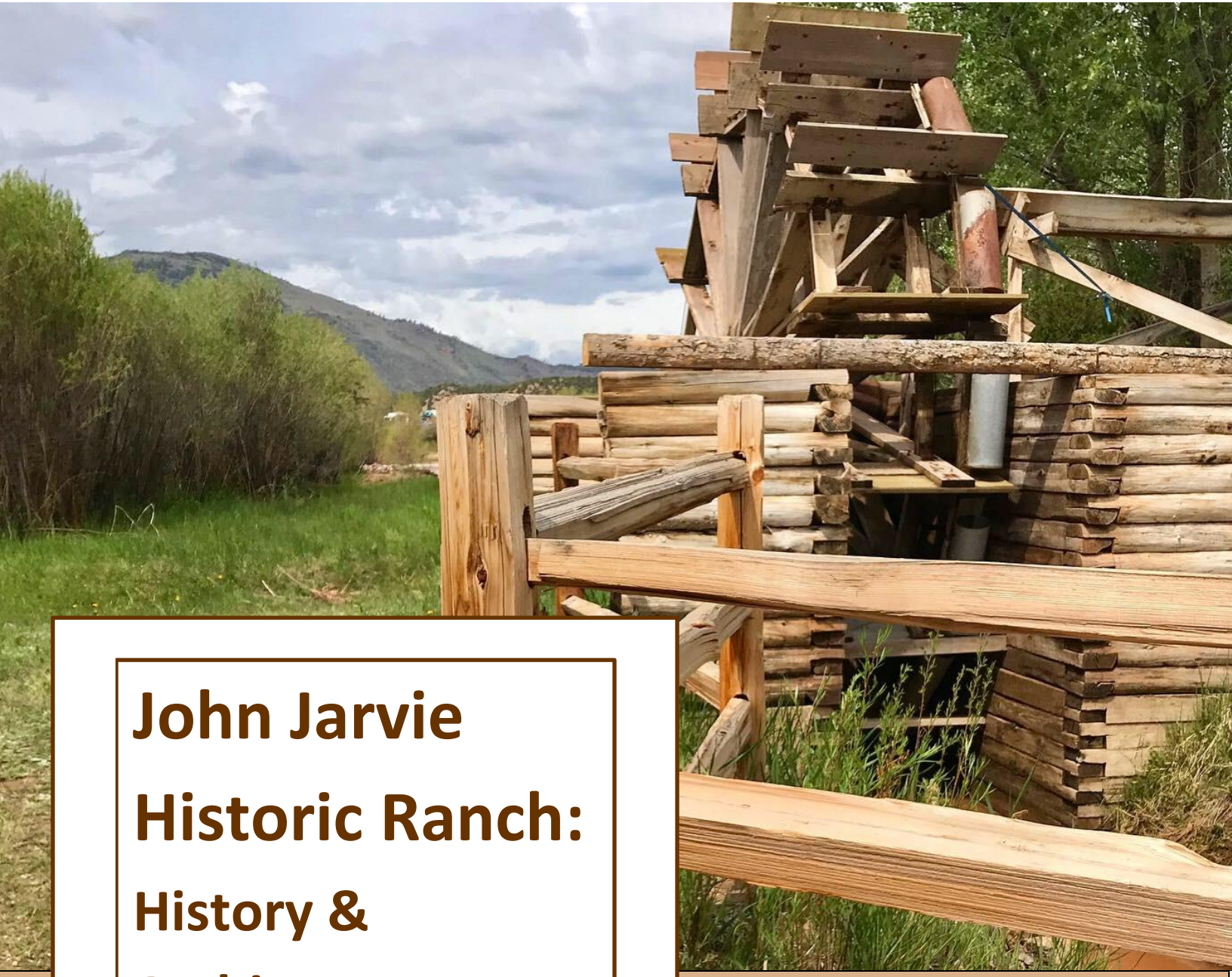


John Jarvie Historic Ranch:

History & Architecture

Authored by: Joel Arvizo-Zavala

Grade 4

Adaptable to Grades 3 or 5

LESSON PLAN DETAILS

Time Frame:
1 hour and 30 minutes [2 class periods, each at 45 minutes]

Group Size:

- 2-3 to construct the water wheel. Can also be done individually.

