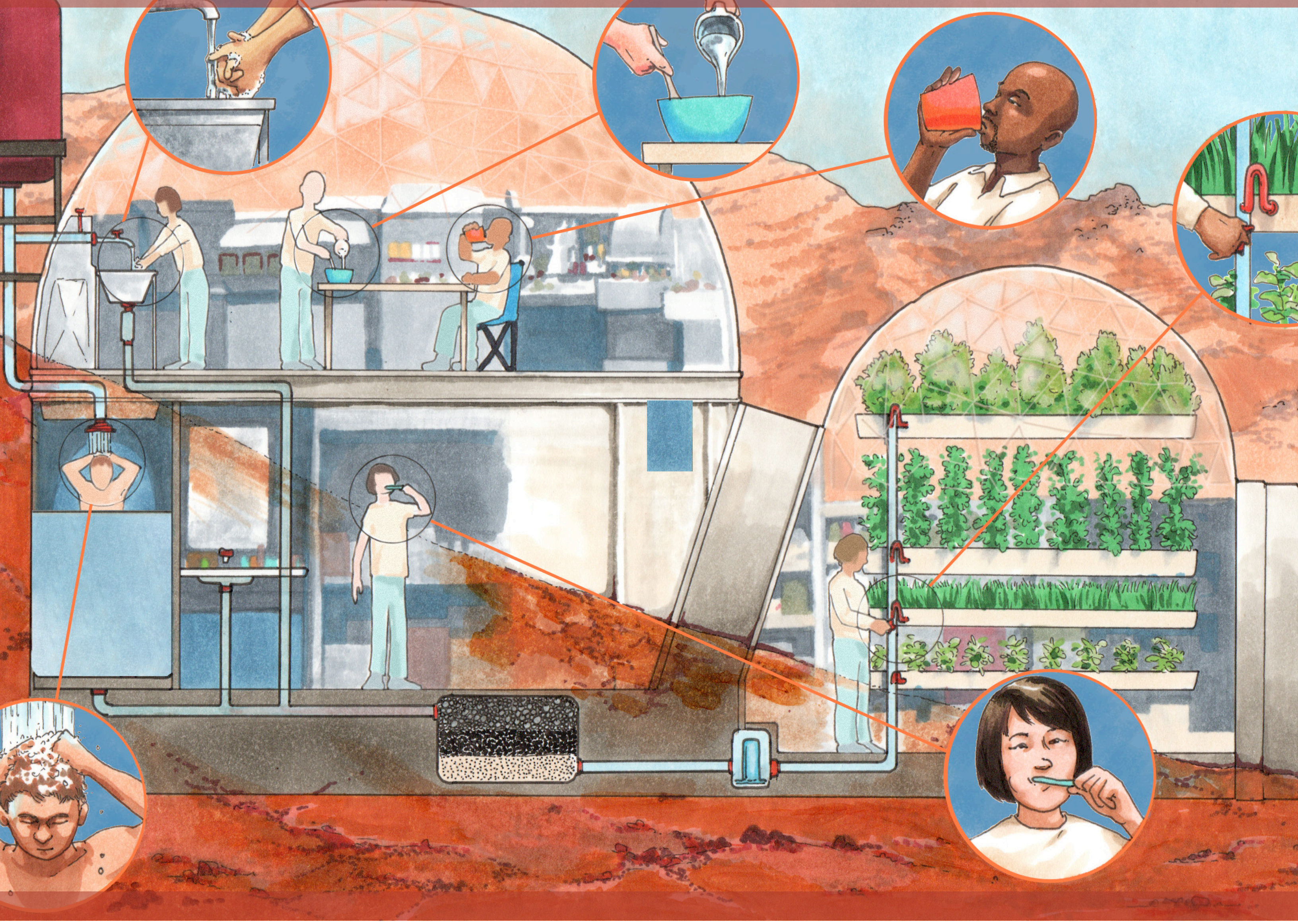
Engineering Everywhere™

Testing the Waters: Engineering a Water Reuse Process

Water Resource Engineering for Out-of-School Time • Grades 6–8



Written by the Engineering is Elementary® Team
Illustrated by Ross Sullivan-Wiley and the Engineering is Elementary® Team

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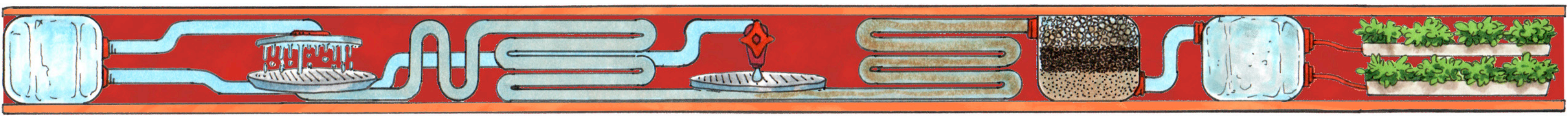

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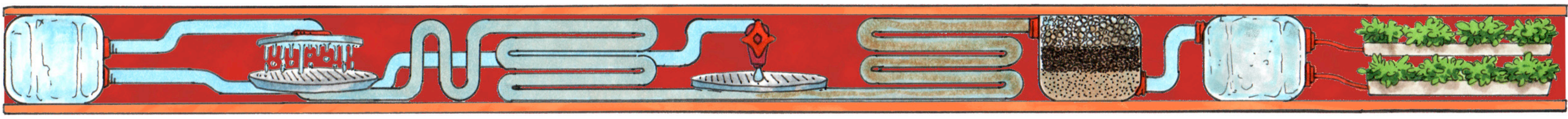
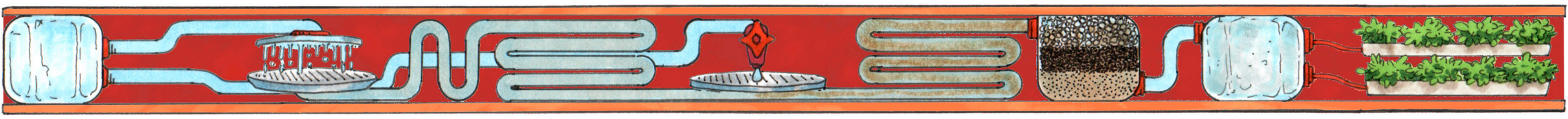


Pilot Sites for Testing the Waters:

This unit would not be possible without the valuable feedback from our pilot sites!

