Project WET: A Drop in the Bucket

** Gray shaded areas demonstrate additional connections that can be made/strengthened with a few minor additions and/or restructuring of activity.*
** Blue text represents the Extension section of the activity.*

Grade: MS	**Earth and Human Activity**	**Project WET Guide, Page #:** Guide 2.0, p. 257
Brief Lesson Description: By estimating and calculating the percentage of available fresh water on Earth, students understand that this resource must be used and managed carefully.		
Performance Expectation: MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.		

Science & Engineering Practice(s)	Disciplinary Core Idea(s)	Crosscutting Concept(s)
Engaging in Argument from Evidence Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **(MS-ESS3-4)** • *Students read U.S. Geological Survey report 'Estimated Use of Water in the United States in 2010' and analyze how water is used in the United States.* • *Students identify areas of the globe where water is limited, plentiful or in excess and discuss the geographical and climatic qualities contributing to these conditions. (Extension)* • *Students do an Internet search to determine the world population projections for 2025 and 2050 and discuss the impact that this growth will cause and possible solutions. (Extension)* • *Students do an Internet search to determine the world population projections for 2025 and 2050 and calculate the impact that this growth will cause and possible solutions.* • *Students develop a television commercial or other presentation outlining reasons why water is a limited and also renewable resource (Wrap-Up).* • *Students investigate and share knowledge of technologies to protect and supply fresh water.*	**ESS3.C: Human Impacts on Earth Systems** Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. **(MS-ESS3-4)** • *Students determine and graph the proportion of Earth's available fresh water (Warm Up and Wrap Up).* • *Students calculate and graph the volume of water available for human use (step 5).* • *Students identify areas of the globe where water is limited, plentiful or in excess and discuss the geographical and climatic qualities contributing to these conditions. (Extension)* • *Students do an Internet search to determine the world population projections for 2025 and 2050 and discuss the impact that this growth will cause and possible solutions. (Extension)* • *Students investigate and share knowledge of technologies to protect and supply fresh water.*	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. **(MS-ESS3-4)** • *Students calculate and graph the volume of water available for human use (step 5).* • *Students read U.S. Geological Survey report 'Estimated Use of Water in the United States in 2010' and analyze how water is used in the United States.* • *Students identify areas of the globe where water is limited, plentiful or in excess and discuss the geographical and climatic qualities contributing to these conditions. (Extension)* • *Students do an Internet search to determine the world population projections for 2025 and 2050 and discuss the impact that this growth will cause and possible solutions. (Extension)* ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. **(MS-ESS3-4)** • *Students determine and graph the proportion of Earth's available fresh water (Warm-Up and Wrap-Up).* • *Students read U.S. Geological Survey report 'Estimated Use of Water in the United States in 2010' and analyze how water is used in the United States.* • *Students calculate and graph the volume of water available for human use (step 5).* • *Students identify areas of the globe where water is limited, plentiful or in excess and discuss the geographical and climatic qualities contributing to these conditions. (Extension)* • *Students investigate and share knowledge of technologies to protect and supply fresh water.* ---

		Connections to Nature of Science **Science Addresses Questions About the Natural and Material World** Science knowledge can describe consequences of actions but does not necessarily prescribe the decisions that society takes. **(MS-ESS3-4)** • *Students calculate and graph the volume of water available for human use (step 5).* • *Students read U.S. Geological Survey report 'Estimated Use of Water in the United States in 2010' and analyze how water is used in the United States.* • *Students identify areas of the globe where water is limited, plentiful or in excess and discuss the geographical and climatic qualities contributing to these conditions. (Extension)* • *Students do an Internet search to determine the world population projections for 2025 and 2050 and discuss the impact that this growth will cause and possible solutions. (Extension)*

NGSS Common Core Connections:
ELA/Literacy –
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-4)
WHST.6-8.1 Write arguments focused on discipline content. (MS-ESS3-4)
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-4)
Mathematics –
6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-4)
7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS3-4)

Connections to other Common Core Standards at this Grade Level: SL.6-8.4, 6.RP.3c; 7.NS.3; 7.RP.2

Additional SEP Connections: Grades 6-8	

Asking questions (for science) and defining problems (for engineering)	Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
	• Ask questions
	  • that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
	  • to identify and/or clarify evidence and/or the premise(s) of an argument.
	  • to clarify and/or refine a model, an explanation, or an engineering problem.
	  • that require sufficient and appropriate empirical evidence to answer.
	  • that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
	  • that challenge the premise(s) of an argument or the interpretation of a data set.

Developing and using models	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. • Use and/or develop a model of simple systems with uncertain and less predictable factors. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena.
Planning and carrying out investigations	Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. • Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. • Collect data about the performance of a proposed object, tool, process or system under a range of conditions.

Analyzing and interpreting data	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. • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. • Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. • Distinguish between causal and correlational relationships in data. • Analyze and interpret data to provide evidence for phenomena.
Using mathematics and computational thinking	Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. • Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. • Use mathematical representations to describe and/or support scientific conclusions and design solutions. • Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.
Constructing explanations (for science) and designing solutions (for engineering)	Constructing explanations and designing solutions in 6–8 builds on K– 5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. • Construct an explanation using models or representations. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. • Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.
Engaging in argument from evidence	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(s). • Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. • Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Additional Crosscutting Concepts by Grade Level 6-8	
Patterns	Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.
Cause and Effect	Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.
Scale, Proportion, and Quantity	Students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. They represent scientific relationships through the use of algebraic expressions and equations.
Systems and System Models	Students can understand that systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. They can use models to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. They can also learn that models are limited in that they only represent certain aspects of the system under study.
Stability and Change	Students explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale. Students learn changes in one part of a system might cause large changes in another part, systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time.

Correlation Comments	**Correlator Initials:** DBB

A Drop in the Bucket correlates to most dimensions of the MS NGSS Performance Expectation MS-ESS3-4 *as written*, but not to most of the connecting CCSS. Correlations to the CCSS *could* be made and all NGSS correlations enhanced if modifications in grey are made. Gray areas suggest revising activity lay-out:

Warm-up – Keep as is with students estimating proportion of potable water on Earth.

Part I: Water on Planet Earth would have students doing the current activity, but would also include reading the latest version of the USGS Fact Sheet *'Estimated Use of Water in the United States'* and analyzing how water is used in different parts of the United States. This is loosely referenced in the current activity extensions, but works so well as part of the activity!

Part II: Global Water Distribution would have students start by trying to estimate the volume of potable water available on Earth per person – This has great math potential, if students are asked to explain how they arrived at their estimates based on the available information in the activity to this point. Students would do the latter part of the existing activity as written – It just changes the emphasis from Earth to human allocations and opens the door to having students research and identify areas of the globe where water is in short supply. This is currently an extension, but would add greatly to the depth of knowledge gained by integrating it into the activity.

Part III: ActionEducation would incorporate other currently listed extensions into the activity by having students do the research on projected worldwide population trends at different points in the future, then discussing and calculating the potential impacts to global water supplies available for human use – and the potential ramifications for all other life on the planet. Students would then develop the television commercial or other presentation outlining reasons why water is a limited and also renewable resource in the extensions.

I also suggest having students make an engineering connection by investigating and share knowledge of technologies to protect and supply fresh water either as part of the ActionEducation component or as a suggested extension.

A Drop in the Bucket also correlates to some aspects of the NGSS Performance Expectation MS-ESS3-3 - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* and doesn't connect at all with other dimensions, but with the suggested alignments in gray and revising of activity flow, I could see teachers using this activity as a Secondary support to investigate this PE and connecting Engineering PEs.