

**PUBLIC SCHOOLS OF EDISON TOWNSHIP
OFFICE OF CURRICULUM AND INSTRUCTION**

Course Name: AP Environmental Science

Length of Course:	1 year
Elective/Required:	Elective
Schools:	High School
Eligibility:	Grades 11, 12
Credit Value: (High School Only)	7 Credits
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Statement of Purpose

The AP Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in environmental science. Unlike most other introductory-level college science courses, environmental science is offered from a wide variety of departments, including geology, biology, environmental studies, environmental science, chemistry, and geography. Depending on the department offering the course, different emphases are placed on various topics. Some courses are rigorous science courses that stress scientific principles and analysis and that often include a laboratory component; other courses emphasize the study of environmental issues from a sociological or political perspective rather than a scientific one. The AP Environmental Science course has been developed to be most like the former; as such, it is intended to enable students to undertake, as first-year college students, a more advanced study of topics in environmental science or, alternatively, to fulfill a basic requirement for a laboratory science and thus free time for taking other courses.

The AP Course Description and AP Exam have been prepared by environmental scientists and educators who serve as members of the AP Environmental Science Development Committee. In both breadth and level of detail, the content of the course reflects what is found in many introductory college courses in environmental science. The exam is representative of such a course and therefore is considered appropriate for the measurement of skills and knowledge in the field of environmental science.

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Course Objectives

The goal of the AP Environmental Science course is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving or preventing them. Environmental science is interdisciplinary; it embraces a wide variety of topics from different areas of study. Yet there are several major unifying constructs, or themes, that cut across the many topics included in the study of environmental science.

The following themes provide a foundation for the structure of the AP Environmental Science course.

1. Science is a process.
 - a. Science is a method of learning more about the world.
 - b. Science constantly changes the way we understand the world.

2. Energy conversions underlie all ecological processes.
 - a. Energy cannot be created; it must come from somewhere.
 - b. As energy flows through systems, at each step more of it becomes unusable.

3. The Earth itself is one interconnected system.
 - a. Natural systems change over time and space.
 - b. Biogeochemical systems vary in ability to recover from disturbances.

4. Humans alter natural systems.
 - a. Humans have had an impact on the environment for millions of years.
 - b. Technology and population growth have enabled humans to increase both the rate and scale of their impact on the environment.

5. Environmental problems have a cultural and social context.
 - a. Understanding the role of cultural, social, and economic factors is vital to the development of solutions.

6. Human survival depends on developing practices that will achieve sustainable systems.
 - a. A suitable combination of conservation and development is required.
 - b. Management of common resources is essential.

Topic Outline

The following outline of major topics serves to describe the scope of the AP Environmental Science course and exam. The order of topics in the outline holds no special significance, since there are many different sequences in which the topics can be appropriately addressed in the course. The percentage after each major topic heading shows the approximate proportion of multiple-choice questions on the exam that pertain to that heading; thus, the percentage also indicates the relative emphasis that should be placed on the topics in the course.

I. Earth Systems and Resources (10–15%)

- A. Earth Science Concepts (Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)
- B. The Atmosphere (Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere–ocean interactions; ENSO)
- C. Global Water Resources and Use (Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)
- D. Soil and Soil Dynamics (Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

II. The Living World (10–15%)

- A. Ecosystem Structure (Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)
- B. Energy Flow (Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)
- C. Ecosystem Diversity (Biodiversity; natural selection; evolution; ecosystem services)
- D. Natural Ecosystem Change (Climate shifts; species movement; ecological succession)
- E. Natural Biogeochemical Cycles (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

III. Population (10–15%)

- A. Population Biology Concepts (Population ecology; carrying capacity; reproductive strategies; survivorship)

B. Human Population

1. Human population dynamics (Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)
2. Population size (Strategies for sustainability; case studies; national policies)
3. Impacts of population growth (Hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use (10–15%)

A. Agriculture

1. Feeding a growing population (Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)
2. Controlling pests (Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