Bellesini Academy Lawrence, MA
Bethel Math and Science Jamaica Plain, MA
Blue Ridge Junior High School Lakeside, AZ
Boys & Girls Clubs of Boston, Jordan Club Chelsea, MA
Chaminade Julienne Catholic High School Dayton, OH
Coconino County Parks and Recreation Flagstaff, AZ
Fox Creek Junior High Bullhead City, AZ
Girls, Inc. of Lynn Lynn, MA
Knoles FACTS Flagstaff, AZ
Lawrence Catholic Academy Lawrence, MA
Mesa Public Schools, Summit Academy Chandler, AZ
Quabbin Regional School District Hubbardston, MA
Quality Life Center of Southwest Florida, Inc. Fort Myers, FL
Roosevelt Elementary School Port Angeles, WA
Sinagua Middle School Flagstaff, AZ
Spark of Knowledge Learning Center Fountain Valley, CA
St. Ann's Home and School Methuen, MA
The STAR School Flagstaff, AZ
Tennessee Valley 4-H Huntsville, AL
Tompkins Square Middle School New York, NY
Tuba City Junior High School Tuba City, AZ
Vermont Afterschool, Inc. Burlington, VT
Wayne Metro Community Action Agency Wyandotte, MI
YMCA Southcoast New Bedford, MA



PLANETS

Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (*PLANETS*) is an interdisciplinary and cross-institutional partnership that integrates planetary science, education, technology, and engineering (NASA #NNX16AC53A).

The Center for Science Teaching and Learning at Northern Arizona University (NAU), the U.S. Geological Survey (USGS) Astrogeology Science Center, and the Museum of Science, Boston have partnered to develop, pilot, and research the impact of three curriculum units and related professional development resources (http://planets-stem.org).

The purpose of *PLANETS* is to increase public awareness and use of NASA resources by highlighting the relationship between science, technology, engineering, and mathematics in the context of planetary science in out-of-school time settings.

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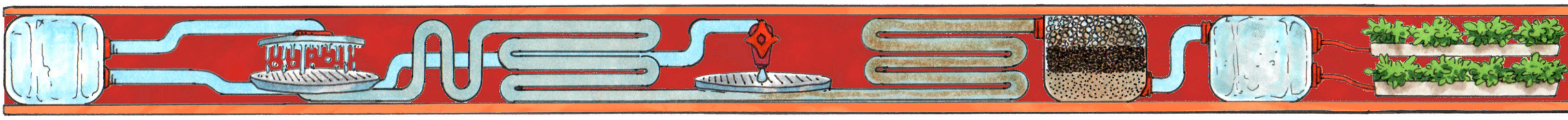


Unit Map

Here is an overview of the activities in this unit and how they all fit together.

Prep Activity 1: What is Engineering?

Youth are introduced to the Engineering Design Process as they work together to engineer a tower to support a model water tank.

Prep Activity 2: What is Technology?

Youth will play a quiz game to define the word "technology" and learn that engineers design technologies to solve problems.

Activity 1: A Grey Area

Youth *investigate* how using water for various tasks can impact the water's quality.

Activity 2: Investigating Filters

Youth *investigate* the properties of filter materials and create their own water filters to remove or treat contaminants from a water sample.

Activity 3: Order Up!

Youth apply what they learned about filters and water quality to re-pipe a model house to reuse as much water as possible.

Activity 4: Create a Process

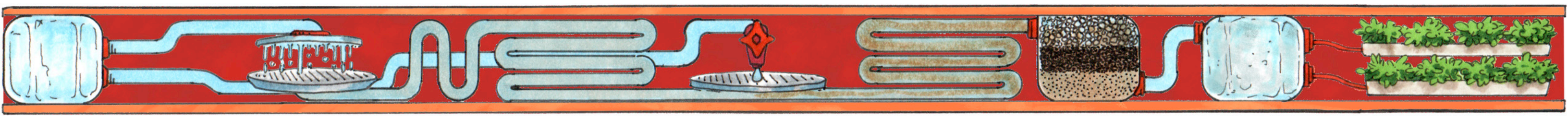
Youth work in groups to *plan*, *create*, and *test* their water reuse processes designed for an extreme environment scenario.

Activity 5: Improve a Process

Youth work in groups to *improve* their water reuse process to better meet the criteria in their extreme environment.

Activity 6: Engineering Showcase

Youth *communicate* their ideas about designing a water reuse process in the Engineering Showcase.



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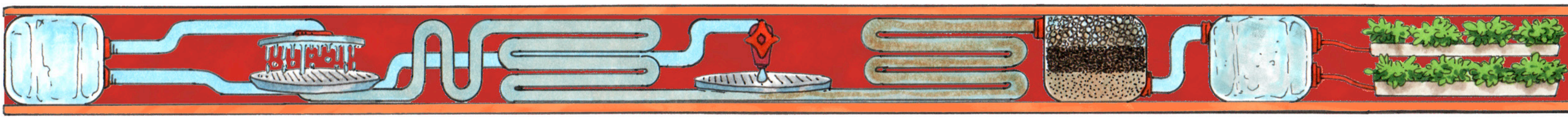


About Engineering is Elementary

Engineering is Elementary® (EiE®) fosters engineering and technological literacy among children. Most humans spend over 95% of their time interacting with technology. Pencils, chairs, water filters, toothbrushes, cell phones, and buildings are all technologies—solutions designed by engineers to fulfill human needs or wants. To understand the world we live in, it is vital that we foster engineering and technological literacy among all people, even young children! Fortunately, children are born engineers. They are fascinated with building, taking things apart, and learning how things work. Engineering is Elementary harnesses children's natural curiosity to promote the learning of engineering and technology concepts.

