SCIENCE 3D

HELLBENDERS

In this packet, sample student answers are provided in red and notes to teachers are in blue.

In this **STEM Project**, students will explore different engineering careers and discuss how these fields work to develop solutions to environmental problems. They will then propose a solution for hellbender conservation that each subfield might work on. Finally, they will collaborate to modify and improve their proposed solutions.

ACTIVITY I: TYPES OF ENGINEERS

There are many different types of engineers, and they are all important to science and society! When we think about saving hellbenders, biologists are important for learning about populations, reproduction, and ecosystem health. But, to restore their ecosystems and rebuild their populations, engineering is very important!

1. For each of the types of engineer listed below, research the kinds of challenges and problems that they try to solve. Write a brief paragraph for each, describing what these engineers do and why they are important.

A. **Environmental Engineer**

Environmental engineers try to solve environmental problems by using engineering, biology, and environmental science. Environmental engineers are important because they can find solutions to protect people from environmental hazards. They are also important because they can develop solutions that use the environment to protect the environment.

B. **Chemical Engineer**

Chemical engineers produce and transform different materials. They figure out how to transform chemicals and raw materials into useful products. They are important for producing medicines, fertilizers, and many other useful chemicals. They are also important for ensuring that plants that make and use chemicals operate safely.

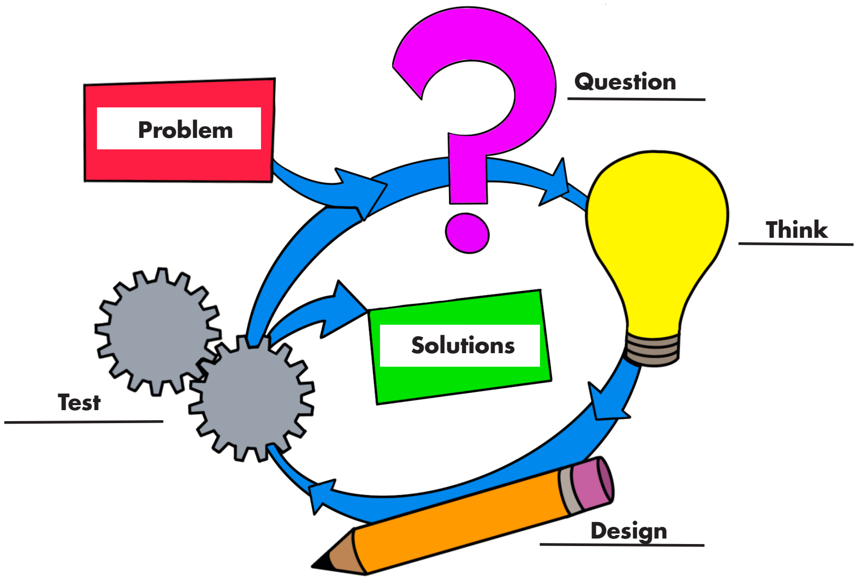
C. **Structural Engineer**

Structural engineers design structures like houses, bridges, and buildings. Structural engineers are important because they create designs to make sure that man-made structures work and do not collapse.

ACTIVITY 2: DEVELOPING CONSERVATION SOLUTIONS

For this activity, you can have students work independently or preferably in groups. Have each group member individually write a paragraph to answer the question, but they should discuss the problem and develop solutions together. You can expand the activity beyond engineering to ask students to consider any other technological advances that would help hellbender conservation science. In activity 3, have each group create a visual aid to define each step in the engineering design process and to present their idea for helping hellbenders.

Now that you know the kinds of problems different types of engineers solve, describe how each type of engineer might help to save hellbenders! For each type, be sure to follow the engineering design process. Define the problem they can help solve. Think about how this problem can be solved. In this step, think about the constraints on a design and the criteria you need for it to be successful. Then, design a solution, and propose how you would test your design solution. Finally, describe what results of testing would cause you to either accept or reject your proposed design as a solution!



Students may come up with many possible answers. They should develop plausible answers that are supported with evidence or logical thinking. Below are some examples of potential answers.

A. **Environmental Engineer** (HINT: Think about erosion/deposition and the flow of pollutants.)

Problem: To protect hellbenders, it is important to reduce the amount of fertilizer or pollution flowing into rivers. It is important to reduce the amount of soil flowing into the river.

