Chapter Project Design and Build a Dam

The following steps will walk you though the Chapter Project. Use the hints and detailed directions as you guide your students to design and build a dam and then to test and redesign, if time allows.

Chapter Project Overview

The purpose of this project is to introduce students to the concepts of building an earthen dam, using the engineering design process and the scientific method.

Introduce the purposes for building earthen dams:

- Dams help control floods by regulating water flow. Often the reservoirs above dams are able to absorb some of the floodwater to protect downstream locations.
- Dams are used to produce a reservoir that can be used to generate electricity or can be used recreationally.
- Dams are also used to impound a stream or river, creating a water supply area for area towns and cities.

Dams result in a human-made change to Earth's surface and require upkeep.

Students might investigate the levees along the Mississippi River, which are mainly earthen dams running along the edge of the river to keep it from overflowing its banks and flooding adjacent towns.

Distribute Chapter Project Worksheet 1. After students have read the worksheet, ask if they have any questions. Students should use the worksheet while completing the Chapter Project.

Organize students in teams of two or three to work together to investigate the project.

The teams should plan their designs together, although they may decide to divide the tasks.

In conducting the permeability test, students should place the same height of soil sample in a test tube for each of the different grain sizes.

A sample of water should be carefully poured onto the soil. Students should use a stopwatch to determine how long it takes the water to travel a set distance. (This distance should be the same for each of the test tubes.)

The sample with the shortest time has the highest permeability since it allows water to pass through it more quickly.

In conducting the erosion study, students should just pour water over the soil at an equal rate and determine how much material is eroded. This can be done visually if equal amounts of soil are used.

When designing the dam, students should consider the placement of material based on the materials' properties.

Students should either redesign the dam or discuss approaches they would take to do so.

Materials and Preparation

Have water, test tubes, and stopwatches on hand.

The types of soil given to students need to represent three different grain sizes. This could be accomplished by using silt, sand, and gravel. If silt is difficult to obtain, cornstarch may be used. If it is difficult to obtain gravel, aquarium gravel may be used.

The permeability test may be completed in test tubes or graduated cylinders.

The dam can be constructed inside a large foil roasting pan. The dam can be built in the middle of the pan, across the short dimension. Water can be poured into one half of the tray, and students can time how long it takes to penetrate the dam.

Keep Students on Track—Section 1

Students should design a scientific experiment to determine the permeability of the soil and the ease of erosion for the different grain sizes. They need to know how rapidly water can pass through the sample and how rapidly water can remove the soil. Credit should be given for innovative approaches.

Teams should brainstorm the project to determine which construction materials to use. If possible, they should create a sketch showing the layers of the structure.

Alternate solutions should be evaluated, and teams should select the best design for the project.

Keep Students on Track—Section 2

Students should complete construction of the dam.

Keep Students on Track—Section 3

Students should test the structure, noting how well the dam performed.

Keep Students on Track—Section 4

Allow students the opportunity to redesign their structure. Ask them to reflect on their design and make suggestions for how they would alter the construction.

Keep Students on Track—Section 6

A group presentation should be developed, explaining all the steps taken to construct the dam. How did students accomplish the design? Why did they choose a particular technique? Students should create a diagram of the dam they constructed, outlining the placement of the different soils.

Chapter Project Wrap-Up

Investigating the permeability of the soils may be difficult, depending on the equipment available to students. If this is the case, tell students that the coarse-grained soils are the most permeable, which means that the soil will allow water to pass through easily, while the fine-grained soils are the least permeable, which means they will form a barrier against the water.

The soils may need to be compacted slightly in order to be more effective. They may also be more effective if they are slightly damp (sprayed with a misting bottle).

The shape of the dam should be a rough triangle for maximum integrity.

Extension

The weathering of Earth's surface accounts in part for the creation of the different grain sizes of the soil. A mountain river begins with large coarse materials, but the time that river reaches the sea, it is generally depositing very fine silts and clays. Engineers are aware of the different properties of soils and use those properties to their advantage in dam construction and other projects. In sealing off a landfill, engineers use the fine-grained clays to form an impermeable barrier above and below a landfill. This prevents water from entering the landfill and becoming contaminated.

Lab zone Chapter Project Design and Build a Dam

Dams are something that we are all familiar with, yet many of us may not know why they exist. Dams have many purposes: They can be used as a means of controlling flooding, they can be used to generate power, and they are also integral in many communities for creating and maintaining a public water supply. Dams can range in height from a low of 1 to 2 meters to as high as the world's tallest dam—292 meters. Dams can be constructed from a variety of natural and synthetic materials, including wood, concrete, and soil.