The EiE program has four primary goals:

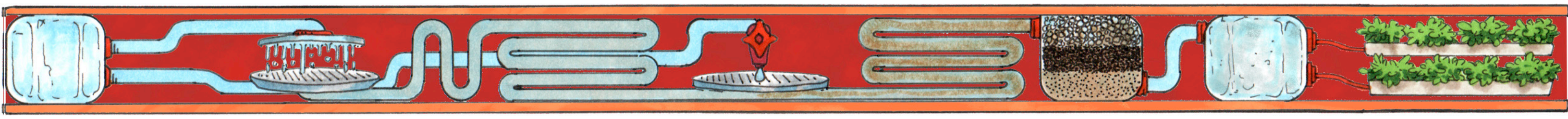
- Increase children's technological literacy.
- Increase educators' abilities to teach engineering and technology.
- Increase the number of schools and out-of-school time (OST) programs in the US that include engineering.
- Conduct research and assessment to further the first three goals and contribute knowledge about engineering teaching and learning.

The first product developed by the EiE program was the Engineering is Elementary curriculum series. Designed for use in elementary school classrooms, this curriculum is hands-on, research-based, standards-driven, and classroom-tested. For more information about EiE, visit: www.eie.org.

In 2011, EiE began development of Engineering Adventures® (EA®), a curriculum created for 3rd–5th grade children in OST environments. EA is designed to provide engaging and thought-provoking challenges appropriate for the OST setting. More information about EA can be found online at: www.engineeringadventures.org.

In 2012, the Engineering Everywhere™ (EE™) curriculum was created. EE is designed to empower middle school-aged children in OST settings to become engineers and solve problems that are personally meaningful and globally relevant. For more information, visit: www.engineeringeverywhere.org.

Engineering is Elementary is a part of The National Center for Technological Literacy (NCTL) at the Museum of Science, Boston. The NCTL aims to enhance knowledge of technology and inspire the next generation of engineers, inventors, and innovators. Unique in recognizing that a 21st century curriculum must include today's human-made world, the NCTL's goal is to introduce engineering as early as elementary school and continue through high school, college, and beyond. For more information, visit: www.nctl.org.



About Engineering Everywhere

The mission of Engineering Everywhere is to create engaging out-of-school time learning experiences for 6th–8th graders that positively impact youth's attitudes about their abilities to engineer. Our goal is to provide youth with personally meaningful and globally relevant challenges that empower them to problem solve, think creatively, and learn from one another.

The main ideas that guide the developers of EE are listed below.

We believe youth will best learn engineering when they:

- engage in activities that are fun, exciting, and connect to the world in which they live.
- choose their path through open-ended challenges that have multiple solutions.
- have the opportunity to succeed in engineering challenges.
- communicate and collaborate in innovative, active problem solving.

Through EE units, youth will learn that:

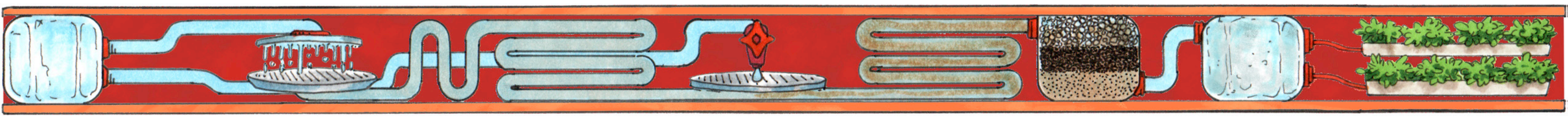
- they can use the Engineering Design Process to help solve problems.
- engineers design technologies to help people and solve problems.
- they have the talent and potential to design and improve technologies.
- they, too, are engineers.

As youth work through their engineering design challenges, they will have the opportunity to build their problem solving, teamwork, communication, and creative thinking skills. Most importantly, this curriculum is designed to provide a fun learning opportunity!

Unit Goals

In this unit, youth will be introduced to engineering and the eight-step Engineering Design Process as they work together to design a solution to an engineering challenge. Youth will explore the problem of water scarcity and learn how to evaluate water quality and *improve* it by creating filters. Then, they will engineer a process for reusing water that makes it safe and clean enough for people to use in a variety of extreme environments.

By the end of the unit, youth will be ready to present what they learned about water resource engineering, water quality, and the Engineering Design Process by sharing the water reuse processes that they have engineered.