Materials: Complete list of materials located under the Student Replica Waterwheel exercise.

Life Skills:
Critical thinking, literacy development, scientific inquiry, mechanics and engineering

Intended Learning Outcomes:

Students will learn the basics of engineering through the history and use of place-based learning.

Jarvie Ranch History & Architecture Lesson Plan

By: Joel Arvizo-Zavala

This lesson plan is intended for fourth and fifth grades.

SUMMARY

The water wheel at Jarvie Ranch is the inspiration for this lesson. Water wheels in multiple variations have served instrumental to helping humans build their societies. From irrigation to the generation of power, water wheels have significantly influenced how we approach providing water and electricity to our growing communities. We hope that when you and your students visit Jarvie Ranch, you'll take what you learn from this lesson and apply it to what you see at the ranch.

The purpose of this lesson is to introduce students to the history and architecture of the water wheel. Through leveled reading content, students will be able to directly connect with the history and architecture of water wheels; leading to students building their own replicas of water wheels at the end of the lesson. Students will have opportunities to work in teams of two or three as well as individually.

Relevant Core Standards

Utah Standards 4th Grade

Language Arts (Reading)

1. *Informational Text – Key Ideas and Details:* Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
2. *Informational Text – Craft and Structure:* Determine the meaning of general academic and domain-specific words or phrases in a text relevant to the subject area.
3. *Informational Text – Integration of Knowledge & Ideas:* Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
4. *Foundational Skills – Phonics and Word Recognition*: Know and apply grade-level phonics and word analysis skills in decoding words.
5. *Foundational Skills – Fluency:* Read with sufficient accuracy and fluency to support comprehension.

Science

1. Standard 3; Objective 1 - Demonstrate how forces cause changes in speed or direction of objects.
2. Standard 3; Objective 2 - Demonstrate that the greater the force applied to an object, the greater the change in speed or direction of the object.

Colorado Standards & Skills 4th Grade

1. Science; Standard 1; Physical Science – Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable.
    a. Concept and Skill 1 - Energy comes in many forms such as light, heat, sound, magnetic, chemical, and electrical
        i. Evidence Outcomes: Identify and describe the variety of energy sources.
        ii. Evidence Outcomes: Use multiple resources – including print, electronic, and human – to locate information about different sources of renewable and nonrenewable energy.
        iii. Relevance and Application: There are multiple energy sources, both renewable and nonrenewable.
        iv. Nature of Science: Critically evaluate model of energy, identifying the strengths and weaknesses of the model in representing what happens in the real world.

Wyoming Standards & Skills Elementary Grades

1. Science; Content Standard 4; Energy – Ask questions and predict outcomes about the changes in energy that occur when objects collide.

    a. Literacy Connections: Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
2. Science; Content Standard 4; Energy – Apply scientific ideas to design, test, and refine a devise that converts energy from one form to another.
    a. Literacy Connections: Conduct short research projects that build knowledge through investigation of different aspects of a topic.

Background for Teachers

Students will be able to:

1. Identify the different types of water wheels and their various uses.
2. Understand the purpose of the water wheel at Jarvie Ranch and then use this knowledge to better understand the process of irrigation.
3. Be able to understand the architecture of water wheels and use this knowledge to build smaller replicas in the classroom setting.
4. Be able to identity three historical elements that have informed the use of the water wheel in modern times.

