Operation Oil Spill Cleanup

Offshore oil drilling and the use of supertankers for transporting oil pose the risk of oil spills. Oil spills can damage commercial and recreational fishing areas, spoil beaches, kill marine birds, mammals, and other aquatic life, and destroy shellfish communities. A mere 3.8 L of oil can contaminate as many as 20 million liters of water!

Suppose you are a scientist or an engineer for Eco-Marine, Inc., an environmental remediation firm that specializes in resolving ocean pollution problems. Your supervisor has just distributed the memo below that describes your latest assignment.

Memo

To: All Eco-Marine Staff
From: Marina Waters, Lead Scientist
Re: Oil-Spill Cleanup Proposal

I would like to inform you that Del Mar Oil Company is accepting proposals for a cleanup plan that could be implemented in the event of an oil spill from one of the many supertankers that sail the seas. There are several top-notch companies competing for this contract, but I am confident that we at Eco-Marine, Inc. can develop the best plan for oil spill cleanups that is fast and effective yet has a minimum impact on the affected marine ecosystems.

I would like each team in my department to develop its own plan. The first part of your plan should test the various cleanup materials currently available. Phase two of your plan should involve using the materials to clean up on a small-scale oil spill along a model beachfront. Once all the plans have been tested, we will decide which to submit to Del Mar Oil Company.

Marina Waters, Lead Scientist

OBJECTIVES

Select various materials and use them to determine their effectiveness at cleaning up a model oil spill.
Design an experiment to clean up a model oil spill.
Test the plan and evaluate the results.

MATERIALS

- beaker (250 mL)
- cake pan, large rectangular
- clock or watch
- containers or bowls, small (2)
- cooking oil (100 mL)
- feathers
- gravel or sand
- measuring spoon
- pipe cleaners
- water
Potential cleanup materials: spoons, craft sticks, toothpicks, dip nets, drinking straws, plastic wrap, aluminum foil, pieces of plastic foam, string, pieces of brown paper bag, cotton balls, pieces of nylon stocking, pieces of sponge, paper towels, coffee filters, cloth, wood shavings, sawdust, liquid detergent, cat litter, baking soda, flour, vinegar

Procedure

PART I—TESTING CLEANUP MATERIALS

1. Work with a team of students as assigned by your teacher. Choose 8 items from the potential cleanup materials list which your group will use to clean up a model oil spill.

2. Use the measuring spoon to pour a spoonful of oil onto the surface of some water in one of the shallow containers or bowls. This represents an oil spill in the open ocean.

3. Pour a small amount of oil onto rocks, sand or gravel, pipe cleaners, and feathers in another container to test cleanup of a shoreline and wildlife. Note that the pipe cleaners represent sea mammals, and the feathers represent birds.

4. Test your cleanup materials to determine their effectiveness in the following categories: containing the oil spill, cleaning up the water and recovering spilled oil, and cleaning up the shore and affected wildlife. Also evaluate the potential environmental impacts of using a large quantity of each of your cleanup materials in the ocean.

5. Rate each material as poor, average, good, or excellent. Record your observations from step 4 in the table below.

Evaluation/Effectiveness of Cleanup Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Containment</th>
<th>Water Cleanup</th>
<th>Oil Recovery</th>
<th>Shore Cleanup</th>
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Operation Oil Spill Cleanup continued

PART II—DEVISING A PLAN

6. Work with the other members of your group to devise a plan for cleaning up an oil spill based on the results of the materials you tested. Note that your plan must specify which materials and techniques you will use for containing the spill, cleaning up the water and recovering the oil, cleaning up the shoreline, cleaning up the affected wildlife, and minimizing the impact on ocean ecosystems. Write your complete plan below. Use another sheet of paper if needed.

PART III—TESTING THE PLAN ON A MODEL BEACHFRONT

7. Build a model ocean shore in the cake pan. Create a beach using sand or gravel and a few rocks at one end of the pan as shown in the Figure below. Place a feather and a pipe cleaner on the beach as shown. Slowly add water to your model.

8. Use the small beaker to pour 50 mL of cooking oil into your model ocean. Gently blow the oil toward the shore.

9. Work together with the others in your team to implement your cleanup plan. Your goal should be to work as quickly and effectively as possible. For each cleanup task (oil containment, oil recovery, shore cleanup, and wildlife cleanup), have one member of your group record below the time it takes to complete the task and how well the task was completed.
Analysis

1. Describing Events Which containment method worked best? Which was least effective?

2. Analyzing Results Which of the major cleanup tasks was the most difficult to carry out? Explain.

3. Analyzing Results How much of the original spill was your group able to recover?

4. Describing Events What happened when the oil reached your model beach? How effective was the cleanup of the sand or gravel and the objects representing wildlife?

Conclusions

5. Drawing Conclusions How might the weather affect attempts to contain an actual oil spill?
6. **Applying Conclusions**  What factors make an actual oil spill different from your simulation?

