Unit Title: Water Resources and Pollution	**Content Area: Environmental** Science	**Grade Level:** 9-12

Unit Summary: This unit begins with an exploration of water distribution and usage globally, nationally and locally. Students will study what happens when demand for water exceeds supply by examining The Colorado River Story, and applying what they have learned to their own watershed. Students will learn about how water quality is evaluated through physical, chemical and biological tests. The mechanisms by which water is polluted will be explored, as well as the types of water pollution. Students will attempt to clean up a hypothetical sample of wastewater and distinguish between primary, secondary and tertiary water treatment. An alternative or additional laboratory investigation would be examining the effect of different quantities of nutrients on duckweed growth to simulate cultural eutrophication. Solutions to water quality issues and water overconsumption issues will be explored with an emphasis on prevention and conservation. In this unit, students will demonstrate a proficiency in the following science and engineering practices: asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions; and obtaining, evaluating, and communicating information.

Unit Essential Questions:

- How have human activities impacted the availability and quality of fresh water?
- How can adequate and safe water supplies be ensured for future use?

Unit Enduring Understandings:

- Our civilization depends upon drinkable water and its uneven distribution will cause future political tensions. Earth has a limited supply of fresh water that is available for human use, and this supply must be protected from overconsumption and physical and chemical contamination.
- The wastewater that is generated by society must be treated by a series of steps at municipal water treatment facilities in order to protect future water supplies and prevent ecosystem damage.

Possible Student Misconceptions: The amount of fresh water on Earth is more than 3%. Although water on Earth is plentiful, usable water is not plentiful. Even though water on Earth is recycled, humans do not have unlimited water resources, and the availability of these resources depends upon your geographic location. Increasing human consumption and degradation of existing supplies place severe stress on water resources, and the rate of depletion is often greater than the rate of recharge. There is a common misconception that most of the pollution in our water comes from industrial pipes dumping toxic wastes into water, but this point source pollution has largely been controlled by the Clean Water Act and other legislation. A large amount of pollution found in our waterways actually comes from nonpoint source pollution. There is a common misconception that water traveling into storm sewers ends up treated at the local wastewater treatment plant. Because of this misunderstanding, many citizens use storm drains and ditches as places to dispose of all kinds of pollutants. There is the misconception that water treatment removes all water contaminants from drinking water, or that bottled water is safer to drink than tap water.

NJCCCS: 5.1.12.A.1-A.3, 5.1.12.B.1-B.4, 5.1.12.C.1-C.3, 5.1.12.D.1-D.3, 5.3.12.B.4-B.5, 5.3.12.C.1-C.2, 5.4.12.C.1, 5.4.12.F.3, 5.4.12.G.1-G.7

NGSS Performance Expectations: *Students who demonstrate understanding can…*

- HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- 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.

Primary CCSS ELA/Literacy Connections:

RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-8)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

Primary CCSS Mathematics Connections:

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-6)

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7)

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8) WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1),(HS-LS2-2) WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS4-6) WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7), (HS-LS4-6) RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)	HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

Lesson Pace & Sequence

Lesson Title/Number: Making a Model of Earth's Water/Lesson 1	**Learning Objective(s):** Describe the distribution of water resources on a global, national, state and local level.	**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Water Distribution on the Earth - Taking Notes from Different Graphics	• Water Distribution on the Earth - Taking Notes from Different Graphics: http://www.buncombe.k12.nc.us/cms/lib5/NC01000308/Centricity/Domain/3030/Water_Distribution_on_the_Earth.ppt • Freshwater Availability Classroom Activity: http://pmm.nasa.gov/education/lesson-plans/freshwater-availability-classroom-activity	Asking Questions and Defining Problems, Developing and Using Models, Using Mathematics and Computation Thinking	ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources	Systems and System Models
Engage: How will you capture	Describe how you would feel if	• Toxic Ohio tap water	Asking Questions and Defining	LS2A: Interdependent	Cause and Effect: Mechanism