Introduction to Project-based Learning

In this lesson students will have access to both traditional and non-traditional content. The traditional content comes in the form of a guided reading that teachers can do with their students to gain background knowledge and information on the architecture of Jarvie Ranch. The other part of the lesson is based in project-based learning (PBL). As the teacher, you have the option to guide the students into two different directions. One is a guided PBL where you will direct students on how to create a replica water wheel as a means to learn about the basic components to the machinery. The second is a more creative and flexible PBL where you can give students the materials listed in the lesson and they can work in teams of three or four to design their own water wheel technology using the lesson and pictures provided as a guide. Either

Lesson Plan Procedure

Class One & Two

- **Create the water wheels over the course of two class periods. You are the best judge of students' abilities and time management skills.**
- **Explain the purposes of water wheels, their history, and the places they have been used throughout history.**

option will help students improve their cognitive skills in three primary ways:

- Students will have an opportunity to develop critical thinking especially when given the option to design their own water wheels without explicit instruction.
- Students will develop skills in inference by taking what they know and using that information to pilot and test a model.
- Students will learn skills inquiry skills by providing the students with time and space to ask questions and get feedback on their models.

Teacher Resource: Water Wheels

General History of Water Wheels

Existing for many centuries, water wheels have been used by many human societies for two primary purposes, to generate energy and to provide irrigation for food sources (such as crops). With the invention of the water wheel, humans were able to bring water from nearby rivers into their homes, gardens, and to generate movement to grind grain, among other things. The water wheel requires minimal upkeep and is used in many areas throughout the world as a source of irrigation for crops. The water wheel is considered to be a much more environmentally friendly and sustainable technology; especially for areas of the world where economic inequity may prevent communities from gaining access to modern technology such as hydroelectric plants. Water wheels come in three major types, undershot, overshot, and horizontal. Undershot waterwheels, typically, are emerged in a water source (e.g. river) where the force of the current moves the water wheel upwards while simultaneously collecting water. Once the water wheel reaches the top with water collected in its wells, the water is transferred to a flume, connects to an irrigation ditch, and then water is provided to crops.

The Water Wheel at Jarvie Ranch

The waterwheel located at Jarvie Ranch (a replica of the original) is an undershot water wheel that uses the current of the Green River to move the wheel from underneath. As the current from the river passes under, buckets located on the inside of the frame of the water wheel fill with water as the wheel moves upward, clockwise. Once filled, the buckets empty into a flume that leads to a trench carved out of the soil to irrigate the ranch's garden. The current replica of the original Jarvie Ranch water wheel, is located inside a small dam. Enclosed in concrete, the dam fills with water when the water level of the river rises. This process aids in water being delivered to both the water wheel and then subsequently to the nearby ranch garden.

Lesson Vocabulary

Function	A activity that is natural to the person or thing.
Irrigate	Supply water to plants or the land to help them grow.
Undershot	A waterwheel that has water flowing under it.
Version	A form of something that is different from a previous version of itself.
Specific	Cleary defined or identified
Ditch	A narrow channel dug in a field to hold or carry water away.
Replica	A copy or model of something such as art or a machine.
Creative	Using the imagination or an original idea to create something new.
Similar	Having a similar appearance or quantity of something without being exactly the same.
Ranch	A large farm where animals are kept.

Student Replica Waterwheels

Students will be provided with a set of materials to brainstorm and then build their waterwheel replicas in the classroom. The materials list is below and includes the name and quantity of each item. The process for students is the following:

Step 1: Provide students with materials listed in the table below

Materials List – Water Wheels Lesson		
Item	**Purpose**	**Quantity per Model**
Plastic Water Cups – Clear – 3 or 4oz size	Fills Buckets	4
Straws – Biodegradable or Standard	Fulcrum/Pivot	3
Hot Glue & Glue Gun *OR Tacky Glue (Safer Option)*	Attaching Buckets to Spokes	1 Gun & 2 Glue Sticks *OR 1 Bottle*
Standard School Glue	Miscellaneous	1 Small Bottle
Craft Sticks Large (Tongue depressor size)	Base of water buckets	4 (Approximately)
Clay (Quick Drying)	Hub of Water Wheel	2 ounces
Standard Ruler	Measure cuts in straws	1
Black (or another dark color) marker	Mark areas to cut on straws	1
Scissors	Cut straws to hold craft sticks	1
Duct Tape	Attaching fill buckets to wood	About 6 inches total

