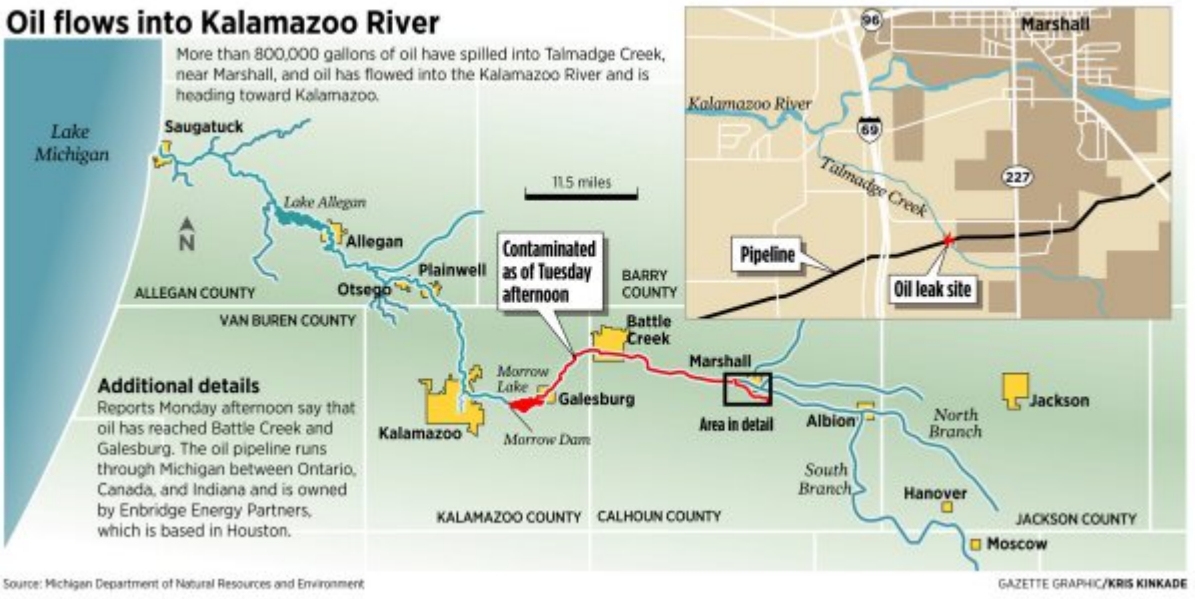
The Million Gallon Oil Spill

Overview of problem: In 2010 a leak in an oil pipeline led to an estimated one million gallons of oil flowing into the Kalamazoo River. This was the largest inland oil spill in American history. Nearly one billion dollars has been spent on the clean up and multiple impacts remain in 2013. Yet, many Michigan citizens know little about this oil spill and its relationship to their lives. In this lesson students learn the purpose of an oil pipeline, the impact on the environment of an oil spill, and the challenges posed by an oil spill cleanup.



mlive.com July 28, 2010

Standards:

Next Generation Science Standards

HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

Earth Science Literacy Principles

Big Idea 7: Humans depend on Earth for resources. 7.9 Fossil fuels and uranium currently provide most of our energy resources. Fossil fuels, such as coal, oil, and natural gas, take tens to hundreds of millions of years to form. Their abundance will make them the dominant source of energy for the near future. New sources, such as methane hydrates, are being explored. 7.10 Earth scientists help society move toward greater sustainability. Renewable energy sources, such as solar, wind, hydroelectric, and geothermal, are being developed. They will replace fossil fuels as those become scarcer, more expensive to retrieve from Earth, and undesirable due to environmental damage. Earth scientists foster global cooperation and science-informed stewardship that can help to ensure the availability of resources for future generations.

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Michigan High School Content Expectations
E2.4 Resources and Human Impacts on Earth Systems: E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.

Intended student outcomes:

- Students will describe the purpose of an oil pipeline in their region.
- Students will create a model of an oil spill and cleanup and relate this model to the environmental impacts of an oil spill.
- Students will compare the design of the current oil pipeline with an alternative pipeline or alternative energy source based on cost-benefit ratios.