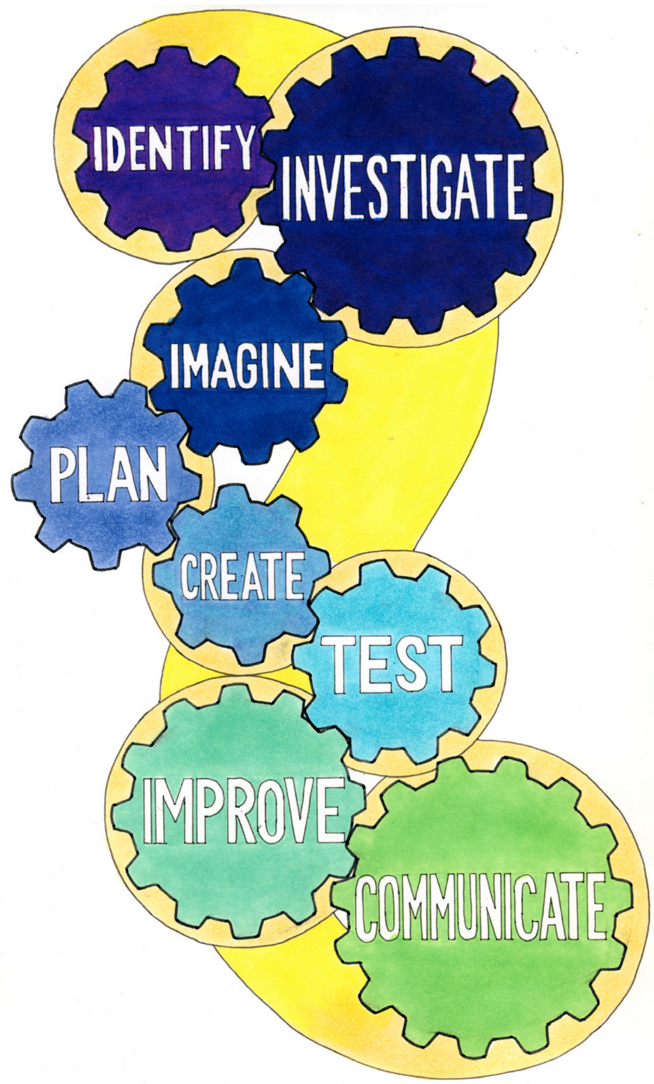
The Engineering Design Process

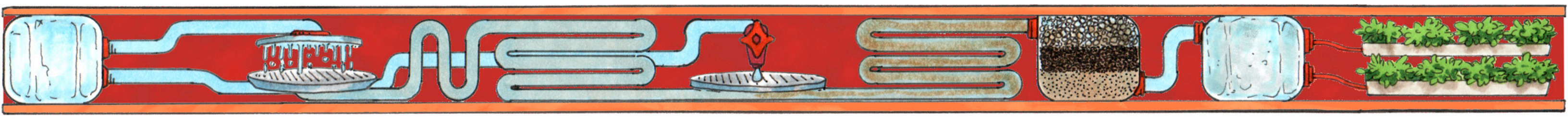
The Engineering Everywhere Engineering Design Process (EDP) is the backbone of each Engineering Everywhere (EE) unit. It is an eight-step process that guides youth in solving engineering challenges. Our goal for each EE unit is for youth to understand that the EDP can help them solve problems not only in engineering, but also in other areas of their lives.

While there are many versions of the EDP used in academic and professional fields of engineering, we developed an eight-step process that builds on the five-step process used in our elementary curriculum. There are guiding questions throughout the activities for the educator to ask to promote discussion about the EDP. There are also sections in the Engineering Notebook to encourage youth to engage in the process.

The EDP begins with *identifying* a problem that needs to be solved and *investigating* what has already been done. Next, engineers *imagine* different solutions and *plan* their designs. Then, they *create* and *test* their designs and make *improvements* based on the test results. Finally, engineers *communicate* their findings to others. While the process is shown as linear, youth may jump around to different steps as they are engineering. For example, they may need to *imagine* and *plan* new designs in order to *improve*.

To further highlight the EDP throughout the unit, the steps are italicized in this guide. Youth are also provided with an explanation of each step, which can be seen in their Engineering Notebooks. The EDP used in EE units is illustrated to the right.





Educator Guide Components

An **Educator Preview** with background information, activity timing, key concepts, materials lists, and preparation.

An **Activity Guide** with step-by-step instructions, including discussion questions, extension ideas, and tips.

Prep Activity **1** What is Engineering? — Educator Preview

Overview
Youth are introduced to the Engineering Design Process as they work together to engineer a tower to support a model water tank.

Note to Educator:
The main goal of this activity is for youth to engage in the Engineering Design Process, which they will use throughout the rest of the unit. The success or failure of the towers is less important than the interactions youth have with each other and the understanding that they can use the Engineering Design Process as a tool to solve different problems.

Activity Timing

Introduction:	5 min
Identify:	5 min
Create:	20 min
Test & Communicate:	15 min
Reflect:	10 min
	55 min

21st Century Skill Highlight
Collaboration

Prep Activity 1 Materials

For the whole group
- ☐ *Engineering Design Process* poster
- ☐ 1 plastic container with lid, 8 oz.
- ☐ 1 roll of duct tape
- ☐ 1 roll of masking tape

For each group of 3
- ☐ 1 pair of scissors
- ☐ 1 ruler
- ☐ 100 index cards

For each youth
- ☐ Engineering Notebook

Prep Activity 1 Preparation (5 min)
1. Arrange 100 index cards, a ruler, and a pair scissors for each group on the Materials Table so groups can easily retrieve their materials.
2. Place the roll of masking tape on the Materials Table for groups to share.
3. Fill the plastic container with water, and seal the lid with duct tape.

Testing the Waters: Engineering a Water Reuse Process 1 © Museum of Science

Prep Activity **1** What is Engineering? — Activity Guide

Youth will learn:
- the Engineering Design Process is a tool used by engineers to solve problems.
- they are engineers and they can design a solution to a problem.

Tip
If youth are not familiar with water towers, show the examples on p. 7 in this guide. Tell youth that water towers store water high off of the ground. Gravity causes water from the elevated towers to flow downhill to taps.

Introduction (5 min)
1. Tell youth you have an engineering problem for them to solve.
2. Explain to youth that they have been hired as engineers to solve a problem in the city of Watertown. The town wants to help its residents conserve water. They have decided to design a water tower for the roof of city hall to collect rainwater.
3. The town is not sure how to design the water tower so they have hired this group of youth to engineer a model water tower as an example for them.
4. Ask youth:
   - **How would you state the problem we are trying to solve?** *We need to engineer a model tower that can support a container of water.*

Tip
Criteria and constraints are referred to several times throughout this unit. It can be helpful for youth to have a general sense of the terms.

Criteria: Things you or your design needs to do.

Constraints: Ways that you or your design are limited.

Identify (5 min)
1. Split youth into groups of 3. Ask:
   - **What questions do you have before you begin working?** *Accept all answers.*
2. Encourage the whole group to ask questions about what they need to know before they start, such as what the tower needs to do (criteria), how they are expected to make it (constraints), and how to evaluate success.
3. Pass out an Engineering Notebook to each youth. Explain that the notebook is a place they can find information about their engineering challenges and record their ideas. Tell them to turn to p. 2 to find the answers to some of the questions they came up with.
4. Have a volunteer read about the criteria and constraints. As you review the information, make sure youth know:
   - They will work in groups.
   - Towers must be at least 1 foot tall (not including the container).
   - Towers need to hold up an 8 oz. container filled with water (model water tank) for at least 10 seconds.
   - They can use 100 index cards, masking tape, a ruler,

Testing the Waters: Engineering a Water Reuse Process 3 © Museum of Science

Engineering Notebook pages that allow youth to record their findings and reflect on their learning.