Question: How do I use the environment to help ensure that pollution or soil is not flowing into the river?

Constraints and Design Criteria: Criteria: Solution must reduce the amount of pollution/soil flowing into a stream. It results in water quality conditions that allow hellbenders to survive and reproduce. Constraints: You must use environmental solutions to address the problem.

Design: Designs might include creating wetlands along the shoreline to capture soils or pollution. Designs could include creating forests along rivers to stabilize soils.

Proposed tests: Measure the water quality upstream and downstream of where the forest or wetland was planted before and after the design was built. If water quality improves to conditions that are good for hellbenders, the design would be considered a success. If not, the design would have to be modified.

B. **Chemical Engineer** (HINT: Think about the challenges of fertilizers and chemical pollution from industry.)

Problem: Too much fertilizer runs into rivers. Chemicals from a plant are being released into the water.

Question: Examples: How do we make fertilizers that are more efficient and don't run off into rivers? How do we make sure fertilizers go into the soil deep enough so they don't flow into rivers? How do we reduce the amount of chemicals flowing into a river?

Constraints and Design Criteria: Criteria: Solutions must reduce the amount of fertilizer/chemicals flowing into rivers. They must reduce the effect of fertilizers/chemicals on the environment and hellbenders. Constraints: Solutions must still allow farmers to effectively grow crops and allow chemical plant to still produce the chemicals.

Design: Designs might include fertilizers that are injected into the soil, fertilizers that are more efficient, some kind of chemical at the edges of farms that absorbs fertilizers and keeps them from flowing off the farm, ways to store or dispose of chemicals so they don't get released into rivers, and/or chemicals that convert dangerous chemicals into harmless ones.

Proposed tests: Tests could include measuring the amount of fertilizer running off of fields, testing whether chemicals are no longer flowing into streams, and testing the toxicity of new chemicals. If the tests still show high toxicity levels in streams, then the design would have to be modified. If the water quality in the streams improves, the design would be considered a success.

C. **Structural Engineer** (HINT: Think hellbender nesting and habitat requirements.)

Problem: Hellbenders need more places to lay their eggs. Scientists need to be able to access the nests to study them or collect eggs for head start programs.

Question: How do we build a house for hellbenders that helps them survive and reproduce while allowing people to study them more easily?

Constraints and Design Criteria: Criteria: Houses need to be able to withstand conditions and allow for hellbenders to survive and reproduce. Houses need to allow scientists easy access. Constraints: Houses need to not be too heavy. Costs cannot be too high. Houses need to prevent fish or other predators of eggs from entering.

Design: Designs may vary widely but should include a single opening and some way for scientists to access and monitor the nests. They should be streamlined or attached to the bottom to keep them from washing away.

Proposed tests: Deploy houses and measure how durable they are in the field. Monitor the use of houses by hellbenders, and survey scientists about their ease of use. If the hellbenders are using the houses, and the scientists are able to access them easily for study, then the design would be considered a success. If there is no evidence of hellbenders using the houses, then the design may need to be modified, or their placement may need to change. If the hellbender houses are not durable, consider using different materials. Factor in scientists' feedback when redesigning.

ACTIVITY 3: PRESENTING AND MODIFYING DESIGN

Collaboration is one of the most important parts of science and engineering. It is important to get many different views on a proposed solution and to **modify** designs based on varied and good input.

For the presentation, have each group present their solution either as an oral or poster presentation. Instruct groups to address each of the steps of the engineering design process in their presentation. Then, give the other groups listening to the presentation 2-5 minutes to discuss the presentation and to come up with constructive comments on how the design might be improved or other issues the team that presented might consider. Have each group select a spokesperson to give the feedback. Alternatively, have each group that is listening write down one or two comments and have them submit them to the teacher. Provide the feedback to each group at the end of the presentations.

1. Choose one of the engineering solutions that you developed in Activity 2 and create a presentation for your class.

2. After presenting your solution, solicit input and ideas from your classmates. Summarize their suggestions below:

   Good answers will include constructive suggestions made by the class.

3. Write a brief paragraph describing how you would modify your design based on the input from your class.

   Answers should include modifications that come directly from the input of classmates.