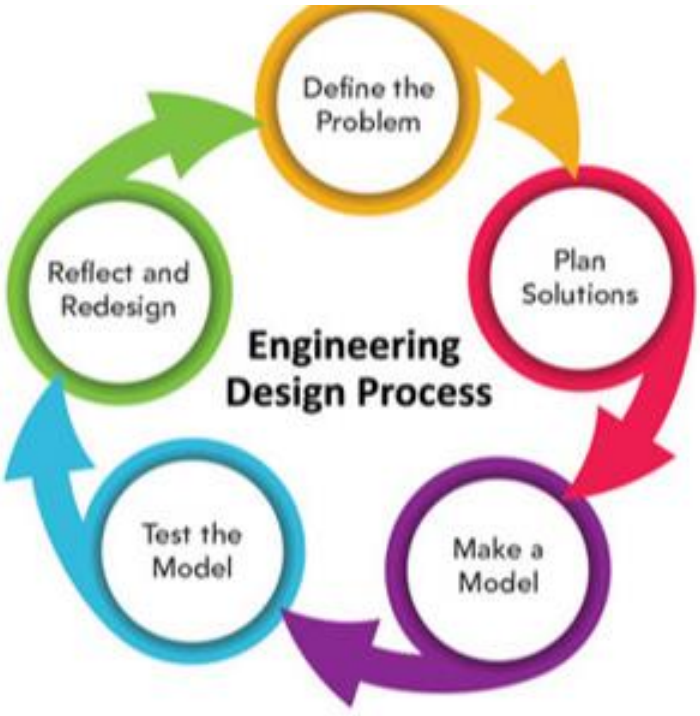
Engineer a water level monitoring tool
Location: Classroom
Time: 1 hr

General Lesson Overview: In this lesson, students will engineer a water level tool with consumable materials. Students will interact with a water level sensor and learn about data output for water level during a number of different scenarios.

Background Information:



75% of the world's population lives within 30 miles of a coastline and 90% live within even closer to freshwater. Our development close to water bodies requires that water levels stay mostly stable. Drought that reduces water levels may have negative effects on water quality, and excess rain results in flooding. This is why we monitor water levels very closely. Federal, state, and local governments want to know so that we can best prepare and manage.

Why do we care about water level? Flood risk management, emergency action planning, and land and habitat management.

- Environmental health
    - Too low = Loss of habitat/food/drinking water, higher concentration of pollutants, erosion or exposed soils.
    - Too high = erosion of riverbanks/beds, spread of pollutants and silt, damage vegetation and development, loss of life.
- To manage these risks we engineer levees, spillways, dams ect.

What can we do with water level data?

- Optimize engineering efforts to mitigate flood risks.
- Anticipate floods and take protective measures to reduce people from harms way.

Water level measurement methods

1. Staff gauge – giant stick out in the water
2. Wire-weight gauge
3. Shaft encoder/ strip chart recorder – early sensor

4. Pressure transducer – sensor type
5. Bubbler– sensor type
6. Radar– sensor type
7. Hydroacoustic sensors – sensor type - doppler principle to measure.

Definitions:

Water level – the vertical distance (or elevation) from a specific point of reference to the water's surface. In rivers and streams, it is often referred to as **gauge height** or **stage**.

Flood – water on land that is normally dry. Common natural occurrence impacting every US state and territory. Costs of flooding estimate is $8.2 billion and rising annually.

Crest Gage: A Quick Way to Measure River Stage | U.S. Geological Survey

Materials:

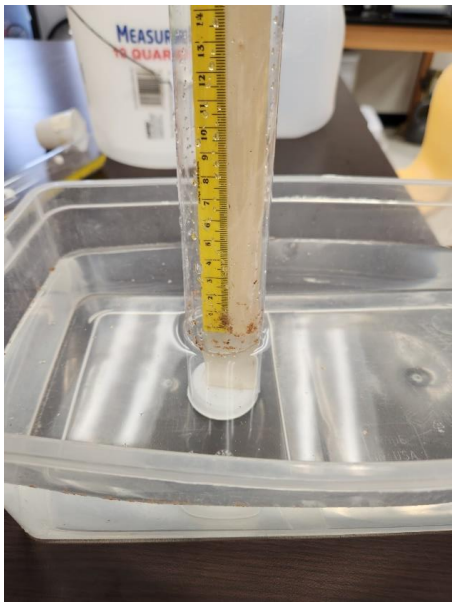
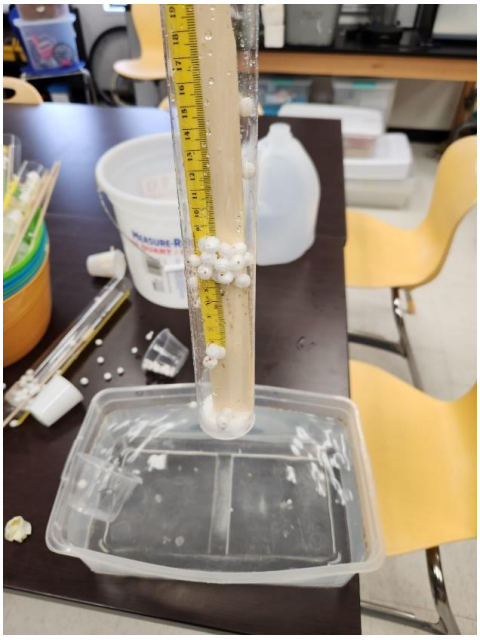
- Bottle caps
- Dowels
- Clear tubing
- Ruler tape
- Floating Styrofoam
- Floats

Procedure:

1. Begin this lesson by having students think about how water moves during a rainstorm. With that in mind, read the picture book *FLOOD*. *FLOOD* is a true picture book and does not have any words.
    a. If there is time have students sit in a circle and pass the book around with student telling the story by making up sentences to tell the group what is happening on each page. They can create characters or read in 1st person of a kid in the family.
    b. If you are tight on time the instructor can walk around telling the story on each page.
        i. Key things to point out in the book include:
            1. The water body in the back of the property.
            2. Ominous storm rolls in.
            3. Parents watching the weather and planning while the kids sleep
            4. Preparing the property for the storm.
            5. Deciding to evacuate.
            6. Flood happening overtime
            7. Receding flood
            8. Resilient and rebuild as community not alone.
2. Review the definitions of a flood and water level, can use to accompanying PowerPoint, EngineerAWaterLevelMonitoringTool.pptx
    a. Flood: An overflowing of water onto land that is normally dry.
    b. Water level: the vertical depth of water from a reference point. Often referred to as gauge height or stage.
3. Why do we care about the water level???
    a. After asking students why we should monitor the water level in present the photo and figure to them.
    b. The photo on the slide shows Smith Creek at Kerr Ave. Ask them if they can guess when based on the graph the photo was taking. Using a few context clues they might be able to guess that the photo was taken during TS Debbie in August 2024.
4. Using the engineering cycle, students are tasked with engineering a no tech water level monitoring tool.

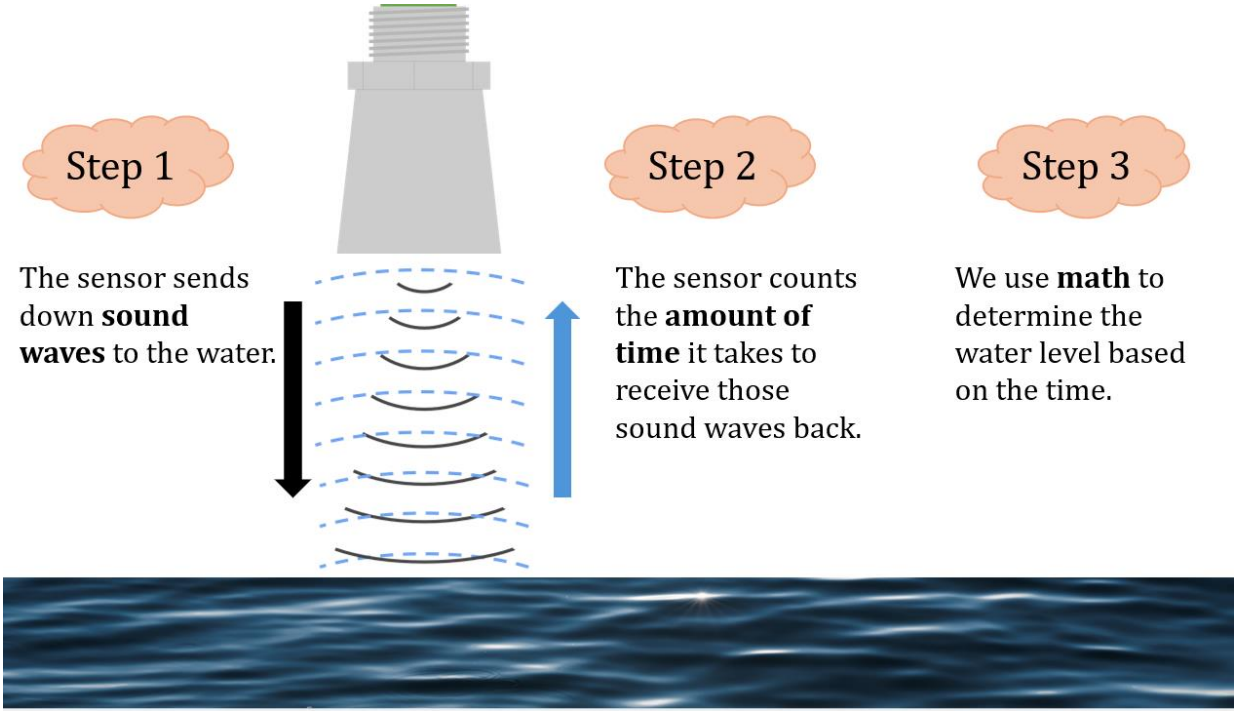
a. Present the engineering cycle
b. Brainstorm solutions that are already in existence.
    i. Photo of crest gauge.
    ii. Ask if they can think of anything students have already seen in the environment.
c. Present the problem: engineer a water level monitoring tool that doesn't require you to be in the environment to see the highest height of the water level.
d. Review materials with the students

e. 5 minutes to talk with their table team and draw their design.
f. 10-15 minutes to build.
i. Drilling, box cutting, and dowel cutting ask teacher for help.
g. Test by adding water into a bucket.
i. With about 3 inches of water as the existing water level place the design in the water, for some kids this could be up to the 0 level or at the normal level of the water body (A). Then add more so that the water level increases. You can mimic waters receding as you slowly pull up the monitoring tool (B).

	
A. Water monitoring tool in water at mean level.	B. Water level monitor being removed from a flood stage test mimicking water levels receding. Notice how the cork dust and Styrofoam balls stay at the highest high level.

5. If there is time have students present their tool. They should identify pros and cons of their design and what they would do in their redesign.

6. Show students the USGS cork tool.
7. Now that students have designed and identified pros and cons I'm sure they all will want to add some TECH! In the next 5 minutes introduce how electronics have revolutionized environmental monitoring.
    a. Show students how the ultrasonic water level sensor works.
    b. Give students and opportunity to ask questions and look at the sensor up close.



References:

https://blog.aem.eco/fundamentals_of_water_level_measurement#Whatiswaterlevel

https://www.youtube.com/watch?v=JprtI_MA5pM

Increase the challenge:

Give students a budget for their supplies and they must purchase supplies for the build.