students' interest and get students' minds focused on the concept/topic?	you woke up one morning and you were told that you could not drink the water coming out of the tap, because the water would make you sick. What questions would you have about the situation?	tested as 500,000 residents wait: http://www.latimes.com/nation/nationnow/la-na-nn-toledo-ohio-toxins-water-20140802-story.html#page=1	Problems	Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources	and Explanation
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Making a Model of Earth's Water	• Distribution of Earth's Water: http://www.agiweb.org/education/energy/hydro/act1.html	Developing and Using Models; Using Mathematics and Computational Thinking	ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources	Systems and System Models
Explain: How will you help students connect their exploration to the concept/topic under investigation?		• Text Chapter 11 Water pp. 289-290			
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Videotape Section 1, Reading Sections 1-3; Students generate questions from the videotape/readings.	• The Habitable Planet: Water Resources: http://www.learner.org/courses/envsci/unit/text.php?unit=8&secNum=0	Asking Questions and Defining Problems	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	post quiz			LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation
Extend: How will students deepen their conceptual understanding through use in new context?	Scientific American Article - The Coming Mega Drought:	• Baked Australia Water Management Lessons: http://www.scientificamerican.com/article/australia-water-management/ • Scientific American Article - The Coming Mega Drought: http://www.scientificameric	Obtaining, Evaluating, and Communicating Information; Constructing Explanations and Designing Solutions	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation

		an.com/article/the-coming-mega-drought/			
Lesson Pace & Sequence					
Lesson Title/Number: The Balance of the Supply and Demand for Fresh Water/Lesson 2		**Learning Objective(s):** Interpret water use data at the national, state, and local levels. Analyze water usage patterns over time, comparing consumption levels with local precipitation.			**Lesson Duration:** 240 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Provide students with a water cycle diagram to complete, as well as accompanying questions.	• The Water Cycle: http://water.usgs.gov/edu/watercycle.html • Unlabeled Water Cycle Diagrams: http://water.usgs.gov/edu/watercycleprintnotext.html	Developing and Using Models	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Water Footprint Calculator	• Water Footprint Calculator: http://environment.nationalgeographic.com/environment/freshwater/change-the-course/water-footprint-calculator/ • Freshwater Usage Quiz: http://environment.nationalgeographic.com/environment/freshwater/freshwater-101-quiz/	Using Mathematics and Computational Thinking	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Scale, Proportion and Quantity
Explore: What hands-on/minds-on common experience(s) will you provide for students?	The Colorado River Story	• The Colorado River: http://www.esrl.noaa.gov/gsd/outreach/education/Colorado-River-lesson.pdf	Using Mathematics and Computational Thinking; Analyzing and Interpreting Data	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale Proportion and Quantity; Systems and System Models
Explain: How will you help students connect their exploration to the concept/topic under	Why are fresh water resources being depleted?	• Why are fresh water resources being depleted?: http://education-	Obtaining, Evaluating, and Communicating Information	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience,	Cause and Effect: Mechanism and Explanation; Scale Proportion and Quantity

investigation?		portal.com/academy/lesson/aquifer-depletion-and-overdrawing-of-surface-waters-affects-on-water-resources.html#lesson • Groundwater depletion: http://water.usgs.gov/edu/gwdepletion.html		ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can research Newark's watershed (Hackensack-Passaic Watershed -- 02030103) and the watershed that supplies Newark with fresh water (Pequannock Watershed).	• Surf Your Watershed: http://cfpub.epa.gov/surf/locate/index.cfm	Obtaining, Evaluating, and Communicating Information	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Patterns, Cause and Effect: Mechanism and Explanation
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Activity Responses			LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	
Extend: How will students deepen their conceptual understanding through use in new context?	California Drought May Have to Migrate People	• California Drought May Have to Migrate People: http://www.unz.com/isteve/cnbc-california-drought-may-have-to-migrate-people/ • World Water Day: The US is running out of fresh water: http://www.washingtonpost.com/blogs/capital-weather-gang/wp/2013/03/22/world-water-day-a-forceful-reminder-that-the-u-s-is-running-out-of-fresh-water/	Obtaining, Evaluating, and Communicating Information	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale Proportion and Quantity