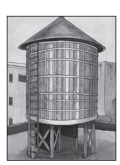
Prep Activity **1** Criteria and Constraints

In engineering, guidelines for your design are called criteria and constraints.

GOAL: Engineer a model tower that can support a water collection tank.

CRITERIA Things you or your design needs to do
You will work in groups to engineer your tower.
Your tower must be at least 1 foot tall, not including the water container.
Your tower must hold the plastic container filled with water for at least 10 seconds.

CONSTRAINTS Ways you and your design is limited
You will have 100 index cards, masking tape, a ruler, and a pair of scissors.
The scissors and the ruler cannot be used as a part of the tower.
You only have 20 minutes to *create* your tower.
You can hold the water container as you build, but you cannot *test* with it until the official testing time begins.



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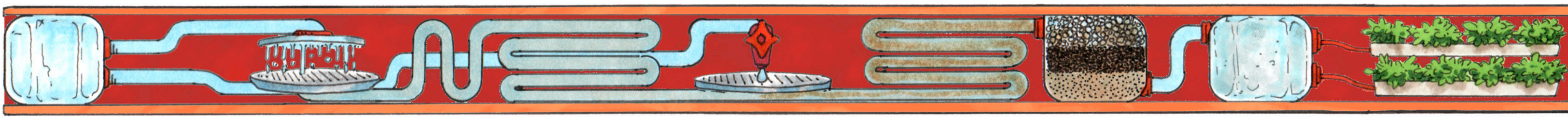


What You Need to Know Before Teaching an EE Unit

Engineering is Fun

The EE team hears this from many OST educators and youth. Engineering is a way of problem solving—a way of thinking about the world—that is very fun and creative. Any time you need to solve a problem in order to reach a goal, you are engineering.

There are No Right or Wrong Answers

There are often many great ways to solve the same problem. Not only is this a good engineering lesson, it is a good life lesson for the youth in your program.

You are a Guide

As the educator, it is your role to guide youth through these activities by encouraging them to pursue and communicate their own ideas, even if you think they might not work. Every problem has many possible solutions and multiple ways to reach them.

Ask Questions

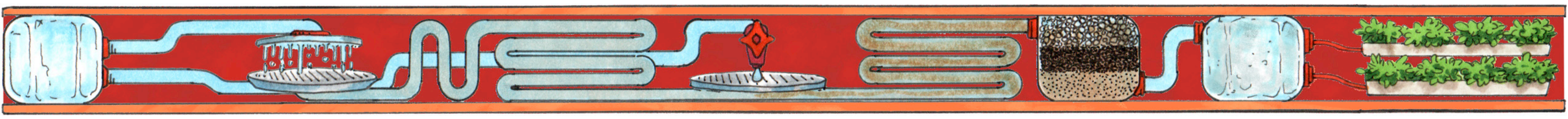
Throughout the activities, you can ask questions prompting youth to share their prior knowledge, predict what they might find, or remind them of criteria that will help them as they engineer. Asking questions like these sets your youth up to succeed and feel confident in their ability to engineer.

It is Okay to Try It Out

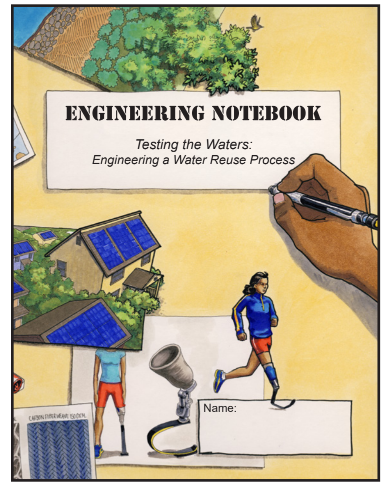
It can be very helpful to try out the engineering challenge yourself—either beforehand or right alongside the youth in your program as they work through the activities. This can help you understand the challenges they might face.

Support Reflection

Each activity includes 5-10 minutes at the end for youth to communicate with their peers by sharing their work. This gives youth the chance to discuss new ideas, think about their own work and the work of others, and reflect on what was learned. Group reflection can help reduce competition by encouraging youth to support each other as they move through the Engineering Design Process.



Engineering Notebooks



Make a copy of the Engineering Notebook for each youth before you begin working through this Engineering Everywhere unit. Youth will use them as directed in the Educator Guide during every activity.

The Engineering Notebook serves as a central location for youth to record their thoughts and ideas as they move through the unit. Its pages guide youth through the Engineering Design Process, pose questions, and prompt youth to reflect on their engineering work. The time youth spend with their Notebooks during each activity will allow them to create a personalized record of their engineering learning.

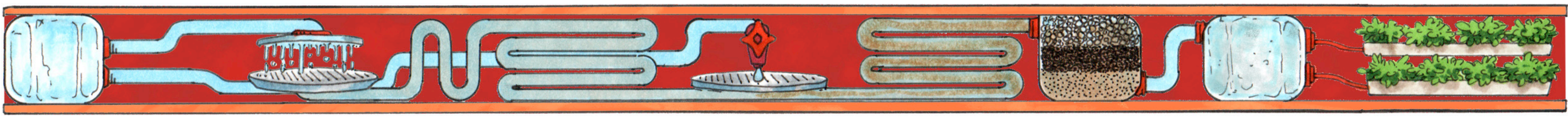
There are a few ways you can use the Engineering Notebook. You may want to have groups share one Engineering Notebook as a central recording spot for all group data and findings. This allows group members who enjoy writing and recording to do so. You may also encourage groups to share the responsibility by having group members rotate who records.

Alternate Prep Activities

The two prep activities, “What is Engineering?” and “What is Technology?” introduce youth to engineering and technology. “What is Engineering?” gives youth the chance to collaborate, experience a mini hands-on engineering challenge, share their designs, and learn about the Engineering Design Process. This activity sets the stage for what they can expect in the rest of the unit.