Project Rules

- The purpose of this project is to introduce you to the concepts of building an earthen dam. You will use an engineering design process and the scientific method.
- You will be using soils with three different grain sizes. You will need to test the permeability of each soil to determine how readily water passes through it. You will then need to develop an experiment to test how easily water erodes each soil. When constructing the dam, you will need to combine the information from your two experiments to make the best dam. Think about which layers or combinations of materials will make the most effective dam.
- Create a chart that shows which soil eroded easily and which did not. Identify which soil was most permeable. Record your data on a single chart to make evaluation of the soil types easier. Then describe the construction process for your dam and why you chose to put each soil type where you did. Include in your description a diagram of the dam that shows the placement of the different soils.
- In your journal, please comment on the following questions: If you were able to redesign, what did you change? If you did not have an opportunity to redesign the project, what would you do differently next time? Which part of the project was most difficult for you? Can you create a relationship between how easily a material is eroded and the permeability of the object?

Project Hints

- Your class may choose to conduct the permeability experiment together, rather than in individual groups. The results would be shared as a class.

Name _____ Date _____ Class _____

Overview *(continued)*

- Your class may choose to have different groups working on separate parts of the project. For example, one group might be responsible for testing the permeability of each soil. Another group might be responsible for testing how easily each soil is eroded.
- The permeability test may cause problems. If the soil is not placed in the test tubes properly, the water could run down the side of the tubes. This would make it impossible to calculate the permeability of the soil.
- Care should be taken when pouring water into the large foil pan to decrease the erosion of your work, unless that is the desired outcome.
- In redesigning your dam, you may want to consider the following:
  - Use the medium-grained materials to form the basic shape of the dam.
  - Place the fine-grained materials around the basic shape of the dam, compacting the materials as you proceed.
  - Construct the exterior of the dam of coarse-grained materials that do not erode easily. They will help keep the fine-grained materials from eroding.
  - Experiment to determine the appropriate mass of the dam needed to hold back the water from one half of the tray.

Project Timeline

Task	Due Date	Teacher's Initials
1. Complete Worksheet 1.	_____	_____
2. Design your dam.	_____	_____
3. Conduct the permeability test.	_____	_____
4. Conduct the erosion study.	_____	_____
5. Build the dam.	_____	_____
6. Test the structure.	_____	_____
7. Complete Worksheet 2.	_____	_____
8. Present your dam and your findings to the class.	_____	_____

Name _____ Date _____ Class _____

Planning Your Investigation

With other members of your group, you will be designing and building a dam. To help you get started, answer the following questions and share your answers with the group.

1. What three types of soils will you use to build your dam?

_____

_____

_____

2. How will you design your permeability test?

_____

_____

_____

3. How will you conduct the permeability test?

_____

_____

_____

4. How will you design your erosion study?

_____

_____

_____

5. How will you conduct the erosion study?

_____

_____

_____

6. How might these test results impact the design of your dam?

_____

_____

_____

Name _____ Date _____ Class _____

Design and Build a Dam

As you conduct your project experiments and build your dam, complete this worksheet to document your findings. Upon completion of your project, use this worksheet to present your findings to the class.

Progress Checklist

Task	Notes	Completed Y/N
Conducted permeability test		
Conducted erosion test		
Created a chart listing the soil types and their relative permeability and ease of erosion		
Brainstormed dam solutions and selected the best one		
Tested the dam		
Assessed what would be done differently when redesigning the dam		

Lab zone Chapter Project: Design and Build a Dam

In evaluating how well you complete the Chapter Project, your teacher will judge your work in three categories. In each, a score of 4 is the best rating.

	4	*3*	*2*	*1*
Permeability and Erosion Analysis	Students conducted an experiment , analyzed data, and successfully ranked the soils.	Students conducted two successful experiments, but soil ranking was incorrect.	Students conducted only one successful experiment .	Students sorted the soils without any investigation.
Dam Construction	Students constructed a successful dam with justification for choosing particular soils.	Students constructed a successful dam but did not include justification for choosing soils.	Students constructed an unsuccessful dam and did not provide justification for soil change.	Students built the dam from non-sieved soil.
Final Presentation	Students tie all three parts together and state how they would improve the dam in the future.	Students state how they would improve the dam.	Students relate how the first two steps impacted their decision for construction.	Students talk about their project.