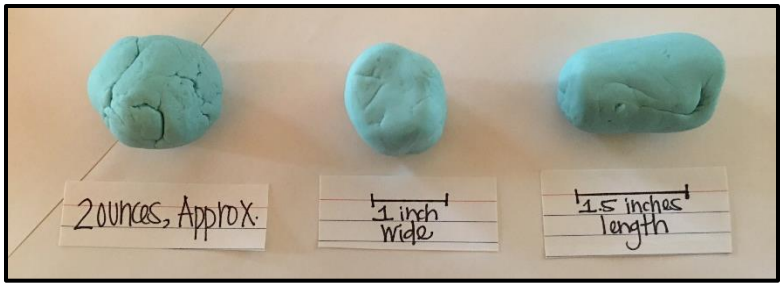
Step 2: Set a timer for 10 minutes to give students the ability to brainstorm their design and model.

Step 3: Set a timer for 25 minutes for student collaboration time to build their model

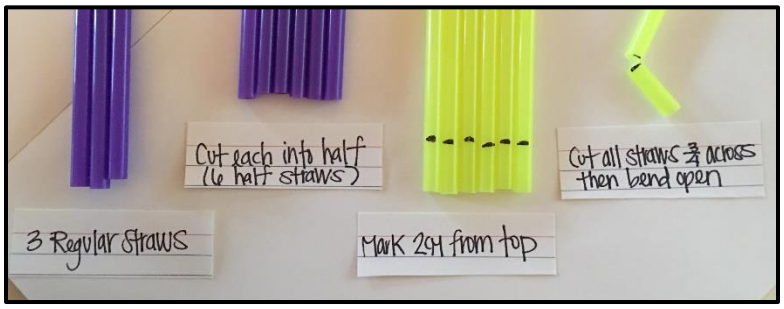
Step 4: Set a timer for 20 minutes for students to present their replica to the class.

Step-by-Step Guide for Miniature Replica Water Wheels

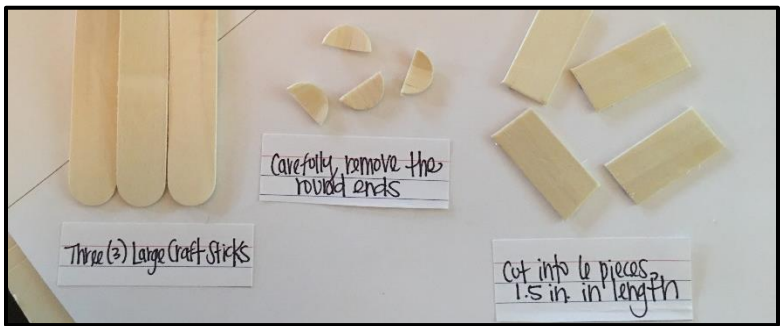
1. Pass out materials to students one-by-one starting with the quick drying clay. Students should be provided with approximately two ounces of clay but exact measurement is not necessary. Students should roll the clay into a tube that is approximately one inch in diameter and 1.5 inches long. This will serve as the hub of the water wheel. Put this aside for when it's time to assemble the water wheel.



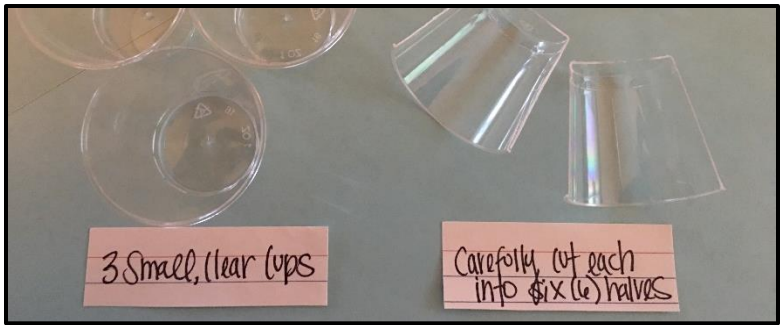
1. Pass out three straws to each student. Once complete direct them to cut the straws in half to get a total of six. Using the rulers and markers provided have the students mark each straw 2 centimeters from the end. Ensure that the marks are dark enough and go across the diameter of the straw. Lastly, cut the straw on the mark ¾ of the way across ensuring not to cut the straw all the way through but rather creating a slit which will hold the craft stick later on. Put these aside for when it's time to assemble the water wheel.