“What is Technology?” has youth interact with technologies, working with the definition that a technology is any thing or process designed by humans to help solve a problem. Most youth think of technology as things that can be plugged into the wall. They do not realize that the items that they interact with every day—including pencils, paper, and water bottles—are also technologies. This activity introduces the definition of technology that they will refer to as they engineer their own technologies to solve the problem presented in the unit.

While the prep activities for Engineering Everywhere are unit-specific, there are alternate prep activities you can use if you would like to reinforce the concepts and vocabulary related to these activities. You can find the alternate activities online at www.engineeringeverywhere.org. If you have questions about these activities, please email engineeringeverywhere@mos.org.



Tips and Tricks for Teaching the Unit

Post a Daily Agenda

Giving youth a sense of the day's activity will help them to plan ahead and manage their time.

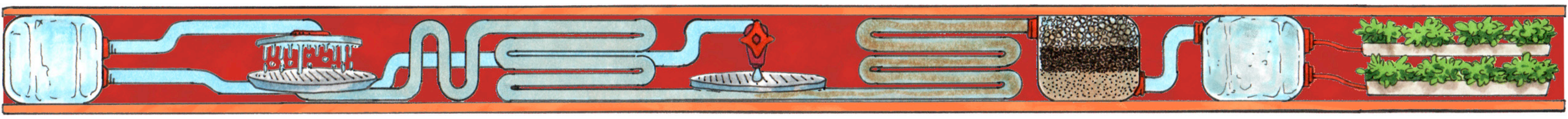
Facilitate Teamwork

Being able to work well in teams is an important skill for any engineer. You may want to assign team roles to help youth that struggle with teamwork. Possible roles include: the note taker, the materials gatherer, the tester, and the presenter.

This unit requires a collaborative workspace. Tables, desks, and chairs should be movable. It is a good idea to establish a materials table where you can set up materials for the day. Then, groups can be in charge of gathering their own materials when they are ready.

Invite Others to the Engineering Showcase

The Engineering Showcase, the last activity in the unit, is a big deal! This is a chance for youth to highlight the engineering they have done and share their accomplishments with others. Consider inviting families, program staff, and other youth to come to the Showcase.

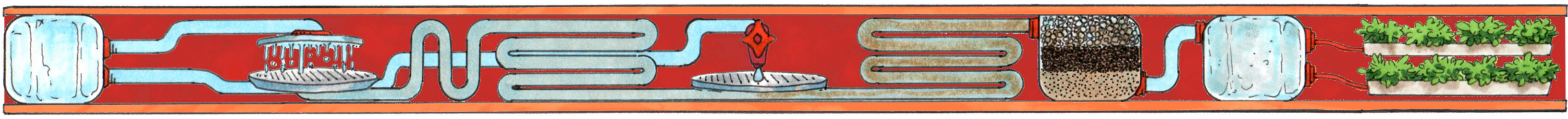


Scheduling the Activities

Each activity requires 50-60 minutes of teaching time. We recommend that you budget at least 8-9 hours in order to complete this unit, as some activities may run longer than expected.

You can schedule this unit in several ways: once a week, several times a week, or daily. It is also possible to group certain activities together. The chart below shows which activities are easily taught together. Use this chart to help you plan your schedule.

Prep Activity 1: What is Engineering? Prep Activity 2: What is Technology?	2 hours
Activity 1: A Grey Area Activity 2: Investigating Filters	2-3 hours
Activity 3: Order Up!	1 hour
Activity 4: Create a Process Activity 5: Improve a Process	2-3 hours
Activity 6: Engineering Showcase	1-2 hours



Background

Process Engineering

Process engineering is a way of thinking and designing that can be applied to problems in many different fields of engineering. A process is any series of steps designed to meet a goal. Process engineers work to optimize and improve processes so they are efficient and result in high-quality products. Process engineering can be a tough area to introduce to youth because the resulting products are less tangible than those in other fields of engineering. A process engineering challenge might involve engineering the steps of an assembly line or directions for creating a product. In this unit, youth will tackle process engineering by creating a step-by-step process to increase the amount of water that can be reused by ordering the flow of water through filters.

Water Resource Engineering

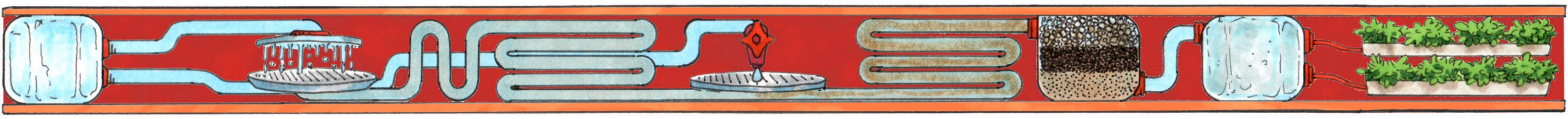
Water resource engineering focuses on the design of systems and equipment, including water treatment facilities, to ensure that people are provided with clean water for drinking, living, and recreation. UNICEF estimates that one in nine people do not have access to safe and clean drinking water. Factors such as environmental pollution and drought conditions threaten the availability of clean, drinkable water for future generations. Access to drinkable water is not just a problem here on Earth—it is one of the biggest challenges facing planetary explorers, who must recycle as much water as possible to stay hydrated on long missions. To do this, they utilize water filtration systems that purify contaminated water to produce drinkable pure water.

Pure water is water that is clean and safe for people to drink. It contains no contaminants introduced by humans, such as pathogens, metals, or harmful microbes.

Greywater is water produced from sources that do not contain fecal contamination. Throughout this unit, greywater is defined as water that has been used at least once and can be used again. Examples of greywater sources include washing machines, dishwashers, and sinks. Until recently, greywater was only deemed safe for uses like irrigation, but advances in water purification technology have made it possible for greywater to be purified to potable (drinkable) standards. These new technologies are being used around the world, from Singapore to California, and in space by scientists aboard the International Space Station.