7. **Applying Conclusions**  What impacts might cleanup methods have on marine plant and animal life in an actual oil spill?

8. **Evaluating Methods**  After each group has presented its results to the class, vote to determine which plan Eco-Marine, Inc. should submit to Del Mar Oil Company. Explain your choice.
Teacher Notes

TIME REQUIRED  Two 45-minute periods

SKILLS ACQUIRED
Collecting data
Communicating
Constructing models
Experimenting
Organizing and analyzing data

RATING
Easy 1 2 3 4 Hard
Teacher Prep–2
Student Set-Up–2
Concept Level–2
Clean Up–3

THE SCIENTIFIC METHOD

Make Observations  Procedure, steps 4, 6, and 9
Analyze the Results  Analysis, questions 2 and 3
Draw Conclusions  Conclusions, questions 5–8
Communicate the Results  Conclusions, question 8

SAFETY CAUTIONS
Any glassware can be substituted with plastic to prevent cuts from broken glass. Warn students to pick up items dropped on the floor immediately. Cooking oil, water, sand, gravel, and pebbles can be especially hazardous due to their near invisibility. Be sure to check for any known student allergies to any of the proposed materials groups are going to use in their cleanup plan.

MATERIALS
Adding food coloring to the model ocean water will make the oil more visible. To make the model more realistic, use a 3.5 percent saltwater solution [made by adding 35 g of sodium chloride (salt) to 965 mL of water] in place of tap water.

TIPS AND TRICKS
Groups of 4–6 students work well for this activity.

Library research prior to doing this laboratory activity may improve students’ cleanup proposals.

Explain to students that this experiment is a very simplified model of a complex situation. The difference in scale makes it difficult to extrapolate the results of this lab to an actual oil spill.

Detergents are likely to be favored by students for use as a cleanup material, but are likely to have additional negative environmental impacts.
Inquiry Lab

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Operation Oil Spill Cleanup continued

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Plans may vary. Provide constructive criticism to each group to help them evaluate their plans before they actually implement them. Inform students that they need your approval before testing their plans.

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**PART III—TESTING THE PLAN ON A MODEL BEACHFRONT**

7. Build a model ocean shore in the cake pan. Create a beach using sand or gravel and a few rocks at one end of the pan as shown in the Figure below. Place a feather and a pipe cleaner on the beach as shown. Slowly add water to your model.

![Model Beachfront](image)

8. Use the small beaker to pour 50 mL of cooking oil into your model ocean. Gently blow the oil toward the shore.

9. Work together with the others in your team to implement your cleanup plan. Your goal should be to work as quickly and effectively as possible. For each cleanup task (oil containment, oil recovery, shore cleanup, and wildlife cleanup), have one member of your group record below the time it takes to complete the task and how well the task was completed.

Answers will depend on the materials selected for each stage of cleanup.

Have groups with the most effective techniques demonstrate them for the rest of the class.
Analysis

1. **Describing Events** Which containment method worked best? Which was least effective?

   Answers may vary. Most real-life containment methods include erecting a physical barrier such as an impermeable sheath around as much of the spill as possible.

2. **Analyzing Results** Which of the major cleanup tasks was the most difficult to carry out? Explain.

   Most students will probably agree that shore cleanup and cleanup of wildlife was most difficult.

3. **Analyzing Results** How much of the original spill was your group able to recover?

   While the oil will become dispersed into the water, most groups should be able to recover most of the oil from the model oil spill.

4. **Describing Events** What happened when the oil reached your model beach? How effective was the cleanup of the sand or gravel and the objects representing wildlife?

   At least some of the oil seeped into the sand or gravel and adhered to the model wildlife. Oil removal from the beach and its inhabitants was probably difficult for students to accomplish without using some chemical agent.

Conclusions

5. **Drawing Conclusions** How might the weather affect attempts to contain an actual oil spill?

   Strong winds can cause oil dispersal over a larger area of water and shoreline. Strong winds result in larger waves, further increasing the range of oil dispersal.
6. Applying Conclusions  What factors make an actual oil spill different from your simulation?

Answers should include at least some of the following: winds, ocean currents, water temperature, salinity, the type of oil spilled, the amount of oil spilled, area covered by the spill, availability of materials and personnel for cleanup efforts and number of wildlife affected.

7. Applying Conclusions  What impacts might cleanup methods have on marine plant and animal life in an actual oil spill?

Cleanup methods which use detergents or water at high temperature and pressure can further stress plant and animal life in an area by adding toxins to the environment and causing physical damage to the shoreline.

8. Evaluating Methods  After each group has presented its results to the class, vote to determine which plan Eco-Marine, Inc. should submit to Del Mar Oil Company. Explain your choice.

Answers may vary. Stress that students should explain their choices.

Challenge students' opinions to encourage them to think about their choices.

Consider having students compete to win the contract through debate and a final vote.