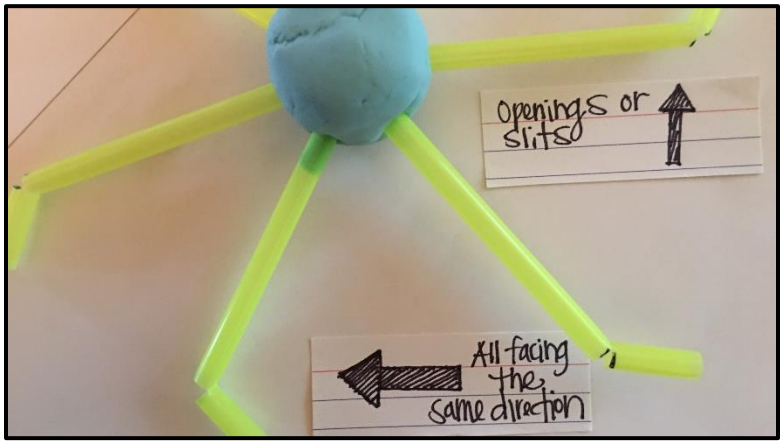
2. Pass out the large craft sticks to students; each model will need three. Remove the rounded ends from the sticks using scissors and discard. Using the ruler and scissor, instruct the students to cut each craft stick into two pieces, each totaling about 1.5 inches in length. Each model will need six 1.5 inch pieces from three craft sticks. Put these aside for when it's time to assemble the water wheel.



3. Pass out small, clear water cups to students; three (3) in total. Using scissors have the students carefully cut the water cups in half from top to bottom. Once completed each water cup half should be able to hold water when held at a 45 degree angle. Put these aside for when it's time to assemble the water wheel.

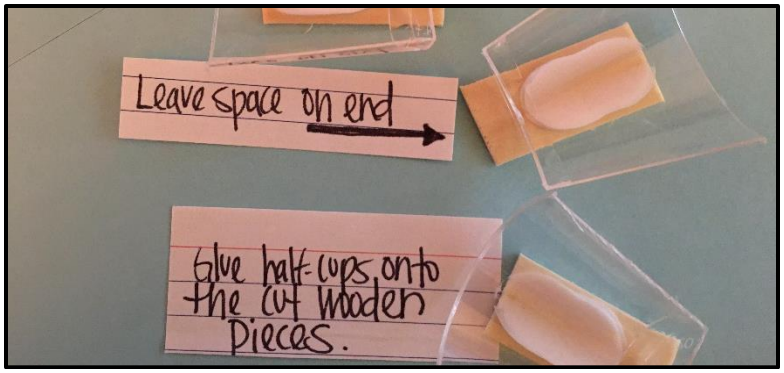


4. Assembly time, part one. Start by placing the clay hub the students made in the center of the desk or table with at least a few inches of working space around it. Grab the straw halves and place them into the soft clay to create the spokes of the water wheel. Make sure the slits that were cut into the straws earlier are on the outermost edge of the wheel (e.g. not in the clay). All the slits should open towards the same direction either to the right or left. During this stage, ensure that the straws are as equidistant as possible.