Online Resources

The *PLANETS* website (http://planets-stem.org) supports both educators and youth through science extension exercises, educator support materials, and youth content enhancements. Science extension exercises are intended to integrate and apply planetary science concepts with the engineering unit. The educator support materials include immediate management tips and provide additional resources for meeting the unique needs of youth in out-of-school time settings. Be sure to check out these videos, infographics, and connections to other NASA resources!



Vocabulary

Constraints: Ways that your design is limited.

Contaminant: A substance that makes water dirty or unsafe to drink.

Criteria: Things your design needs to do.

Engineering Design Process: The steps that engineers use to design technologies to solve a problem.

Extreme environment: A place where it is difficult for people to survive.

Greywater: Water that has been used at least once and can be used again.

Process: A series of steps completed in a certain order to solve a problem.

Pure water: Water that is clean and safe enough to drink.

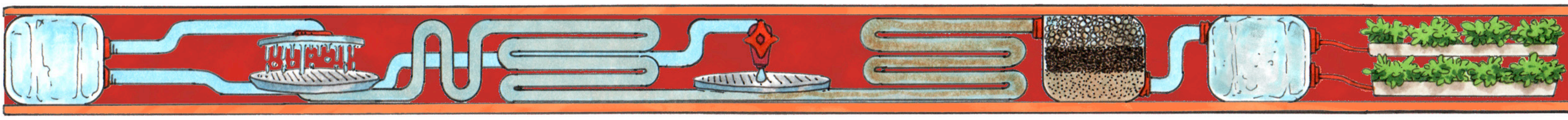
Technology: Any thing or process designed by people to solve a problem.

Waste water: Water that is too dirty to be used again.

Water quality: The characteristics that let us know if water is safe to use.

Water resource engineer: Someone who uses his or her creativity and knowledge of math and science to design technologies that solve problems related to providing people with access to clean and safe water.

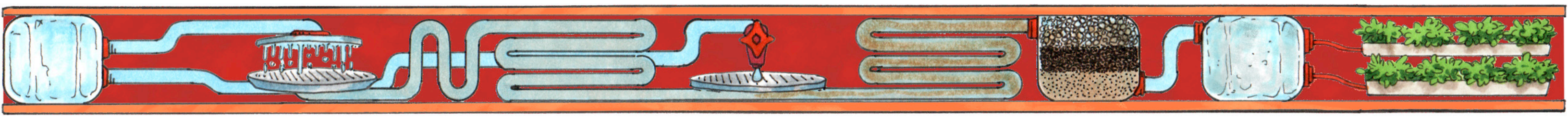
Water scarcity: When people do not have enough water to complete all the tasks they need to live.



Materials List

This kit is prepared for 8 groups of 3.

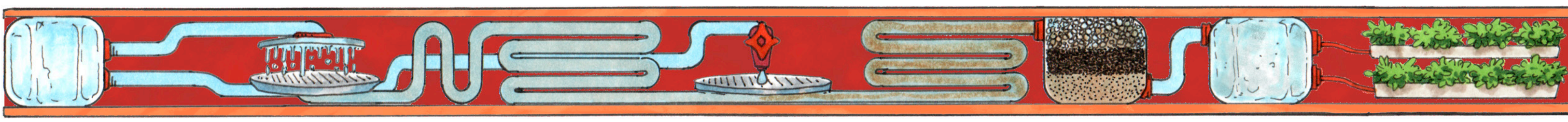
Quantity	Item
Non-Consumable Items	
1	*Engineering Design Process* poster
1	*Engineering Everywhere Special Report* video
1	*Technology Trivia* PowerPoint file
1	measuring cup, 1/4 cup
1	measuring cup, 1 cup
1	container with lid, clear plastic, 8 oz.
1	strainer
4	tablespoons
4	teaspoons
8	jars with lids, clear, 1/2 gallon
8	rulers
8 pairs	scissors
8	trays, foil, 12” x 12”
Consumable Items	
1/4 cup	detergent, powder
1 vial	food coloring, yellow
1 bottle	soap
1 cup	soil
1 cup	vinegar, white
1 roll	tape, duct
1 roll	tape, masking
1 spool	thread
1 tube	toothpaste, travel size
2 packages	modeling clay, 1 lb.
4 cups	charcoal, activated
4 cups	limestone gravel
4 rolls	tape, painter’s
5 sheets	cardstock
6 cups	sand
6	tea bags, black tea
8	markers, black, permanent
8 packets	pH strips



Materials List (continued)

Quantity	Item
Consumable Items	
32	craft sticks
37 pieces	*cheesecloth, 12” x 12”
40	rubber bands
40	straws, jumbo, color 1
40	straws, jumbo, color 2
40	straws, jumbo, color 3
60 sheets	copy paper
120	cups, plastic, clear, 8 oz.
150	cotton balls
800	index cards, 3” x 5”
NOT INCLUDED IN KIT	
1	chart paper and markers
1	computer and projector
1 roll	plastic wrap (optional)
1 pad	sticky notes (optional)
1	utility knife
2 rolls	paper towels, half-sheet perforations
8	buzzers (optional)
16	bottles, 2-liter (caps not needed)
18	sheet protectors (optional)
24	Engineering Notebooks

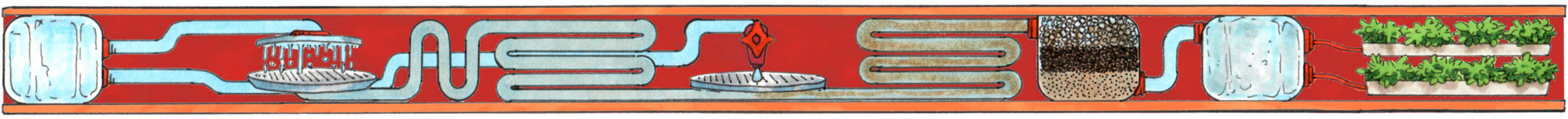
* Youth use cheesecloth in their water filter technologies in Activities 2, 4, and 5. Consider cutting squares (12” x 12”) in advance.