Lesson Pace & Sequence

Lesson Title/Number: Determining Water Quality/Lesson 3	**Learning Objective(s):** Describe the water tests that determine the Water Quality Index of a local body of water. Perform laboratory tests to measure water quality and interpret the data that is collected. Describe how water quality is protected.	**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	What water quality tests are routinely performed on tap water to make sure it is safe to drink? Provide students with a concept map to complete.	• Pequannock and Wanaque Water Systems Annual Water Quality Report: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.ci.newark.nj.us%2Fuserimages%2Fdownloads%2F2013WaterQuality2014CCR.pdf&ei=spbeU8neNfjNsQSDsIKgDA&usg=AFQjCNEW90yvU8Q3ZZouuroiyTNBWxWGnA&sig2=V3ro_skmfJNGLvh25xTZ0Q&bvm=bv.72197243,d.cWc	Obtaining, Evaluating and Communicating Information	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Obtain a water sample or samples from a local body of water, such as the Passaic River or Branch Brook Park.	• Article Discussion: Ex-top official of East Orange water agency admits concealing chemical in drinking water: http://www.nj.com/news/index.ssf/2014/07/ex-top_official_of_east_orange_water_agency_admits_hiding_chemical_in_drinking_water.html	Obtaining, Evaluating and Communicating Information	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Water Testing Laboratory	• Water Testing Laboratory: http://www.pathfinderscience.net/stream/cproto4.cfm • Carolina Exploring the Quality of Natural Waters Kit: http://www.egansciencecla sses.org/APES%20Natural%20Waters%20Kit_2010.pdf	Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Using Mathematics and Computational Thinking	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Mini lesson	• Introduction to Water Testing: http://www.teachengineering.org/view_lesson.php?url=collection/wst_/lessons/wst_environmental/wst_environmental_lesson02.xml#intro	Obtaining, Evaluating and Communicating Information	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can generate questions about the effects of fertilizer runoff on nitrogen and phosphorous levels in water, including the cause of toxic algal blooms in Ohio.	• Harmful Algal Blooms: http://www.glerl.noaa.gov/res/waterQuality/	Asking Questions and Defining Problems	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience, ESS2.C: The Roles of Water in Earth's Surface Processes, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Patterns, Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Laboratory Report		Obtaining, Evaluation and Communicating Information	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity
Extend: How will students deepen their conceptual understanding through use in new context?	Students can research and generate questions about prescription drugs that are present in tap water.	• Drugs in Our Drinking Water?: http://www.webmd.com/a-to-z-guides/features/drugs-in-our-drinking-water	Asking Questions and Defining Problems	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation; Scale, Proportion and Quantity

Lesson Pace & Sequence

Lesson Title/Number: Wastewater Treatment/Lesson 4	**Learning Objective(s):** Describe and explain the major steps in the process of wastewater treatment.	**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	How is wastewater treated? What would be the result of not treating wastewater? Provide students with a concept map to record their responses.	• Water Resource Recovery Facility: https://www.youtube.com/watch?v=A2FmNrEmowE		ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Create a simulation of wastewater with the class; include food coloring, soil, garlic powder, etc...	• You can create a story about the wastewater sample that is generated by the class or teacher.: http://www.msp.umb.edu/dirtied_water.html	Developing and Using Models	ESS3.C: Human Impacts on Earth Systems	Systems and System Models
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Wastewater Treatment Laboratory	• Wastewater Treatment Laboratory: http://iws.collin.edu/bburkett/Lab%2011%20-%20Exercise%20-%20Wastewater%20Treatment.pdf • Carolina Wastewater Treatment Kit: http://tyang-web.cuhsd.org/apes/Ch%2020%20Water%20Pollution/Waste+Water+T+Lab.pdf	Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Developing and Using Models, Using Mathematics and Computational Thinking	LS2B: Cycles of Matter and Energy Transfer in Ecosystems, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Systems and System Models
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Mini lesson: Primary, Secondary and Tertiary Wastewater Treatment.	• Water Treatment Interactive: http://water.epa.gov/learn/kids/drinkingwater/watertreatmentplant_index.cfm	Developing and Using Models	LS2B: Cycles of Matter and Energy Transfer in Ecosystems, ESSC3.A: Natural Resources,LS2B: Cycles of Matter and Energy Transfer in Ecosystems, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Systems and System Models

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can be given a list of materials and they must design a procedure to clean the water sample.	• Test and Treat Before You Drink: http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_waterqtnew/cub_waterqtnew_lesson01.xml	Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Developing and Using Models, Using Mathematics and Computational Thinking	ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions, ETS1.C: Optimizing the Design Solution, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Systems and System Models
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Laboratory Report		Obtaining, Evaluating and Communicating Information	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Systems and System Models
Extend: How will students deepen their conceptual understanding through use in new context?	Students can compare and contrast drinking water treatment with wastewater treatment; Students can research how nature/wetlands can be used to treat our wastewater; students can research how wastewater can be used for drinking water.		Obtaining, Evaluating and Communicating Information	ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions, Solution LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models

