Sewage Spills Educator Guide

A resource for using QUEST video, audio, blogs and maps in the classroom

QUEST SUBJECTS

Life Science	Biology **Health** **Environment**
Earth Science	Geology Weather Astronomy
Physical Science	Physics Chemistry **Engineering**

CORRELATIONS TO THE SCIENCE CLASSROOM

The segments described in this guide provide information on

- **Sewage systems**
- **Water pollution**
- **Health and wellness**

QUEST MEDIA FOR TEACHING ABOUT SEWAGE SPILLS

Read and comment on the blogs for these stories by clicking on the story link and clicking on the blog post link below the video/audio.

Watch **Wastewater Woes: Sewage Spills in SF Bay**
http://www.kqed.org/quest/television/wastewater-woes

- What happens when you flush the toilet? For most of us, what's out of sight is out of mind. But large numbers of sewage spills into San Francisco Bay are forcing cities, water agencies and the public to take a closer look at wastewater and its impacts on the health of the bay. **QUEST** investigates the causes of the spills and what's being done to prevent them.

Listen to **Sewage Happens** http://www.kqed.org/quest/radio/sewage-happens

- Sewage spills happen all the time, even in the eco-conscious Bay Area. Much of the blame lies beneath our feet in a deteriorating network of clay pipes, some of which date back to gold rush days. **QUEST** investigates.

Listen to **Sewage Spills Increasing**
http://www.kqed.org/quest/radio/sewage-spills-increasing

- How much sewage makes its way into our water? Plenty. Statewide, it's likely that the record of 20 million gallons of raw sewage dumped in California waterways in 2008 is going to be broken this year. Decrepit pipes, lack of money and the growing severity of storms could all add up to a disaster of septic proportions.

QUEST Quiz: Sewage
http://www.kqed.org/quest/television/quest-quiz-sewage

- If you live in Oakland, how long does it take for sewage to flow from your house through the EBMUD plant and into the bay?

INTRO QUESTIONS

- What do you think happens to the wastewater from your household?
- Look around your house and list the different sources of household wastewater.
- What could be the possible consequences of a sewage spill in the bay?

FOCUS QUESTIONS

- What are the effects of a sewage spill on the bay's ecosystem and on human beings?
- What steps does raw sewage undergo at a sewage treatment plant before it's emptied into the bay?
- Trace the route of wastewater as it flows from your home to the treatment plant and into the bay.
- What connections between severe storms and sewage spills do the researchers highlight?
- What are some of the reasons for the repeated sewage spills in the Bay Area? How can we address them?

VOCABULARY

Sewage
usually wastewater from households, also a general term for liquid waste from agricultural and industrial sources

Pathogen
a biological agent causing disease or illness

Wastewater Treatment Plant
facility for removal of contaminants from wastewater using physical, chemical and biological methods

Sewerage
the physical infrastructure used to convey sewage from its origin to the point of eventual treatment or disposal

Primary Treatment
the first stage of wastewater processing; usually involves separating solid matter from liquid waste

Secondary Treatment
additional processing of wastewater, usually involving the addition of bacteria and chemicals to remove contaminants

Laterals
pipe system that feeds wastewater from private properties into the sewage mains

Clean Water Act
federal law passed in 1972 mandating wastewater treatment standards

LESSON PLANS and RESOURCES from PBS, TEACHERS' DOMAIN and NPR

NOTE: Resources from the Teachers' Domain collection require a fast and free registration.

Liquid Assets: Wastewater Teachers' Domain
http://www.teachersdomain.org/resource/psu08-liq.sci.wastewater/
This video segment from the WPSU documentary **Liquid Assets** describes the process by which water contaminated with raw sewage can be purified to be clean enough for rivers, seas or even drinking.

Earth Water Filter Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.waterfilter/
In this video segment adapted from **ZOOM**, cast members try to make the most effective water filter using principles adapted from nature's sedimentary filtering systems. The mini water filters strain dirty, salty water through different combinations of sand, gravel and a cotton bandana.

Habitat Earth: H2O PBS Teachers
http://www.pbs.org/teachers/connect/resources/5256/preview/
These video segments from **Habitat Earth** introduce concepts related to the water cycle, availability of freshwater and the impact of humans on water sources. Also included is a teaching guide with suggestions on activities and projects.