Grade level: High school

Time frame: Two sixty minute class sessions

Materials: Cost/benefit chart

Enbridge Responses to Frequently Asked Questions reading (excerpt included in this document or students can read online at http://response.enbridgeus.com/response/main.aspx?id=12783**)**

National Wildlife Federation (NWF) reading (excerpt included in this document or students can read online at http://blog.nwf.org/wp-content/blogs.dir/11/files/2012/07/NWF_EnbridgeOilSpill_Final.pdf)

For each group of 4-5 students:

plastic dish pan or aluminum pan, 2 oz vegetable oil mixed with cocoa powder, laminated map of Kalamazoo River (optional)

objects to represent animals such as plastic fish, turtles, feathers and pompoms (mammals)

materials for oil cleanup such as string, cellophane, nylon stocking, cotton balls, 4 paper towels, hay straw, human hair

materials that can move oil such as pipettes, straws, spoons, popsicle sticks

container for used materials, dish detergent (not to hand out initially, but as an option)

Vocabulary: natural resource, renewable, tar sands oil, pipeline, oil spill, fossil fuel, cost, benefit, Environmental Protection Agency

Lesson Procedure:

Elicit and Engage (Day 1)

1. Read students this scenario: You wake up in the morning and on your way to the bus stop you smell something that you have never smelled before. It's a strong chemical smell, kind of like gasoline at a gas station. What do you do? What could it be? (If you want to report it, who do you call?)
2. Tell students that in 2010 residents of Marshall, Michigan began to notice a strong chemical smell. They didn't know what it could be coming from. Many of them called 911 and eventually someone realized that an oil pipeline owned by Enbridge had cracked and was pouring hundreds of thousands of gallons of thick oil into a creek that flowed into the Kalamazoo River. Oil poured out for seventeen hours before the flow was stopped.

3. Ask students to write a 5 minute response to the prompt "How do you think an oil spill near your town would affect the environment and community?" Wait until after the next activity before responding to their comments.
4. Explain to students that they can help prevent future spills. They will develop an oil spill model and read more about oil pipelines and oil spills so that they can analyze the costs and benefits of transporting oil.

Explore

1. Students build their model environment. If you are using a laminated map, students lay the map flat in the bottom of the tray and identify the communities of Marshall, Kalamazoo, and Lake Michigan. Students pour about 1 inch of water in the tray.
2. Students place the animals in the model with fish and turtles in the water, mammals and birds on land. Ask "Would these animals stay in these positions?
3. Ask students to examine the different materials they have for clean up. Ask "Which are good for trapping oil? For soaking it up? For moving oil?" Students discuss an oil spill response plan with their group. Remind students that they will need to separate the oil from the water – they can't drain the whole river. They need to contain the oil and remove it. They should also try to protect the animals.
4. Students spill the oil and start the cleanup. As you observe groups, ask what challenges they are facing. Drop a feather into each oil spill to represent a bird that has entered the spill area.
5. If students request soap, distribute a few drops, asking them whether the soap should be placed in the river or only on the animals.
6. After the oil spill exercise, have students put all of the objects in a container and dump all of the oily water in a container.

Explain (Day 2)

1. Discuss what worked and what didn't. Show students images from the Enbridge spill and clean up (some images are included in this document). Relate the activity to images from the Enbridge oil spill. How is this model similar? Different?
2. Have students read background information in Enbridge and NWF handouts and relate their model to the Enbridge spill. Ask students why it is important to read information from different sources.
3. From the readings, ask students to identify the source of oil for this pipeline. Where was the oil headed? How did they stop the oil from spreading? What groups of people worked to clean up the spill? What materials and equipment were used? How has wildlife recovered? Is the oil all cleaned up?

Elaborate

1. Ask students to complete the cost-benefit chart for tar sands oil. Then, they should choose another energy source (for example natural gas, wind energy, solar energy, nuclear power, conventional oil drilling) to complete the second column. If this topic is new to students they may need to do further research but their answers do not have to be detailed.

Evaluate

1. Based on the information they have so far, students should make a recommendation for reducing the risk of oil spills in their area in the future.

Extend

1. All energy sources have potential costs and benefits. For homework ask students to choose a third energy source and add it to the cost-benefit chart.

References:

Enbridge website with clean up with videos, photos and text about the clean up and pipelines **http://response.enbridgeus.com/response/main.aspx?id=12913**

EPA Enbridge spill information **http://www.epa.gov/enbridgespill/**

EPA Photos of Kalamazoo River clean up http://www.epa.gov/enbridgespill/photos.html

Michigan Radio article "Three Years and Nearly $1 Billion Later, Cleanup of Kalamazoo River Oil Spill Continues" (print or audio) http://www.michiganradio.org/post/3-years-and-nearly-1-billion-later-cleanup-kalamazoo-river-oil-spill-continues

National Public Radio story: students can listen to this 4 minute broadcast "EPA: Tar Sands Pipelines Should Be Held To Different Standards" http://www.npr.org/2013/04/24/178844620/tar-sands-pipelines-should-get-special-treatment-epa-says

