# Water Management in Utah

| Unit | Utah SEEd Standard / NGSS Performance Expectation | Estimated Lesson Time: |
|---|---|---|
| Stability and Change in Natural Resources | **Standard ESS.4.4**<br>Evaluate **design solutions** for a major global or local environmental problem based on one of Earth's systems. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution.* Examples of major global or local problems could include water pollution or availability, air pollution, deforestation, or energy production. (ESS3.C, ETS1.A, ETS1.B, ETS1.C)<br>(Each standard is a student performance expectation that includes all three dimensions of science.) | 120 minutes<br>(Time can be extended if needed) |

Lesson Website: https://sites.google.com/view/utah-water-problem/problem?authuser=0

## Lesson Overview

### Learning Objective(s)

Students will define Utah's water problem, research it, and propose solutions to reduce water use. They will consider cost constraints and have criteria to ensure water remains accessible to all residents. Students will present their water solutions either in a Google Slides presentation or as a poster. Next, students will evaluate the solutions to help determine the best course of action.

### Anchor Phenomenon

Utah is consistently one of the driest states and among the fastest-growing. Despite being dry, Utahns use more water per person each day than residents of other states. Seventy-five percent of our water in Utah is used for agriculture, even though agriculture makes up less than 1% of the state's GDP.

If current trends persist, the state will lack enough water to support its growth by 2050.

### Driving Question(s)

How can we better manage our water resources in Utah to meet both agricultural and domestic needs?

### Lesson Level Performance Expectations

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Students will create a poster or a slideshow presentation that will promote two different solutions to Utah's water system management problems that Utahns are facing. When they present their ideas to the class, the class will decide which solutions are optimal and evaluate the outcomes. Before students can provide solutions, they must first define the problem. Students will also examine Utah's water system management to identify the criteria and constraints that are present in Utah's water system management to provide feasible solutions. In summary of the lesson, students will have evaluated **design solutions** for a major global or local environmental problem based on one of Earth's systems (Water management).
Students will have: Defined the problem, identified criteria and constraints, analyzed available data on proposed solutions, and determined an optimal solution.

## LESSON SNAPSHOT

LESSON SUMMARY: STUDENTS WILL EVALUATE SEVERAL SLIDES OF DATA TO DEFINE THE PROBLEM UTAH IS FACING WITH ITS WATER SUPPLIES AND HOW THEY ARE AFFECTED BY POPULATION GROWTH PERCENTAGES. ONCE STUDENTS HAVE DEFINED THE PROBLEM, THEY WILL DESIGN TWO SOLUTIONS AND PRESENT THEM BY EITHER CREATING A POSTER OR A SLIDESHOW PRESENTATION, ALLOWING THE CLASS TO EVALUATE THEIR SOLUTIONS. STUDENTS WILL THEN BE TASKED WITH DECIDING ON WHICH SOLUTION IS THE OVERALL OPTIMAL SOLUTION.

| | **Estimated Time** | **Section Overview** | **How are students answering the driving question or meeting the learning objectives?** (Highlight **SEPs**, **DCIs**, and **CCCs**) |
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| **Experience the Phenomenon** | **30 Minutes** | Students will follow along with the teacher, taking notes on the problems identified in the first 10 slides on their worksheet.<br>Students will then finish the next part of the worksheet by identifying the problem. | Students will analyze and interpret data to identify the problem found in Utah's water system management. |
| **Investigate the Phenomenon** | **50 Minutes** | Students will break the problem into two smaller sub-sections on their worksheet.<br>Once students have identified the subsections of the problem, they will propose a solution to address the issue. The proposed outcome is simply them deciding how water sources in Utah should be allocated to meet both agricultural and residential demands. | Students will identify criteria and constraints to design three different solutions and evaluate those solutions overall to improve Utah's water systems and how Utahns manage them. |