The Tremendous Travels of Trash PBS Teachers
http://www.pbs.org/teachers/connect/resources/6221/preview/
This activity guide accompanying an episode of **National Geographic's Strange Days on Planet Earth** contains suggestions for teaching about the path that wastewater takes and the pollutants it contains on its way to the world's oceans. Students identify animals that are affected by wastewater and think of ideas for reuse and treatment of the water.

Clean Water Program City of Oceanside, Marin County
http://www.oceansidecleanwaterprogram.org/kids.asp
The "Just for Kids" section of the City of Oceanside's **Clean Water Program** Web site explains the problems related to surface runoff and stormwater pollution using simple, engaging visuals.

ADDITIONAL RESOURCES and ACTIVITIES

Dirty Jobs: Sewer Inspector
http://dsc.discovery.com/videos/dirty-jobs-sewer-inspector.html
Sewer inspector is probably one of the dirtiest jobs of all time, but someone's got to do it! Watch **Discovery Channel** host Mike Rowe as he finds out what these people do.

San Franscisco Baykeeper
http://www.baykeeper.org/
Baykeeper, a nonprofit watchdog organization, works with the San Francisco Regional Water Quality Board and other organizations to protect and enhance the water quality of the San Francisco Bay for the benefit of its ecosystems and human communities.

Save the Bay
http://www.savesfbay.org/
This nonprofit organization is dedicated to protecting and preserving San Francisco Bay. Find out about issues related to water pollution in the bay and get information on volunteer opportunities and education programs.

Water Quality of San Francisco Bay
http://sfbay.wr.usgs.gov/access/wqdata/
This is the USGS Web site for its long-term program of research and observation in San Francisco Bay. It provides information on water quality measurement methods and recent data.

VISIT OUR PARTNERS

The Bay Institute
www.bay.org

California Academy of Sciences
www.calacademy.org

Chabot Space and Science Center
www.chabotspace.org

East Bay Regional Park District
www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of Northern California
www.girlscoutsnorcal.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

The J. David Gladstone Institutes
www.gladstone.ucsf.edu

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Monterey Bay Aquarium
www.mbayaq.org

Monterey Bay Aquarium Research Institute
www.mbari.org

Oakland Zoo
www.oaklandzoo.org

The Tech Museum of Innovation
www.thetech.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

U.S. Geological Survey
www.usgs.gov

MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21st CENTURY SKILLS IN TEACHING AND LEARNING

Why Use Multimedia in Science Education?
http://www.kqed.org/quest/downloads/QUESTWhyMedia.pdf
- Read about the importance of using multimedia in the 21st century science classroom.

How to Use Science Media for Teaching and Learning
http://www.kqed.org/quest/downloads/QUESTMediaTips.pdf
- A collection of tips, activities and handouts to actively engage students with multimedia.

Science Multimedia Analysis
http://www.kqed.org/quest/downloads/QUESTMediaAnalysis.pdf
- Give your students the tools to recognize the purposes and messages of science multimedia.

Create Online Science Hikes with Google Maps
http://www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf
- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

OTHER WAYS TO PARTICIPATE IN QUEST

LOG ON

www.kqed.org/quest

LISTEN

KQED 88.5 FM San Francisco &
89.3 FM Sacramento
Mondays at 6:30am and 8:30am

WATCH

KQED Channel 9
Tuesdays at 7:30pm

Major funding is provided by the National Science Foundation, the Gordon and Betty Moore Foundation, the Richard and Rhoda Goldman Foundation, and The Amgen Foundation. Additional support is provided by the S. D. Bechtel, Jr. Foundation, the William K. Bowes, Jr. Foundation, Ann S. Bowers - The Robert Noyce Trust, the Dirk and Charlene Kabcenell Foundation, and the Vadasz Family Foundation.

SEWAGE HAPPENS — QUEST RADIO TRANSCRIPT

NOTES & QUESTIONS

If there is a front line in the war on sewage, it's people like Paul O'Grady, owner of the O'Grady plumbing in San Francisco.