National Wildlife Federation information on spill and tar sands oil pipelines "Importing Disaster: The Anatomy of Enbridge's Once and Future Oil Spills" http://blog.nwf.org/wp-content/blogs.dir/11/files/2012/07/NWF_EnbridgeOilSpill_Final.pdf

Oil Spill Lesson Plan: This oil spill cleanup activity was based on a lesson plan about the oil spill in the Gulf of Mexico by Dana Plucinski http://ocean.si.edu/sites/default/files/lesson_plans/Dana%20Plucinski/SelfContainedSpillKit.pdf

Costs and Benefits of Energy Sources

Costs and benefits	**Tar Sands Oil**	**Other energy source**	**Other energy source**
Where does it come from? (location)			
How is it obtained?			
How is this energy source transported?			
What risks are there to the environment with this energy source?			
Is this energy source renewable?			
What other factors should be considered with this energy source?			

What do you recommend to reduce the risk of oil spills in the area where you live?

What other information would be helpful to you to reduce oil spill risk?

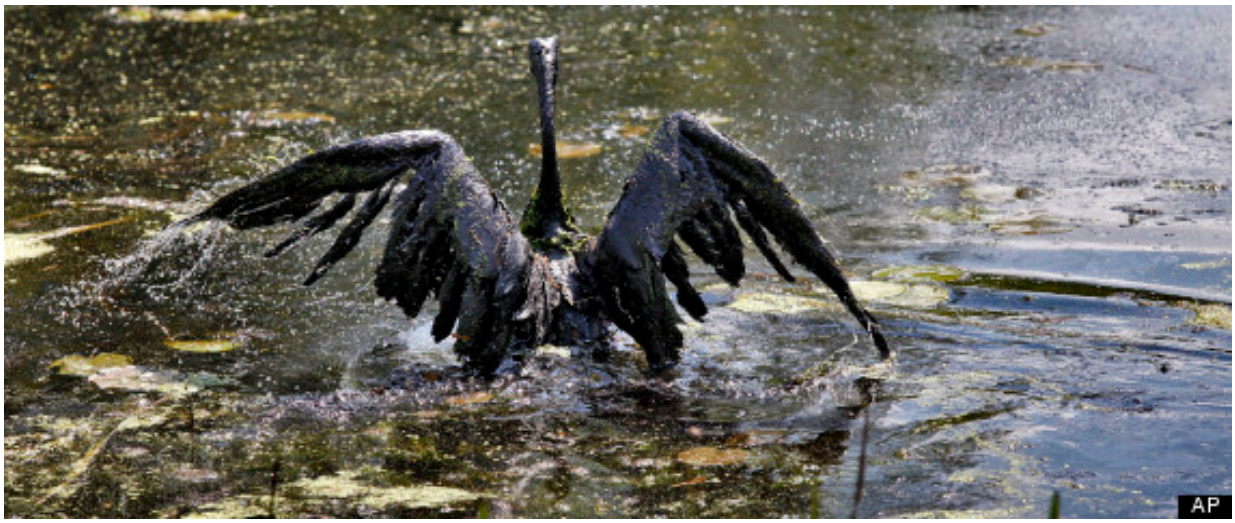
Photos of spill and cleanup

Excavation of oil-contaminated soil from the overbank area located at MP 11.01 (11/15/2011) (EPA)

Overbank excavation at mile post 11.25 (7/18/2011) (EPA)

Recovery of submerged oil on Morrow Lake showing booms. (6/25/2011) (EPA)

A pontoon boat stirs up submerged oil and three sheen sweepers collect the oil that is stirred up. Photograph by John Grap/The Enquirer/AP Photo http://www.bloomberg.com/slideshow/2012-07-25/enbridge-s-quiet-765-million-oil-spill.html#slide18



Canada goose coated with oil from Enbridge spill http://www.huffingtonpost.ca/2012/10/10/enbridge-northern-gateway-leak-detection_n_1955381.html

Oil-covered turtle is cleaned with a toothbrush by a volunteer. Detroit Free Press August 8, 2010

Enbridge Responses to Frequently Asked Questions

(Excerpted from the Enbridge Line 6B Response website http://response.enbridgeus.com/response/main.aspx?id=12783)

What happened and what caused the problem? A leak was detected on Line 6B of Enbridge Energy Partners' Lakehead System on Monday, July 26, 2010, near the company's Marshall, Mich., pipeline pumping station. The cause of the leak is under investigation by the National Transportation Safety Board and the U.S. Department of Transportation's Office of Pipeline Safety (USDOT/OPS).

