies. List out supplies verbally, hold up the supplies in front of the camera, and paste the supply list (in callout box on the right) into the chat.
- Remind students to create a space to work, push back their computer, and gather clean up supplies in case of a spill.
- First, we need to assemble our supplies for the dirty water I am going to give you 1 minute to make sure you have all your supplies (wait 1 minute)

  (Stop screen sharing)
- *"First, we are going to pour our first ingredient in wastewater in- it's water! We clean 270 MILLION gallons of water every day at King County. You alone use 100 gallons of water a day!"*
- Pour the 2 cups of water slowly into the bowl, making sure that you adjust the camera if needed to catch the props.

WATER FILTER SUPPLY

Substitute options in parenthesis

- 2 Medium Bowls or Tupperware containers
- 2 cups of water
- Paper towels (paper napkins, wipes)
- 1 tbs dirt (coffee grounds, flour, masa)
- Table salt
- Dish or hand washing Liquid Soap (detergent, mouthwash)
- Colander/strainer,
- Spoon
- Fork
- Sponge

Optional
- Rubber band/hair tie
- coffee filter/paper towel

- Ask students what should go in the water, thinking about the categories of waste that you just reviewed. You can take categories from students, no need to go in an order.
  - **Organics**: Explain that we are going to use dirt or soil to symbolize all the food and poop. Coffee grounds, flour, or masa can substitute dirt if unavailable. Hold soil near camera, then pour into bowl with water. Stir.
  - **Chemicals**: Remind students that there are hundreds of types of chemicals in wastewater from medications, to glitter bath bombs, to bleach. Squeeze in liquid soap.
  - **Bacteria:** "*Since it's hard to represent bacteria, it's microscopic-too small for humans to see! We are going to use something small that will be invisible in the water, just like bacteria. Salt!"* Pour salt into water.
  - **Trash**: Instruct students to rip up a paper towel into pieces and put it in the bowl. If you are using a wipe, you'll notice it's really, hard to rip up. (goofily try to tear wipe) that's because they are designed to stick together and be strong when they are wet. They clump up together and cause HUGE clogs in our system. That's why we only put the 4 p's in the toilet. Write in what you think one of the four p's is! (Read chat box) Yep, poop, pee and toilet paper!

- *"Ok, now that we have made our wastewater, what are you noticing about it?"* Hold the fake wastewater bowl up to camera.

- *"This is gross, right? Can you imagine all this going out untreated to Lake Washington/Puget Sound every day?! It's so, so important that we are responsible and clean it first*
- *"Now we are going to be engineers and try to clean our fake dirty water as best as we can. What are some thing we could do to clean this water? What do we know works to clean water? What do we know about the properties of the pollutants that could help us filter them out?* Go deeper into discussion depending on time.

Engineering Challenge

- *"I love all those ideas! Get out a blank piece of paper, you have 2 minutes to sketch or write out your filter ideas using the tools that you have in front of you. Feel free to use ideas that you heard in our discussion just now. Your filter can also include multiple steps."*

  (Set timer for 2 minutes)

- *"Ok- now I'm going to give you five minutes to clean the water using the design you just made. It's ok to realize that you want to do something different as you are filtering, we'll talk about those choices when we're finished. Remember that you want to get water that's as clean as possible, and to have the same amount of water as when you started."*
- Remind students that they are using messy stuff in front of a computer, so remember to push their computer further away from their filter, and to be careful and slow as they pour their water.
- Ask if there are any questions before you start filtering.
- Give students have 5 minutes to build their filter and clean the water.
- After five minutes have ended, stop students and have them carefully hold up their cleaned water to the camera.
- Discuss results with students:

    - What worked well in your filters? Which categories where the easiest for you to remove? Which were the hardest? How can you tell the Chemicals and Bacteria are still in the water? Have you smelled your water? Can you smell the soap? Do you see bubbles on the surface? What about the salt? Is there any evidence that it has been removed? How would you know?

    - How would you redesign your filter to make it better? How would you use the available supplies differently? What supplies would you add from your kitchen /where you are if you could?

