Water Transportation

Next Generation Science Standards (NGSS)
and the Common Core State Standards (CCSS)

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NGSS Performance Expectations(s)		
HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **HS-PS3-2**. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). **HS-ETS1-1**. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2**. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3**. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.		
Background Information		
The following lessons have been developed by a committee of STEM teachers at GUHSD with funding from a NSF grant awarded to the Center for Water Studies at Cuyamaca College. Other lessons for Space & Earth Sciences, Chemistry and more are available at cws.careers.		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to	**PS3.A: Definitions of Energy** ● Energy is a quantitative property of a system that depends on the motion and	**Systems and System Models** ● Models can be used to predict the

using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ● Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) **Asking Questions and Defining Problems** Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. ● Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. ● Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (HS-ETS1-2) ● Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (HS-ETS1-3)	interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1),(HS-PS3-2) ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) ● These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer** ● Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) ● Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) ● Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) ● The availability of energy limits what can occur in any system. (HS-PS3-1) **ETS1.A: Defining and Delimiting Engineering Problems** ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) ● Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1) **Energy and Matter** ● Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1) **Influence of Science, Engineering, and Technology on Society and the Natural World** ● New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

Instructional Sequence 1	
Performance Expectation(s)	
Concepts from: ➢ ***Evidence Statements*** ➢ ***Clarification Statements***	•
3 Dimensions of Focus	**SEP**: **CCC**: **DCI**:
Guiding Question(s)	Where does your water come from and how does it get to you?
Guiding Phenomenon	

5E Stage (Time Frame)	**Driving Question(s)**	**What the Teacher Does**	**What the Student Does**
Engage: 20-30 min	What are barriers to water transportation and access?	Show one of the following videos: • Water Changes Everything • The Wait for Water	Make observations and discuss the video in small groups and as a class. Class brainstorm - what are the barriers to water transportation and access?
Explore: 30 min	(same)	How Hard Can It Be to Carry Water? Activity	Complete the activity and consider how their experience is similar to individuals in the Engage video.

Explain: 50 min	(same)	What are the barriers to global water access and transportation? • UN Global Issues - Water • The Global Water Crisis • Water and Development • Access to clean water and sanitation around the world - map	In a group of 4, each student is assigned one of the resources. Students review and make observations from their resource. Students share and discuss their resource, followed by developing questions they would like to explore further based on the information found in each resource.
Explore: 80-120 min	What is the water supply in CA?	Hand out or share links to the CA Rainfall vs. Populations Map and the CA Water Supply and Storage Map. High Adventure Science Water Transport Lesson	Students make observations of the maps and compare water supply and population density in CA. Complete the Will There Be Enough Freshwater? Lesson.
Explain: 30-50 min	Where does CA water come from?	Hand out the Where does CA Water Come From? document. Have students consider where their (home or school) water comes from and create a schematic to show each link.	Read and discuss the document in groups. Students create a similar model/schematic to show where their water comes from - similar page 12 of resource document.
Explore: 120-180 min	Where does CA water come from?	Transporting Water - A jigsaw activity exploring six main systems of aqueducts and infrastructure that redistribute and transport water in California.	Groups research and create presentation on the system and how the system distributes/transports water to CA.
Explore: 30-60 min	How does water behave?	Have students design and conduct Siphon Exploration.	Provide students with materials to build a siphon. Complete the activity and make observations about water property and transportation based on the results.
Explore: 30-60 min	How does water behave?	Have students complete Siphon Data Collection Activity	Introduce the siphon simulation. Students will be asked to collect quantitative data to support a claim using the Siphon Data Collection Activity

Elaborate Varies	How can people solve these barriers to water access?	*Elaborate activities to consider:* Have students design a simple water carrying device from recycled materials capable of making a set number of trips (5 for example) that will be able to transport enough water (2 L for example) for a family to survive for a day. Organize a guest speaker to speak about water career options or a field trip to Cuyamaca Water Studies Program. Consider participation in local 6k for Water event.	
Evaluate Varies		Build a water distribution system from one area to another. The following documents can be provided as a resource: • Water distribution systems introduction • Water Distribution Systems • Water Distribution System Challenges	In a crisis situation where your water becomes unavailable for a long-term period, how would you access a safe, reliable water source at your school and home? Design and present a solution. Identify and map water sources on campus. Develop a conservation plan.