How much product was spilled? An estimated 20,082 barrels (843,444 gallons) of crude oil was released from Line 6B; of that, an estimated 8,033 barrels (337,386 gallons) reached Talmadge Creek and the Kalamazoo River.

How much will the spill cost Enbridge? According to a report that Enbridge recently filed with the Securities and Exchange Commission (SEC), the cleanup cost is currently estimated at $725 million.

What kind of oil was going through the pipeline when it leaked? What chemicals were released?The type of oil that was being transported at the time of the incident was 77 percent Cold Lake and 23 percent Western Canadian Select (WCS) crude, which are heavy oils from western Canada. Crude oil is a hydrocarbon that contains many different compounds such as benzene, toluene, and hydrogen sulfide. Many compounds in crude oil readily evaporate when exposed to air. During a leak, vapor concerns are highest in the first hours or days of an incident, but diminish rapidly.

As a company, has the incident changed how Enbridge operates? The safety of people who live and work near our pipeline rights-of-way has always been a top priority. Enbridge will evaluate all information and learnings from this incident and apply that information to all of our pipeline operations. We will also share those learnings with the pipeline industry so other operators will benefit from what we have learned. Enbridge has always been safety and environmentally conscious and this incident has provided learnings in many different areas of our company, including pipeline inspections and preventive maintenance, public awareness, and communications with emergency responders and the community. We are focused on applying these lessons across our operations.

What is Enbridge doing about the spill?Within one hour of being alerted to the leak, Enbridge had emergency crews starting initial containment. At the height of the response, there were approximately 2,000-to-2,500 workers in the Marshall and Battle Creek areas. The workforce has increased and decreased as needed according to the clean-up activities that we were undertaking and per approved work plans. We are working cooperatively with all of the federal, state and local agencies working on the response and cleanup.

What is Enbridge doing to protect the environment? Protecting the environment is one of the primary goals of Enbridge's response. During the initial response through November 2010, Enbridge took air, water and sediment samples, and the sampling results are posted on this website. Enbridge has met deadlines set by the EPA for cleanup of the source area and Talmadge Creek, and primary cleanup of the Kalamazoo River and submerged oil. This does not mean that the cleanup process has been completed. There is a very rigorous inspection process that every quarter mile section of the creek and river must undergo prior to sign-off by the EPA. Sign-off indicates only that a specific stage of work is complete. We continue to work with the EPA and have signed a compliance order with the Michigan Department of Environmental Quality (DEQ), which will guide cleanup and remediation work going forward. There will be some areas where oil will be left in place because further removal work would cause more damage to the environment than leaving the oil in place. This will be done at the direction of the DEQ and the EPA.

Is there a place for wildlife affected by the spill? Yes, Enbridge is working with Stantec Consulting, the Michigan Department of Natural Resources (DNR), and the U.S. Fish & Wildlife Service to minimize impacts on wildlife. The Wildlife Response Center successfully treated and released 96 percent of the animals that were taken into care. The original site in Marshall has closed. However, we have opened a new center more centrally located to handle any turtles or other wildlife collected that need to be cleaned. We are presently monitoring wildlife conditions along the river and have collected some turtles this summer.

Importing Disaster; The Anatomy of Enbridge's Once and Future Oil Spills -National Wildlife Federation 2012

Excerpted from http://blog.nwf.org/wp-content/blogs.dir/11/files/2012/07/NWF_EnbridgeOilSpill_Final.pdf

As the biggest transporter of Canadian tar sands oil into the U.S., Enbridge has a responsibility to the American public to manage their operations in a manner that protects our communities and natural resources. But tar sands oil is a very different beast than conventional crude oil, and it is difficult to transport the former safely through pipelines that were designed for the latter. That's because tar sands oil is more corrosive (due to its chemical mixture) and abrasive (due to high-grit minerals), weakening the pipes to the point that they are more susceptible to leaks and ruptures. Remarkably, there are no standards in place to ensure that new pipelines are built, maintained and operated with this fact in mind. As if these problems are not enough, when it spills, tar sands oil is much harder to clean up than conventional crude oil, most notably because it sinks in water, rather than floats, putting our streams and rivers at risk.