Conclusion

- *"We are done with the water filtering activity for now, but if you'd like to continue building different filtering methods- I encourage you to do so! You can email me with the water-cleaning solutions you try out!"*
- *"In our last minutes together, I'd like you to share something that you learned about engineering or cleaning water today. "*
- *"Alright, that's the end of our lesson. Thanks for being great engineers today!"*

Additional Lesson Materials

What is Wastewater-If they have NOT received pre-lesson:

- *"To start us thinking about the water we use, I'd like to know one way that you used water today? Go ahead and type it into the chat box. "*
- *"Does anyone want to guess how many gallons of water you use every day? The average person in America uses 100 gallons of water/day! 100 of these!* hold up a gallon of water *We're lucky here-this water comes from a beautiful lake in the mountains."*
- *"Ok, so now that we have used all this water, where does it go next? When you flush the toilet and wash your dishes, where is that water going? Write your ideas in the chat box.*

  (Share screen, Show aerial photo of wastewater treatment plant)

- *"These are great answers, it goes to a huge facility, where we use machines to clean the water. This is a picture of West Point wastewater treatment plant, in Discovery Park in Seattle."*

  (Show service map)

- *"This map is where all the water goes in this whole region. The different colors represent different places that the drain water goes to. Let's take a minute, look at the map and see if you can find where you live, and where your water goes. Type it into the chat box. If you live outside of the pink/red/yellow areas of the map, type where you live into the chat box."*
- *"The next thing we are going to do is really think about all that gross stuff people are putting down drains- what's in this stuff we call wastewater?"*

  (Share slide of blank table)

- *"To figure out all the things that are in wastewater, and make it so dangerous, let's take a step back and think about all the drains in a building. Go ahead and take 30 seconds and list out on your piece of paper all the drains you can think of."*

  (Pull up table with drains filled in)

- *"Great, now we are going to make a mega-list of ALL the things that can possibly be going down drains. Go ahead and wire down all the things you can think of going down each drain. I'll give you 30 seconds."*

  (Show slide with table/four type categories)

- Those were all great answers, so we've listed out everything into four categories here. They are organized by what they have in common- in each category, they share similar chemistry properties that can help us take them out of the water. Can anyone guess what the first category is?
    - Trash- These things shouldn't be there - even flushable wipes! They all clog up our system, but because they are big, we can strain them out of the water.
    - Organics- These things all came from something that was once alive- they are all also heavier than water, so we can use that to take them out.

- Bacteria-There are literally millions of germs in a gallon of wastewater. Everyone has germs on their bodies, so when we wash our hands or go to the bathroom, those germs all end up in the wastewater. But we can use what we know about germs (like that certain things can kill them) to get them out of the water.
- Chemicals - These are the hardest to get out of the water, because there are literally thousands of types of chemicals going down drains, it's really hard to get rid of all of them.

Virtual Wastewater Treatment Plant Tour

Overview: In this 25-minute virtual tour, students will follow a King County educator step by step through a wastewater treatment plant to discover what happens to all the water that we use in our homes, business and schools. Through footage, props, and animations, students will experience learn how engineers have designed machines to solve the problem of dirty water.

Grade Level: 4th-6th grade

Time: 25-30 minutes

Supplies:

- Treatment Plant Tour Video
- Wastewater engineer journal or blank paper and pencil

Viewing Videos Virtually:

When watching video in a virtual classroom it is important remember that when sharing your screen and playing a video, the audio and/or video may be delayed and laggy for students watching at home. There are pros and cons to watching as a class versus having students watch on their own.

Platform: Zoom/ TEAMS

Curriculum Outline:

Overall goal: Students will learn the different components and the supporting science behind a wastewater treatment plant. Students will practice using engineering thinking, and brainstorming solutions to engineering challenges.			
Topic & Goal	**What's happening in lesson/on screen?** **What will students/viewers be doing?**	**Materials Needed? Or People? (what will be needed to do this?)**	**Time: 25-30 minutes**
Virtual Tour Video	Quickly walk through human water cycle	Youtube/Ed Puzzle Link. Journal PDF file, fillable pdf, or blank paper	25
Comprehension Questions	Follow along with the video and answer the questions in the journal	Ed puzzle or journal	Simultaneous

Options for viewing the treatment plant tour:

EdPuzzle Link: https://edpuzzle.com/assignments/5f284e3eb7f5ab3f15df2c89/watch

- EdPuzzle is a great way to monitor if students have actually watching the video as they cannot skip ahead. In addition, the journal questions that students are asked to follow along with, are embedded into the video.