National Education Standards

Engineering Everywhere units are written with the goal of teaching engineering skills and critical thinking practices. Many Engineering Everywhere units also touch upon a variety of science topics and principles. The engineering standards taught in this unit and the science topic links in this unit are noted below.

		Prep Activity 1: What is Engineering?	Prep Activity 2: What is Technology?	Activity 1: A Grey Area	Activity 2: Investigating Filters	Activity 3: Order Up!	Activity 4: Create a Process	Activity 5: Improve a Process	Activity 6: Engineering Showcase
National Science Education Standards	Science as Inquiry	✓		✓	✓	✓	✓	✓	✓
	Physical Science								
	Life Science								
	Earth and Space Science			✓			✓	✓	✓
	Science and Technology		✓	✓	✓	✓	✓	✓	✓
	Science in Personal and Social Perspectives		✓	✓	✓	✓	✓	✓	✓
	History and Nature of Science								
ITEEA	The Nature of Technology	✓	✓	✓	✓	✓	✓	✓	✓
	Technology and Society		✓						
	Design	✓	✓		✓	✓	✓	✓	✓
	Abilities for a Technological World	✓	✓		✓	✓	✓	✓	✓
	The Designed World		✓						



		Prep Activity 1: What is Engineering?	Prep Activity 2: What is Technology?	Activity 1: A Grey Area	Activity 2: Investigating Filters	Activity 3: Order Up!	Activity 4: Create a Process	Activity 5: Improve a Process	Activity 6: Engineering Showcase
Next Generation Science Standards	MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.			✓	✓	✓	✓	✓	✓
	MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	✓				✓	✓	✓	✓
	MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	✓				✓	✓	✓	✓
	MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	✓				✓	✓	✓	✓
	MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	✓		✓	✓		✓	✓	✓

How to Recognize Success Rubric

How do you know if you are leading these activities successfully? This tool will help you keep track of your youth's successful moments and will ask you to identify how your own actions enabled youth to succeed.

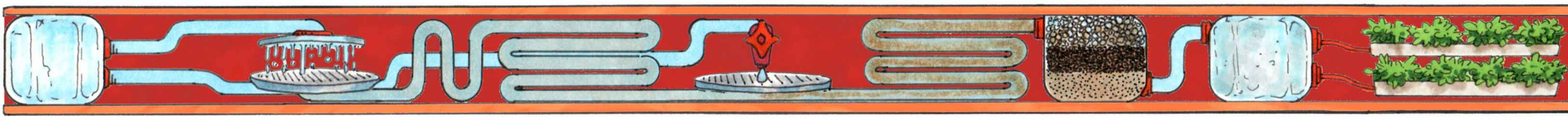
Elements of success	What does this look like?	How does the guide help me facilitate this?
Youth are engaged and challenged by the activity. They persist through difficulties.	• Youth are on-task. • Youth are trying out their ideas. • Youth *identify* what is working well in their designs. • Youth troubleshoot their own work. • Youth *improve* their designs.	• Use the bold prompts to **ask open-ended questions** to help youth troubleshoot their work. • Use the bold prompts to **ask youth about what they think is working well** in their designs and what they would like to improve. This will help youth feel more confident about their problem-solving abilities.
Youth do most of the talking, sharing their ideas with each other during the entire activity.	• Youth bring their own ideas to the activity and are comfortable sharing them. • Youth brainstorm and debate within their groups. • Youth share their designs with others. • Youth talk about how their ideas are changing over time.	• Use the bold prompts in the guide to **encourage youth to share and explain their thinking**. • Have youth **collaborate in groups** so they can brainstorm and *create* a design together. • Use the bold prompts in the Reflect section to **help youth share their new ideas about designs.**
Youth value their engineering work as a process, not just as the end result.	• Youth go beyond talking about their design to talking about how they thought of it and why they designed it. • Youth use the Engineering Design Process to describe their actions.	• Use the bold prompts in the guide to **ask youth how they use the Engineering Design Process.** Spending time talking and thinking about their process will help youth see the value in it. • Use the bold prompts to **ask all youth about *improving*** their designs, even if their designs are working well. • **Encourage youth to reflect individually** in their Engineering Notebooks to give them time for their experiences to sink in and be remembered.

How to Recognize Success Rubric Template

How do you know if you are leading these activities successfully? This tool will help you keep track of your youth's successful moments and will ask you to identify how your own actions enabled youth to succeed.

Date: Activity:

Elements of success	Evidence: Where did I see this during the activity?	What was my role in making this happen?
Youth are engaged and challenged by the activity. They persist through difficulties.		
Youth do most of the talking, sharing their ideas with each other during the entire activity.		
Youth value their engineering work as a process, not just as the end result.		



Dear Family, Date: ________________

We are beginning an engineering unit called *Testing the Waters: Engineering a Water Reuse Process,* a curriculum developed by the Engineering is Elementary program at the Museum of Science, Boston. This week, your child will be introduced to water resource engineering and the Engineering Design Process as the group works together to engineer a solution to an engineering challenge. This unit is set in a real-world context: throughout the unit, your child will explore water quality, investigate filter materials, and work with teammates to create a process for reusing water in extreme environments. There are many reasons to introduce children in grades 6–8 to engineering:

- **Engineering projects reinforce topics children are learning in school.** Engaging students in hands-on, real-world engineering experiences can enliven math, science, and other content areas.
- **Engineering fosters problem-solving skills,** including problem formulation, creativity, planning, and testing alternative solutions.
- **Children are fascinated with building and with taking things apart to see how they work.** By encouraging these explorations, we can keep these interests alive. Describing their activities as "engineering" when children are engaged in the natural design process can help them develop positive associations with engineering, and increase their desire to pursue such activities in the future.
- **Engineering and technological literacy are necessary for the 21st century.** As our society increasingly depends on engineering and technology, our citizens need to understand these fields.

If you have expertise in water resource engineering, water reuse, or have any general questions or comments about the engineering unit we are about to begin, please let me know.

Sincerely,

If you have any of the following materials available and would like to donate them, I would greatly appreciate having them by the following date: ______________________ . Thank you!

____________________________ ____________________________

____________________________ ____________________________

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