O'GRADY: Play for me… Now I run my camera a little further, and I see another break but I want to see what is going on further downstream…

O'Grady is showing me a video clip from his greatest hits of broken sewage pipes.

O'GRADY: We're looking inside of a 12- inch sewer main that is completely broken with roots.

STANDEN: They are actually growing into the pipe?

O'GRADY: Oh yeah, oh yeah, definitely.

This is just one tiny, but typical, slice of the vast subterranean network beneath our feet. There are some 900 miles of pipeline under San Francisco alone. They link every house, business, public bathroom, water fountain, and school. Some of them date back to the Gold Rush. And many of them are a mess.

O'GRADY: That ball of roots is so massive that I actually have to use a shovel…and there's even more roots and I don't make it much further.

And neither, in this case, does the sewage.

Here's what's supposed to happen.

You flush the toilet, you run the sink. Whatever goes down the drain travels through the pipes and to a sewage treatment plant. There, they filter out everything solid, and then disinfect what's left with chemicals. Finally, that much cleaner water is released into the Bay. But if sewage pipes are broken, two things can happen. One, the sewage never makes it to the plant.

CHOKSI: You're seeing sewage running down the street. It's kind of like a third world country.

That's Sejal Choksi, she's an attorney with the environmental group Baykeeper. They're filing lawsuits against cities across the Bay Area, most recently, Burlingame, to force them to fix their aging sewage systems.

CHOKSI: You've got such old systems and they're being poorly maintained, and so more over the next few years you'll be hearing about sewage spills in the streets, in people's backyards, in parks.

But broken sewage pipes don't just let sewage out. They also let water seep in. That's what happened in Mill Valley. During a heavy rain storm, a treatment plant can get up to 15 times more water than usual and, too often, it's more than that plant can handle all at once.

CHOKSI: In many instances, they actually have to just bypass their treatment plant entirely and dump the mixed rainwater and wastewater directly into a body of water, like the San Francisco Bay.

And, dumping sewage into the Bay harms fish and can make swimmers sick. So the pipes need to be fixed. But what would that cost?

This is Tom Mumley. He's with the Regional Water Quality Control Board, which oversees all the sewage plants in the Bay Area.

MUMLEY: So a quick calculation tells me - say I had 500,000 houses that have had to have their sewer lateral fixed and it could cost ten thousand dollars t fix it, that adds up to a price tag of five billion dollars.

Fixing the pipes on private property alone, in other words, would cost about $700 for every man, woman and child living in the entire nine-county Bay Area. And, it's not just the pipes that need fixing.

LOICANO: We're gonna take you out and look at the digesters.

Jon Loicano is with the San Francisco Public Utilities Commission, which runs the city's sewage system. He's taken us up to walk on the roof of a giant, cylindrical sewage digester in Bay View Hunters Point neighborhood.

LOICANO: If you come stick your head in there, you can kind of smell it.

Digesters work a lot like your own stomach - they heat up the filtered materials, swoosh them around, and add bacteria to help break it down. And you'd recognize the byproduct, too.

STANDEN: "eww!"

LOICANO: It's got that sulfur, rotten egg smell.

These digesters are more than half a century old, and they look it. Mumley says the weakest links are the metal lids that float on top of the sludge. Here's what happened during a heavy rain storm back in 1996.

LOICANO: The water ponded up inside the bottom of the cover and the thing just folded like a piece of tin.

Loicano may be a sewage guy, but he works downtown and he wears a suit and a tie. That's because it's his job to convince the city to spend over two billion dollars to fix San Francisco's digesters and other equipment. It's not always an easy sell.

LOICANO: It's hard for any city to go out and ask for money to do infrastructure stuff because people are used to the fact that things are working. And they don't see, until the failure happens, they don't really see it happening.

We've made big improvements before. Last time was in the early 70s, after Congress passed the Clean Water Act, which required billions of dollars of upgrades to sewage treatment plants all across the country. And, says Tom Mumley with the Water Board, it worked.

MUMLEY: Before then, discharges of untreated and partially treated wastewater into the Bay were very common - to the point where there's lots of anecdotal information that it stunk. People even complained when driving across the Bay Bridge that they could smell sewage.