YouTube Link: https://www.youtube.com/watch?v=cxpmXJx2b6o

- Youtube link is simple user friendly and commonly used platform that MOST students should be familiar with.

Lesson 3: Wastewater Stewards

Overview:

In this 45-minute lesson we will conclude the Wastewater Engineering series. Students will review previous lessons, then learn more about different ways they can contribute to taking care of our water systems. Students will work in small groups to make posters to solve wastewater problems and promote stewardship.

Pre-Work: Lesson 1 and 2 in the Wastewater Engineering series, WTD wastewater treatment plant virtual tour

Grade Level: 4-6th grade

Time: 45mins

Supplies:

- Water problems document sharing options
    - Using GoogleSlides: Another way to share the problems with each student
    - Using Jam board: A student friendly program very similar to google slides that students can add “post-it notes” to share their ideas and even add images.
    - Using a pdf or Powerpoint

Platform: Live Zoom/Teams Lesson

Outline:

Overall goal: Students will learn that stewardship of our water system is important and achievable. Students will synthesize previous lessons and learn about water stewardship methods they and their families can take.			
Topic & Goal	**What's happening in lesson/on screen?** **What will students/viewers be doing?**	**Materials Needed? Or People? (what will be needed to do this?)**	**Time: 45 minutes**
Zoom Tech Housekeeping, intro	Teacher establishes virtual classroom expectations and does quick tech intro	Teacher onscreen, students listening	5
Water Questions	Students review the virtual tour video and ask follow-up questions. Time permitting, they can ask their zaniest, STEM based water questions	Teacher: FAQ answer sheet	10
Water Stewardship PSAs	Students break out into groups to create a PSA for a water-systems problem	Teacher: Share screen with example google doc Students: google doc problems	20
Water Steward Pledge	Students work together to create a water stewardship pledge	Teacher on Screen	5
Conclusion	Wrap up lesson series and thank students	Teacher on screen	5

Program:

Introductions, Tech Reminders (5 minutes)

- *"We've been on a whole journey through the water system- today in our last lesson together we are going to review what we've learned, ask questions about the water system, and use our water knowledge to creatively solve a water system problem."* Check that most of the students have seen the video tour.
- Review classroom expectations for interaction over video platform

Water Questions (10 minutes)

- Review the tour video, ask students to list what they learned or what surprised them from the video tour.
- Ask and answer any questions that they have about the tour.
- Share that this is also their moment to ask any water question they've been wondering (as long as they are appropriate). If we can't answer the question ourselves, we will find an expert at King County and send the teacher the answer (within reason).

Water Steward Problems (25 minutes)

- *"We are going to take what we have learned about the water system and use it to help fix a wastewater problem." Ask students what problems that you know of in our water system.*
- *"Today we'll be looking closer at some of the issues with wastewater that we have in our community and seeing if we can come up with different ways to address them. In your breakout groups, you're going to get a google doc that lists a wastewater problem. In your breakout rooms, you're going to learn about this problem, answer the questions listed in the google doc, and develop a solution that changes people behavior and attitudes around a water problem "*

(Share your screen and an example google doc)

- Show students what the problems look like, and the questions.

- Start breakout rooms, then go into each breakout room and drop a link to the google doc for each group.

- First breakout session, 5 minutes:
    - Students are asked to read as a group their scenario page and answer question number 1 on their google docs
    - Move between the rooms and google docs checking in with students and monitoring how they are doing.

- Close breakout rooms. Ask a representative from each group to share with class their wastewater problem.

- "*Before we jump to solutions, we want to make sure we have everything we need to really solve these problems that we've identified. In your groups you'll going to answer questions in the doc after the problem to help you develop your solutions. The questions are: who do we need to talk to? What else do we need to know? What evidence do we need to convince people to solve this? Once you've discussed the problems, move on to the solution step."*

- Inform students that their solution can be creative! Instruct students to write or draw solutions in the google do or sketch out ideas on scratch paper. Their solutions can be a way of helping people make a different choice (like putting in trash cans or informational posters) or changing the structure of the site.