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| **Model the Phenomenon** | **30-80 Minutes** | Students will use the "Decision-Making Matrix" worksheet to help them organize, evaluate, and identify evidence that makes each solution effective. If students researched a residential solution, they will go on a gallery walk and evaluate another group's residential solution and visit TWO agricultural solution posters/slide presentations as well. While they are evaluating the solutions, they will rate the poster/slides on how well their steps are thought out, the evidence of cost considerations, and the feasibility of the solution. They will also record details that they liked and identify if the plan would be effective, and provide their evidence. | Students will communicate, obtain, and evaluate their peers' posters and slideshows, and then engage in the argument from evidence to determine which solution is optimal overall as a class. Afterwards, they will finally elaborate on the data for discussion on how to make Utah's water system management less of a problem. |

| DISCIPLINARY CORE IDEAS | SCIENCE & ENGINEERING PRACTICES | CROSSCUTTING CONCEPTS |
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| • .C) Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies. (ETS1.A) The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (ETS1.B) A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (ETS1.C) Optimizing the Design Solution<br>Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.<br>The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. | NGSS Appendix F<br>Asking Questions and Defining Problems<br>Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.<br>• Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)<br>Developing and Using Models<br>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>• Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)<br>Analyzing and Interpreting Data<br>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>• Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)<br>Engaging in Argument from Evidence<br>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world. | NGSS Appendix G<br>***Systems***<br>Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering. |

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| | • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2) | |
| Related knowledge and skills from prior grades | | |
| Disciplinary Core Idea: Things people do can affect the environment but they can make choices to reduce their impacts. Societal activities have had major effects on the land, ocean, atmosphere, and even outer space. Societal activities can also help protect Earth's resources and environments. Human activities have altered the biosphere, sometimes damaging it, alathough changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people's impacts on Earth.<br>**NGSS Appendix E** | Science and Engineering Practices<br>**NGSS Appendix F**<br>Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.<br>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br>Engaging in Argument from Evidence<br>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world. | Crosscutting Concept: Systems<br>**NGSS Appendix G**<br>Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering. |

# Materials

**Link to Lesson Website:** https://sites.google.com/view/utah-water-problem/residential-water-management

**Link to all lesson materials on the 3DRST website (3drst.byu.edu): https://3drst.byu.edu/ess-4-4-water-management**
**Link to all materials on Canvas Commons:** https://tinyurl.com/3DRSTearth

| Student Materials | Teacher Materials | Lab Materials/Other Resources |
|---|---|---|
| - Student Worksheet: Designing a Solution<br>- Water Management Solution Slides-Template (Optional)<br>- Water Management Solutions Data for Students (Slides) | - Teacher Slides: Water Resources in Utah<br>- Teacher Ideas for Constraints<br>- Water Usage Essay Rubric | Posterboard |

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## Lesson Preparation

**Material Preparation:**
Printed Student worksheets
Student access to the internet
Poster boards

**Supports students will need/adaptations:**
The teacher has the flexibility to adjust the lesson length as necessary to accommodate students.

## Experience the Phenomenon/Problem (Engage)

| What Students Are Doing | Teacher Tips |
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| Students will be following along with the teacher, making notes of the problems identified in the first 10 slides on their worksheet.<br>Students will then complete the next portion of the worksheet by identifying the problem. | |
| **What Teachers Are Doing** | **Teacher Tips** |
| The teacher will walk students through **slides 4-13** of the PowerPoint. Stop on each slide and have students analyze the given data, then have them summarize the data in a short sentence on their worksheet.<br><br>Stop on **slide 14** and allow students time to analyze all of the data gathered and identify the problem (The problem is we are growing too fast and are going to run out of water if we do not adjust water management in Utah). | |

## Investigate the Phenomenon (Explore)

**What Students Are Doing**

- Once the Problem has been identified, the students will work together as a class to determine the criteria and constraints for water management in Utah.
- After the criteria and constraints have been considered, students will break the problem into 2 smaller sub-sections on their worksheet (Solving water management issues for agriculture or residential, but not both).
- Students will use the provided resources and the rubric on their worksheet to research and suggest three solutions to either agricultural or residential water management issues. We recommend that students use this website: https://sites.google.com/view/utah-water-problem/agricultural-water-management.
- They will then create a poster board or a Google Slides presentation to share their proposed ideas with other students in the class. Students should use the rubric when creating their presentations to make sure all project criteria are met.

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