Lesson Pace & Sequence

Lesson Title/Number: Cultural Eutrophication/Lesson 5		**Learning Objective(s):** Describe the consequences of the addition of nutrients or wastewater to bodies of fresh water.			**Lesson Duration:**
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***

Elicit: How will you access students' prior knowledge?	Show students images of eutrophic and oligotrophic bodies of water. Compare and contrast the bodies of water and provide possible explanations for the differences. Students generate questions about the different images that are provided.		Asking Questions and Defining Problems	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Article about the Dead zone in the Gulf of Mexico	• The Gulf of Mexico Dead Zone: http://serc.carleton.edu/microbelife/topics/deadzone/index.html	Asking Questions and Defining Problems	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Laboratory: The Effect of Different Environmental Factors on the Population Growth of Lemna minor or Duckweed; The class can be divided into groups of 3-4 students and each group can be assigned a different environmental factor. Duckweed can be collected from the surface of ponds or can be ordered from a biological supply company.	• Carolina Population Growth in Lemna minor kit: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=9&cad=rja&uact=8&ved=0CEIQFjAI&url=http%3A%2F%2Fwww.srvhs.org%2FStaff%2Fteachers%2FCLegan%2FAPES%2FAPES%2520Lemna%2520minor%2520Kit.pdf&ei=no_eU66LGvPgsAS0olHoBQ&usg=AFQjCNFhqR_20Mn0EuL7EuIPkteEql4-Ew&sig2=ScK-APO9inPl1ZwxZYzh4w&bvm=bv.72197243,d.cWc	Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Developing and Using Models, Using Mathematics and Computational Thinking	LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Patterns, Cause and Effect: Mechanism and Explanation, Systems and System Models
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Mini lesson: How does the addition of sewage to fresh water affect BOD (Biological Oxygen demand) and DO (Dissolved Oxygen)?		Analyzing and Interpreting Data, Using Mathematics and Computational Thinking	LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation

Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Laboratory Report		Analyzing and Interpreting Data, Developing and Using Models, Using Mathematics and Computational Thinking	LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Patterns, Cause and Effect: Mechanism and Explanation, Systems and System Models
Extend: How will students deepen their conceptual understanding through use in new context?	By creating eco-columns, students can examine the impact of the addition of fertilizer to the terrestrial portion of the eco-column, as well as the interrelatedness with the aquatic portion of the eco-column.	• Eco-Column Laboratory: http://teachingrealscience.com/2013/02/07/eco-column-lab/	Developing and Using Models	LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models

Lesson Pace & Sequence

Lesson Title/Number: The Global Water Crisis/Lesson 6		**Learning Objective(s):** Students can describe how water quality can be protected and conservation methods to ensure a sustainable supply for personal, agricultural and industrial use.			**Lesson Duration:** 80-120 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Pre-quiz	• Quiz World Water Crisis: http://news.bbc.co.uk/2/hi/science/nature/3747588.stm		ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Patterns, Cause and Effect: Mechanism and Explanation
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students generate questions from watching the video about the water conservation model in South Korea or other water conservation models in future sustainable cities, such as Masdar City.	• Cities of the Future, Songdo, South Korea - Water Conservation: https://www.youtube.com/watch?v=GHKTDOYfVy0	Asking Questions and Defining Problems, Developing and Using Models	ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions	System and System Models
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Divide the class into groups. Each group will be given a country to research regarding water crisis conditions and present their research to the class.	• Global Water Supply High School Curriculum: http://static.water.org/docs/curriculums/WaterOrg%20HighCurricFULL.pdf	Obtaining, Evaluating, and Communicating Information	ESSC3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems	Patterns, Cause and Effect: Mechanism and Explanation

Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Post quiz; activity chart responses				
Extend: How will students deepen their conceptual understanding through use in new context?	Discuss models of the water sustainable city of the future.	• Blue City The Water Sustainable City of the Near Future: http://www.blue-economy.ca/sites/default/files/BEI%20Blue%20City%20report_econics_final.pdf	Constructing Explanations and Designing Solutions, Developing and Using Models	ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions	Systems and System Models