- Send back into breakout rooms for 10 minutes. Monitor students' progress and the google docs. Cut groups shorter depending on progress, behavior, and time left in lesson.
- Close break out rooms, have students share the solutions that they've developed.
- Discuss as a class problems like this that they've noticed at school or home

Alternative for class without breakout rooms:

- After introducing activity, inform students that they will study multiple problems, choosing one at the end to solve. Share screen and read 2-3 of the scenarios to students. Discuss scenario questions with class, taking notes on screen as students share. Have students choose on of the problems, then allow them five minutes to draw a solution. Do a "gallery walk" at the end- have them hold up their drawings to the camera all at the same time.

Water Quality Pledge (5 minutes)

- *"As our last activity together, we are going to think up commitments (those are things you are going to do!) for yourself and your family, to make our water cleaner. Take a minute and think of one thing you know you'll do going forward."*
- (Pause) Have students share verbally or in chat box.
- Have students raise their right hand, and "repeat after me, I, state your name, promise to… (string together the pledges students have shared in the discussion).

    - For example, "I promise to only flush the four P's, not to pour cooking grease down the drain, use green chemicals, and teach everyone I know about how we are connected to the Puget Sound"

Conclusion (10 minutes)

- Thank you all so much for letting us join your class for this series. We hope you've learned that you are part of the water cycle, and that there are so many things you can do to be a good water steward.

Pre-Lesson Activities

Overview: Introducing some wastewater concepts in the classroom prior to the lesson will be a big help in having a successful day of learning. These videos are meant to spark students' interest and questions that our team can answer on the day of the lesson.

1.The Poop Cycle

Youtube link: https://www.youtube.com/watch?v=hMIHFR_P7QY (3 minutes) or watch on

EdPuzzle link: https://edpuzzle.com/assignments/5f2b04ad461fae3f88e7ee8e/watch

Note: **This video uses the word condom.** Get an introduction to how dirty water gets cleaned after it leaves your school and homes. Please keep in mind that this video moves FAST! I would watch it more than once if you choose to use it.

Debriefing Questions:

- What surprised you most about this video?
- What kinds of stuff can clog pipes? Wipes, grease, paper towels, condoms, tampons.
- Did you know that poop and food is made into compost to grow food?

2. Part of the Cycle:

Vimeo Link: https://vimeo.com/72320999

This animated short cleverly uses ink and water to explain how water reaches our homes, how we change it, and how we are all part of the water cycle.

Debriefing Questions:

- Review the Water Cycle. How does water move from the Puget Sound or a lake near you? Evaporation, Condensation, Precipitation
- Where does our drinking water come from in Seattle? The mountains
- How do you use water everyday? Toilets, sinks, showers, washing dishes, washing clothes.
- How do the bacteria help clean wastewater? They eat the remaining poop and food out of the water.

3. How the Toilet Changed History

Youtube Link: https://www.youtube.com/watch?v=GWQG1YZS9l4 (7 minutes)

EdPuzzle Link: https://edpuzzle.com/assignments/5f2b03a4a1c1803ef95c3a31/watch

Did you know that 2.4 billion people don't have access to toilets? Take a closer look toilets and other sanitation system changed our daily lives.

Debriefing Questions:

- How many people don't have access to toilets or latrines in the world today? 2.4 billion people or 1 in 3 people.
- What is Cholera and how can it be prevented? A bacterium that can be found in drinking water infected with poop causing serious diarrhea. It can be prevented by having a sanitation system that keeps dirty water away from clean drinking water.
- Who invented the flush toilet and when? 1560 by Sir John Harrington

4. Why Flushable Wipes Aren't Flushable - Adam Ruins Everything

Youtube Link: https://www.youtube.com/watch?v=TgHVO-RZ8c4&t=204s (4 minutes)

Ed Puzzle Link: https://edpuzzle.com/assignments/5f2b0393f54ca33f076fb726/watch

In this video, Adam explains why the toilet paper industry's recent advertising ploy is clogging our drains.

Debriefing Questions:

- Were you surprised by what happened to the toilet paper and wipe when it came out of the mixer? Did you notice how she could pick up the toilet paper in one whole piece and the wipes looked the same?
- Did you know that flushable wipes cause so many problems? How many people have seen or used these wipes before?
- Why are they called flushable wipes if they shouldn't be flushed? It's false advertising - it makes it easier to sell the product and the wording isn't regulated.
- What is a fatberg? Flushable wipes and cooking oils combine and cause enormous clogs in the city sewer system.