The Bay may not stink like it used to, but it's not as clean as it should be, says Mumley. He says fixing the entire system could cost tens of billions of dollars. And the longer we wait, the bigger the bill.

For Quest, I'm Amy Standen, KQED Radio News.

SEWAGE SPILLS INCREASING — QUEST RADIO TRANSCRIPT

NOTES & QUESTIONS

How much sewage makes its way into our water? Plenty. Statewide, it's likely that last year's record number—20 million gallons of raw sewage dumped in California waterways—is going to be broken this year. In one recent rainstorm, broken sewer pipes dumped more than 1.4 million gallons of sewer water directly into San Francisco Bay. Decrepit pipes, lack of money and the growing severity of storms could all add up to a disaster of septic proportions. David Gorn reports.

A dozen workers swarm around a pipe as big as a tree trunk. The waters of San Francisco Bay are just a couple of feet away, and these guys are working fast, trying to get done before the tide rises and this spot is submerged under four feet of water.

They're fixing the large pipe that broke during a February 17 rainstorm, a pipe that spewed half a million gallons of sewage right into the Bay. So workers first plugged that leak, and are now encasing the entire pipe in a foot-thick layer of concrete.

SIMMONS: This is the area where the leak was. We're at low tide and the pipeline is accessible during low tide; high tide we've got about a four-foot surcharge...

Robert Simmons surveys the damage from a perch just above the mess. He's the general manager for the Sausalito Marin City Sanitary District

SIMMONS: So, we're going to have a similar type of concrete encasement all the way along the length of that pipe, approximately 100 feet. And with that we'll have protection from corrosion, abrasion and if there is any other additional defects in that pipeline, they'll be well-secured, and we won't be experiencing this problem again.

Yes, not this particular problem, anyway. But it turns out that affluent and effluent can end up in the same sentence, since well-to-do Marin is an older county with older sewer pipes. Nine sewer districts in Marin County were cited and fined last year, after 5 million gallons of sewage were spilled into the Bay. Another fine followed the recent spill. Across California, the numbers are scary.

RICE: For 2008, it appears to be around 20 million gallons of sewage spilled. That's a lot of sewage.

Dorothy Rice is the executive director of the State Water Resources Control Board. That figure is just the raw sewage spills; that doesn't even count all the partially treated wastewater spilled in California. She says that local municipalities run local sewer plants, and they are just not equipped to deal with the scope of this problem.

RICE: The systems are simply not sized for the population that exists today, for the amount of water that's flowing through that area today. Given the age of our infrastructure, some pipes more than 100 years old, we are starting to see increasing failures year after year, and are simply woefully unable to keep up with the need.

Those aging large sewer pipes are not the only problem, she says. The little pipes, the so-called laterals—that is, the pipes running from our toilets out to the street—are the real reason we have such disasters during wet weather. So, if you're in a

neighborhood that was built 50 or 100 years ago, think of it like this: There are cracks in many of those old pipes, and that doesn't stop sewage from flowing out, but it does allow water to seep in, lots of it during a rainstorm. And if water leaks into the sewer system from your cracked pipe and all your neighbors' cracked pipes, then pretty soon, those giant sewer pipes are gushing with rainwater and sewage.

And in the case of the tiny Marin City sewage plant, those old pipes can't take that kind of hammering. That's the case from San Diego to Sacramento, says Marin Sewer's Robert Simmons.

SIMMONS: We had our biggest storm hit on December 31, 2005. We saw in excess of 12 1/2 million gallons coming into the treatment plant. So, I think we are seeing kind of a change in weather pattern.

Ah, that's the other wild card. One of the reasons we've had such bad sewer spills over the last decade is we've had such bad weather. And that, says Norm Miller, climatologist with Lawrence Berkeley Laboratory, is going to get worse.

MILLER: All indicators suggest that we'll see more intense storms. Things are tending towards a California that's going to have less snowpack, more intense storms, but less frequently and more flooding.

More intense storms—that's not good news to an infrastructure the state describes as "crumbling." California is getting about $283 million in stimulus money to spend on its wastewater plants. But the state board of water resources estimates it will take about $30 billion to fix California's sewer infrastructure.

For QUEST, I'm David Gorn, KQED Radio News.

I'm Andrea Kissack, KQED Public Radio.