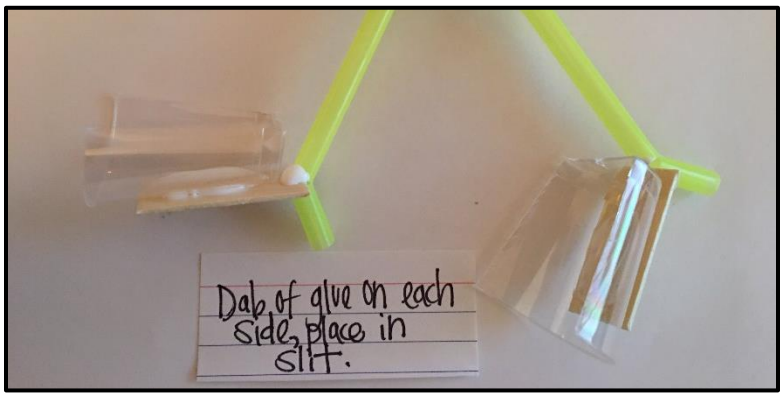


5. Provide an additional straw to each student. Take the full-length straw, cut in half and insert one end into the other side of the hub this will serve as a test fulcrum to spin the replica waters wheels and test whether they can hold water, sand, or another material of your choice. Add glue around the straw as well.

6. Assembly time, part two. Take the cut craft sticks rectangles and the cut half-cups and glue them together. Using hot glue or tacky blue, place a small line of glue onto the 1.5 wooden pieces and place the cup on top with the curved bottom glued to the wood. Ensure that you leave space on one end so that the wood pieces can be attached to the straws later on. Let dry for about 30 minutes.



7. <u>Assembly time, part three.</u> Take the hot glue or tacky glue and open up the slits like a mouth, placing a dab of glue in each one, one at the time. Next, grab the one-inch cut craft sticks (that have the half-cups glued to them) and place them into the slits closing the straw to hold the wood in place. Do this for the next five spokes also.



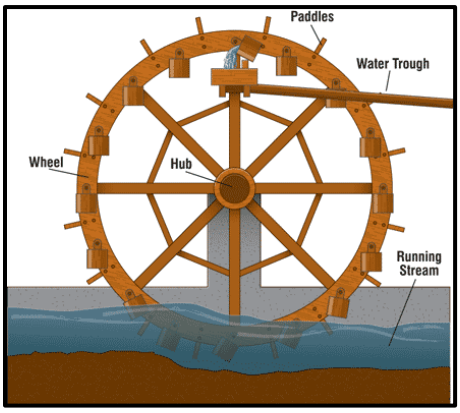
8. Leave the wheel to dry overnight placing in a warm, dry location.

9. When ready, fill a medium sized plastic container with water or sand and have the students test to see how much water or sand their model can hold. Have them make note of when the sand or water falls out. What improvements would they make to their models? Why?

Student Content

What do Water Wheels look like?

Water wheels are made in the shape of a wheel and have been around for over 2000 years. Water wheels have allowed humans to do more and different kinds of tasks. From grinding grain, to irrigating crops, and more. Water wheels have specific parts that help them function for the purposes that we need. Use the picture below to see all the different parts that make up a water wheel. Later on you will have an opportunity to build your own smaller size versions of a water wheel. After your smaller models are built, you will have an opportunity to try them out.



Understanding Water Wheels

Water wheels were built for many reasons. Some water wheels were built to make electricity. Other types of water wheels were built to send water to nearby crops where food was grown. At Jarvie Ranch, a water wheel was used and built in the nearby Green River. Look at the pictures below to see the different types of water wheels that exist today.

		
Modern water wheel that generates electricity	**Traditional water wheel used for irrigation**	**Double water wheel used to irrigate gardens in the country of Syria**

Below, you will see a replica of the original water wheel used at the ranch. Notice the blades or buckets that are inside the frame of the water wheel. This type of water wheel is called an undershot water wheel. It's called undershot because the water from the river moves under the wheel. Water flowing under the wheel then fills buckets that move to the top and drop ater into a flume. As the flume fills with water it flows to an irrigation ditch that connects to the food

garden. People at Jarvie Ranch were able to irrigate the food they were growing in the garden. This is all thanks to the water wheel.