Post Lesson- Personal Water Audit

Overview: Depending on where you live in the world, you may experience water as an abundant resource that you don't think about very much- it flows out of your faucets and doesn't run out. In this lesson we will use math look more closely at how many gallons of water you use each day.

Time: 30 minutes

Supplies: Personal Water Audit worksheet

Personal Water Audit

Answer the following questions about your household water usage today. If you do not know the exact numbers, please estimate as well as you can.

Pre-Question: Before completing the chart below, take a guess at how many gallons of water your household uses per day:_____gallons

Compare your guess with the **Daily Total** below:

Question	Answer	Calculation	Answer
1. How many times today have you flushed a toilet?		**Multiply this number by 3.** The average toilet uses 3 gal of water per flush	_____ Gal
2. Did you take a shower or bath?		**Write down 40 gal if you took a bath. Write down 2 gal for every minute you were in the shower.**	_____ Gal
3. If you have a dishwasher, how many times was it run today?		**Account for about 10 gal per load.**	_____ Gal
4. How many minutes today did you run your sink faucet? Think about brushing teeth, washing hands and face, washing dishes, filling pots for cooking, shaving, etc		**Factor 4 gal per minute.**	_____ Gal
5. Whether you have a washing machine or use a laundromat, how many loads of laundry did your household do today?		**Multiply this number by 40 for top loading washers.** (If you used a front-loading washer, multiply by 25 per load.)	_____ Gal
6. Do you have any leaky faucets? A faucet is leaky when it drips water even if it's turned off. Write that number here.		**Multiply each leaky faucet by 1.4. The average leaky faucets wastes 1.4 gallons/day.**	_____ Gal
7. How many glasses of water did you drink today?		**Multiply each glass by 0.0625.** There are about 8 oz in an average glass. 128 oz = 1 gal (or about 16 glasses of water).	_____ Gal
8. Did you use a hose today? Think about watering a garden, washing a car, or bathing a pet.		**Factor 10 gal per minute.**	_____ Gal
Daily Total		**Add up the numbers in the right-hand column.** This is how many gallons of water you used today.	_____ Gal

Figures for calculations estimated from "Conducting a Household Water Audit," Maryland Department of the Environment.

Extra Credit:

Questions:

At the South Treatment Plant we have 12 primary wastewater tanks that are L=164ft x H=9.5ft x W=34ft. If we filled all 12 tanks with wastewater how much volume could we hold in all 12 tanks combined?

Answer:

164x 34= 5576

5576 x 9.5= 52,972 ft^3 per tank

12x 52,972= 635,664ft^3

Teacher Resources

Wastewater Background Information

King County Reginal Wastewater Treatment System

King County protects water quality and public health in the central Puget Sound region by providing high quality and effective treatment to wastewater collected from the local sewer agency.

The county's Wastewater Treatment Division (WTD) serves about 1.8 million people within a 424-square-mile service area, which includes most urban areas of King County and parts of south Snohomish County and northeast Pierce County.

For more information about our region system check out facts about our system here: https://www.kingcounty.gov/depts/dnrp/wtd/system.aspx

Detailed Treatment Process Description

South Treatment Plant in the second oldest wastewater treatment plant in King County. It services residential and commercial area of Kirkland, Bellevue, Issaquah, Renton, Black Dimond, Covington, Kent, Auburn, and South Seattle. South Plant has the capacity to treat 250 million gallons of wastewater per day, but on average treats bout 80 million gallons. South Plant is designed to treat two types of waste: the water itself and the solids removed from the water.

Treating the Water

Water entering the treatment facility is called *influent*. It contains trash, grit, organic solids (food from garbage disposals, fecal matter, etc.), microorganisms, and chemicals. These contaminants are removed in order of largest to smallest, heaviest to lightest. The water takes about 12 hours to go through the entire treatment process. Once the water is treated it is called *effluent* and is used as reclaimed water at industrial and commercial sites. Surplus effluent is transported to the Puget Sound through the Brightwater Tunnel, which empties into the sound at near West Seattle Light House.