A Shoddy Safety History

On the evening of July 25, 2010, an Enbridge pipeline ruptured near Marshall, Michigan. Hundreds of miles across the border in the company's Edmonton, Alberta control center, alarms sounded, but operators ignored them and attempted several times to restart the pipeline——a mistake that compounded the disaster. Meanwhile, Marshall residents flooded the 911 line with alerts about a noxious petroleum smell permeating the air. Finally, a local natural gas worker alerted Enbridge to the spill that was pouring into Talmadge Creek and the Kalamazoo River.

Just ten days prior, in testimony to Congress, Enbridge Vice President Richard Adams, had vouched for his company's ability to respond quickly to emergencies. "Our response time from our control center," said Adams, "can be almost instantaneous, and our large leaks are typically detected by our control center personnel." But in Marshall, when it mattered, 17 hours passed between the initial warnings and the time the first Enbridge employee arrived on site. By the time they had managed to shut down the pipeline, more than 1.1 million gallons of crude oil had been spilled.1 It stands as the largest inland pipeline accident in U.S. history.

The Environmental Protection Agency ordered Enbridge to clean up the mess, but after two years, workers are still struggling to remove residual crude oil that has sunk into the riverbed and wetlands. As of July 2012, approximately $800 million has been spent on a cleanup that is still not finished. So far, the cost of the tar sands clean-up has been 18 times more expensive than conventional oil spills.2 The federal government levied a record $3.7 million fine and 24 enforcement actions against Enbridge, a mere drop in the bucket for a company that files over 42 billion in profits annually.

In July 2012, the National Transportation Safety Board (NTSB) released findings from their two year investigation into the spill, and revealed that Enbridge knew that its pipeline had been damaged five years prior to the spill. The NTSB was scathing in its assessment of the company's response, comparing Enbridge to the "Keystone Kops," the pinnacle of incompetence.

The Kalamazoo spill may have been a poster child for corporate negligence but it is far from the company's only black mark. According to Enbridge's own reports, between 1999 and 2010 they have been responsible for at least 800 spills that have released close to seven million gallons of heavy crude oil into the environment—–or approximately half the amount of oil that spilled from the *Exxon Valdez* in 1989.

The ruptured pipeline after it was excavated
AP Photo/National Transportation Safety Board

Background information for teacher on oil spill cleanup equipment used

(from **http://response.enbridgeus.com/response/main.aspx?id=12913)**

To guarantee that the cleanup is handled as effectively as possible, Enbridge has ensured that a wide range of the latest oil cleanup equipment and technology is available. Some of the equipment Enbridge has used throughout the cleanup process includes:

- **Containment booms:** The cleanup crew has deployed thousands of feet of containment boom across several dozen control points in the Talmadge Creek and Kalamazoo River. Containment booms are floating barriers that can be stretched across a waterway. They are used to entrap oil that is floating on top of the water and to force it to a collection point. Once the oil has been trapped or directed by the boom, skimmers are used to remove the oil from the surface.
- **Absorbent booms:** Thousands of feet of absorbent booms have been used throughout the cleanup effort. Absorbent booms are essentially giant sponges that soak up oil, while repelling water. These booms are effective at controlling and cleaning oil near shorelines and in shallow water areas.
- **Airboats:** This unique type of boat continues to be an essential tool in the cleanup effort. Airboats were selected for a number of reasons. First, they are propelled by air thrust, which does not churn water as a underwater propeller would. Second, they can traverse through shallow water as well as tall grass, mud, and the containment booms used throughout the river. Lastly, airboats can carry heavy loads across this variety of terrains without leaving scars on the land or polluting the waterways.
- **Oil skimmers:** Skimmers are machines that float on the water. They are used to separate, pump or scrape oil from the water's surface. The average skimmer can separate and remove 30 to 60 gallons of oil per minute from contaminated water. Once the skimmer has removed the oil from the water, the oil is stored in a reservoir. The oil is then pumped out of the reservoir by vacuum truck and transferred into a storage tank.
- **Vacuum trucks:** Vacuum trucks are used to pump oil directly from the water or from an oil skimmer reservoir. Once the oil is contained in the vacuum truck, it is transferred to a traditional tanker truck to be transported to a storage facility.
- **Temporary dike and flume:** Immediately after the spill, Enbridge deployed a temporary dike and flume system near the leak's origin to block further oil from flowing into Talmadge Creek and the Kalamazoo River. The flumes were used to pond the water and oil. Pipes or culverts installed in the bottom of the dike allowed the water to flow through while the oil floats on the surface to be collected using absorbent pads, vacuum trucks or skimmers.

In addition to the above equipment, Enbridge has utilized dredging equipment, fleet of additional boats, storage tanks, tankers, light planes and excavators in order to help ensure that the cleanup is carried out as effectively as possible.