		
The sign at the water wheel site at Jarvie Ranch	**The water wheel replica of original at Jarvie Ranch**	**The irrigation channel at Jarvie Ranch**

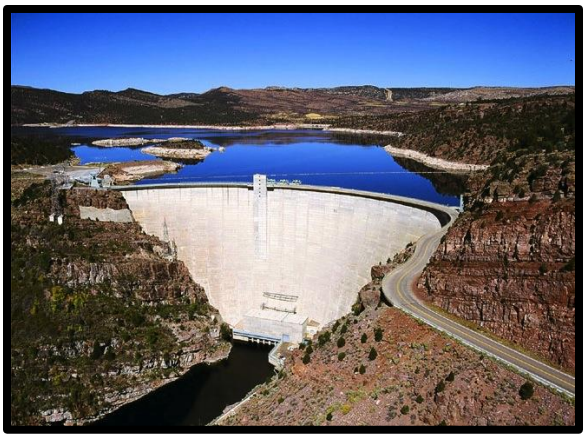
Understanding Water Wheels

Congratulations on learning a little bit about the water wheel. You are going to have a chance to build your own water wheel now. You will be given materials to use. These materials include items such as: glue, craft sticks, straws, and plastic cups. Your job is to be creative. Use the pictures of the water wheel given to you by your teacher to build your own version. Your teacher may also choose to help you build one also. There are no right or wrong ways to build your water wheel. There is a goal, though. Your goal is to build a water wheel (similar to those you see in the pictures) that is able to move.

Jarvie Ranch Visit Extension

1. ***Understanding Hydroelectric Power:*** being onsite at the Jarvie Ranch and interacting directly with the Green River is a great way to get students to think about how moving water helps us to generate electricity for our homes, cities, and towns. There are three main ideas that can be explored with students. First, is that hydropower is generated from moving water. Second, hydropower is a mostly renewable energy source. Third, that the moving water is a form of energy that we can use to generate electricity. Use the video on 'How Reservoirs Work' in the additional resources section of this lesson to introduce students to the concept.

   Located upstream from the Jarvie Ranch is the Flaming Gorge Reservoir (pictured below). Depending on your travel plans, driving over the reservoir and stopped for a quick self-guided tour is a great way to expand the curiosity and learning opportunities for the students. However, even if you only visit the ranch below are some guiding questions that you can have students explore while there to get them thinking about how hydroelectric power works.



   a. *Have students work in teams of two or three and experiment with the movement of the water in the Green River by doing the following:*

      i. *Have students locate various objects (e.g., naturally occurring such as leaves, grass stems, rocks, etc.). Have make hypotheses about whether or not there is enough movement (force) in the water to transport an object downstream. Students can find the objects and before testing them, write down their hypotheses on small pieces of paper or index cards.*

      ii. *Have the students make a blueprint or plan for a reservoir at Jarvie Ranch. They can use paper and pencil to sketch their plan and to imagine what would need to be changed in order for the river (at this location) to hold a reservoir. Is it ideal? What would be needed?*

Lesson Assessment: Exit Tickets

Exit Tickets for Student Engagement & Self-reflection

The sample exit ticket below emphasizes general assessment of how the students experienced the lessons and then some self-reflection questions. Reponses to the questions in this exit ticket can help the teacher gather data to improve lesson delivery in the future.

Jarvie Ranch – Architecture Exit Ticket	
Question	**Response**
What was most confusing for you?	
I need more practice with…	
What did you learn from the lesson today?	
What is one question you still have after the lesson today?	
Write a text message summary of today's lesson.	
How do you feel about your work today?	
What helped you understand the lesson today?	
How hard did you work today?	

Other Resources

Video of the different types of water wheels or water machines from ancient times: https://youtu.be/SetXqEsrvk4

Brief history of the water wheel: https://www.thoughtco.com/history-of-waterwheel-4077881

Technological History of water wheel: http://www.waterhistory.org/histories/waterwheels/

Uses of the water wheel: https://sciencing.com/water-mills-used-8153312.html

Poncelet Water Wheel to generate Electricity: https://youtu.be/TkpRI8YWhPc

Earth Buddies Overview of Water Wheels: https://earthbuddies.net/water-wheels-changed-whole-villages/

How reservoirs or dams work: https://www.youtube.com/watch?v=ztM6tL6LtFs

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