Trash Removal: Things such as 'flushable' wipes, paper towels, band-aids, hair, and floss are often inappropriately flushed and enter the wastewater. Trash is problematic in the wastewater system because it does not break down in the sewer pipes and can cause clogs in pipes or damage pumps and cause overflows to streets or lakes. Trash is removed by perforated steel plates that act as filters. This trash is then loaded into trucks and hauled to a landfill in Eastern Oregon. Brightwater produces about a truckload of trash per week.

Grit Removal: Dirt and grit enter wastewater through cracks in the sewer pipes. Grit is problematic in the treatment plant because it can damage the machinery. Wastewater is aerated to help grit settle to the bottom where it is removed and hauled to the landfill. This process is similar to a hot tub: air and turbulence keep organic waste suspended in the water and gravity causes the heaviest particles (rocks, dirt, sand, etc.) to fall to the bottom.

Primary Treatment: Primary treatment is the process during which most of the suspended solids settle out of the wastewater. Gravity causes the larger, denser, solids to settle to the bottom while the lighter greases and oils float to the top, leaving the cleanest water in the middle. Scum skimmers scrape off the top layer of grease and oil while scrapers remove the solids that have settled to the bottom. These

materials are sent to the beginning of the solids treatment process, in which the organic material is converted into methane and fertilizer. (Please review 'Treating the Solids' section in this document.) After the water goes through primary treatment, 60% of the solids have been removed. Up until the 1950s, this is all that was done to treat most wastewater. This caused problems in our aquatic ecosystems because the wastewater was discharged into nearby Lake Washington and Puget Sound. When wastewater is discharged into the surrounding waterways, it overloads them with organic material and nutrients. These nutrients act like fertilizer and cause algae and other aquatic microorganisms to grow very rapidly. When those organisms complete their life cycle and die, the natural process of decomposition begins. Decomposition requires oxygen, and because there is so much organic material decomposing, all of the oxygen in the water gets used up. As a result, many of the living things in the water do not have enough oxygen to survive, and the lake experiences a population crash. Once this has occurred, it is very difficult to restore the balance to the aquatic ecosystem.

Secondary Treatment: Secondary treatment is the process where soluble substances and fine particles not already removed at primary treatment are removed. This is a two-step process. First, the wastewater is aerated with warm air, which encourages aerobic bacteria growth. The bacteria-rich water is called 'activated sludge.' The bacteria, which naturally exist in freshwater systems, are given an optimal environment for growth. They eat and metabolize the soluble organic material back down into its basic components: nitrogen compounds, carbon dioxide and water, and cause the fine particles of insoluble material to clump. No solids are removed in the aeration process. The aeration process mimics the same decomposition process that is occurring in natural systems, but it is accelerated and magnified by the introduction of massive amounts of oxygen. In the natural world, the rate of decomposition is limited by the amount of oxygen in the water, and ultimately the amount of waste in the water exceeds the amount of oxygen available to help break it down, creating an imbalance in the system. In addition to decomposition, the bacteria also help the remaining fine particles clump together, making them easier to filter out in the next step of secondary treatment: filtration by membrane bioreactors.

Once the activated water leaves the aeration tank, it enters the clarifiers. Clarifiers are settling tanks built with mechanical means for continuous removal of solids being deposited by sedimentation. As the water beings to cool the bacteria begin to clump together in balls known as flocks. These flock or solids sink to the bottom to be collected.

These solids are sent to the beginning of the solids treatment process to be converted into methane and fertilizer in an anaerobic digestion tank (Please review 'Treating the Solids' section in this document.). Once the water has gone through secondary treatment, 99.9% of the solids have been removed.

Disinfection: The final step of the water treatment is to kill enough of the remaining pathogens in the effluent to comply with water quality discharge permits. Sodium hypochlorite, a chemical similar to bleach, is used to disinfect the water. Effluent is highly regulated and tested on a regular basis. Fecal coliforms are monitored and used as an indicator to signal the possible presence of other bacteria and pathogens in the effluent.

Treating the Solids

Organic solids are removed from wastewater during primary and secondary treatment. These solids are mixed with polymer, an additive that helps the solids clump together and congeal, then sent down a gravity belt thickener which uses a thin mesh to strain out the water and compact the solids. The thickened solids are then sent to the digester. The digester is a large tank that is heated to 98° F.

Bacteria in the digester use anaerobic (without oxygen) processes to break down pathogens and organic material. This same anaerobic decomposition process happens in the natural world at the bottoms of lakes where oxygen is in short supply. At Brightwater, the process is accelerated by adding heat to the system, allowing the bacteria to remain active. During this process methane gas is released. At South Plant, this gas is combusted to produce heat for the digester and sold to Puget Sound Energy as a natural gas to heat homes. Solids are constantly being added and removed, but on average they remain in the digester for 30 days.

Once the solids leave the digester, they are sent through a centrifuge which removes most of the remaining water. Polymer is added once again to help thicken and congeal the solids. The final product is called biosolids, or cake. Biosolids are rich in nutrients that plants need to grow. Some of the biosolids are loaded into a truck and sent to eastern Washington to be used in agriculture as fertilizer by farmers, some are applied to tree farms or restoration projects in western Washington, and the rest is turned into a compost product called GroCo that can be used for home landscapes and gardens.

Lesson 3- Water Problem Activity

Water Problem Activity Options

- Sometimes it may not be possible to do virtual breakout rooms (due to student behavior, Teams platform restrictions, teacher request). In this case, you may read through the problems as a class, then ask students to choose on the problems and draw a solution. Allow students 5-10 minutes to draw their solutions and then share out.

Water Problems Scenarios:

1. School: Trash in toilets, clogged pipes
2. Restaurant: Grease clogged pipes
3. Apartment Building: Harsh cleaning chemicals used, pouring extra chemicals down the drain
4. Hospital: People pouring medicine down the drain

Water Problem Group Questions

1. What are the water problems at this place that we can work together to solve?

2. Who do you need to talk to if you want to solve this problem?

3. What other questions do you have about this problem?

4. What evidence would you need to convince someone that this is a problem?

5. What steps will your group take to solve this problem?

Write or draw the solutions that your group has decided on below: Be creative! If your problem could be solved by changing how people act, your solution could be a poster to put up in the community, or a commercial to show. If your problem is something that needs to be changed at the site, draw a picture of your solution.

Problem 1

We've noticed a high amount of trash coming from this elementary school. Students are flushing wipes, paper towels, and sometimes even toys.

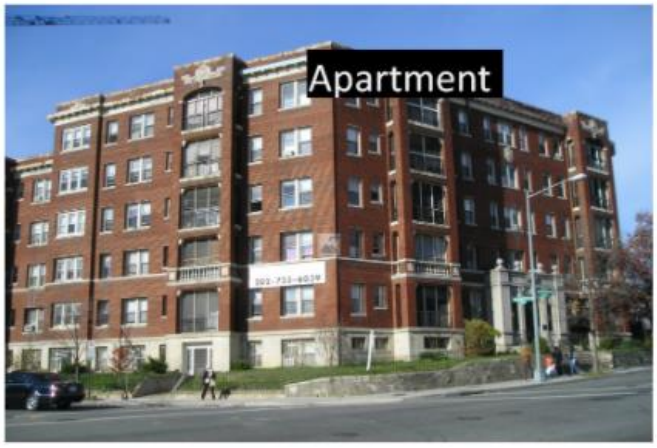
Problem 2

There have been many cooking oil clogs in the sewer pipes near a neighborhood of restaurants. Cooks pour used cooking oil down the drain as a hot liquid, when it cools the cooking oil becomes a solid in the pipes, creating blocks where water can't pass through.

Problem 3

We've noticed a high amount of medicine in the water coming from this hospital. Doctors and nurses are disposing of unused and expired medication down the drain.

Problem 4



In this 100 person apartment building, people are using lots of chemicals to clean their bathrooms and sinks. When they are done using any chemical in their home, they pour the rest down the drain.

Student Questions

Read the problem. Are there any words that you need help understanding? Message the teacher if you don't understand or need help. If the scenario makes sense to you, answer the questions below with your group.

1. What are the water problems at this place that we can work together to solve?

2. Who do you need to talk to if you want to solve this problem?

3. What other questions do you have about this problem?

4. What evidence would you need to convince someone that this is a problem?

What steps will your group take to solve this problem?

Write or draw the solutions that your group has decided on below:

Be creative! If your problem could be solved by changing how people act, your solution could be a poster to put up in the community, or a commercial to show. If your problem is something that needs to be changed at the site, draw a picture of your solution.