B. Forestry (Tree plantations; old growth forests; forest fires; forest management; national forests)

C. Rangelands (Overgrazing; deforestation; desertification; rangeland management; federal rangelands)

D. Other Land Use

1. Urban land development (Planned development; suburban sprawl; urbanization)
2. Transportation infrastructure (Federal highway system; canals and channels; roadless areas; ecosystem impacts)
3. Public and federal lands (Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
4. Land conservation options (Preservation; remediation; mitigation; restoration)
5. Sustainable land-use strategies

E. Mining (Mineral formation; extraction; global reserves; relevant laws and treaties).

F. Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

G. Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption (10–15%)

A. Energy Concepts (Energy forms; power; units; conversions; Laws of

Thermodynamics)

B. Energy Consumption

1. History (Industrial Revolution; exponential growth; energy crisis)
2. Present global energy use
3. Future energy needs

C. Fossil Fuel Resources and Use (Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synthetic fuels (synfuels); environmental advantages/ disadvantages of sources)

D. Nuclear Energy (Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)

E. Hydroelectric Power (Dams; flood control; salmon; silting; other impacts)

F. Energy Conservation (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)

G. Renewable Energy (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution (25–30%)

A. Pollution Types

1. Air pollution (Sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
2. Noise pollution (Sources; effects; control measures)
3. Water pollution (Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
4. Solid waste (Types; disposal; reduction)

B. Impacts on the Environment and Human Health

1. Hazards to human health (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
2. Hazardous chemicals in the environment (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts (Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. Global Change (10–15%)

- A. Stratospheric Ozone (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)
- B. Global Warming (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)
- C. Loss of Biodiversity
 - 1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
 - 2. Maintenance through conservation
 - 3. Relevant laws and treaties

Student Outcomes New Jersey Core Curriculum Standards

5.1 Science Practices: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

5.2 Physical Science: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

5.3 Life Science: All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

Common Core State Standards for Literacy in Science and Technical Subjects (Grades 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.
2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
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.
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.

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.
10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently.

Student Outcomes New Jersey Student Learning Standards (NJSLs)/NGSS

Science, engineering, and technology influence and permeate every aspect of modern life. Some knowledge of science and engineering is required to engage with the major public policy issues of today as well as to make informed everyday decisions, such as selecting among alternative medical treatments or determining how to invest public funds for water supply options. In addition, understanding science and the extraordinary insights it has produced can be meaningful and relevant on a personal level, opening new worlds to explore and offering lifelong opportunities for enriching people's lives. In these contexts, learning science is important for everyone, even those who eventually choose careers in fields other than science or engineering.

Mission: *Scientifically literate individuals possess the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity.*

Vision: These science standards are designed to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields. The learning experiences provided for students should engage them with fundamental questions about the world and with how scientists have investigated and found answers to those questions. Throughout grades K-12, students should have the opportunity to carry out scientific investigations and engineering design projects related to the disciplinary core ideas (pp. 8-9, NRC, 2012).

Five Innovations in the NJSLs Standards

1. **Three Dimensional Learning:** There are three equally important, distinct dimensions to learning science included in the New Jersey Student Learning Standards for Science (NJSLSS): Scientific and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The NJSLs-S connect all three dimensions. To prepare students for success in college and 21st century careers, the NJSLs-S also connect scientific principles to real-world situations, allowing for more engaging and relevant instruction to explore complicated topics.
2. **All three dimensions build coherent learning progressions:** The NJSLs-S provide students with continued opportunities to engage in and develop a deeper understanding of each of the three dimensions of science. Building on the knowledge and skills gained from each grade—from elementary through high school—students have multiple opportunities to revisit and expand their understanding of all three dimensions by the end of high school.
3. **Students engage with phenomena and design solutions:** In instructional systems aligned to the NJSLs-S, the goal of instruction is for students to be able to explain real-world phenomena and to design solutions using their understanding of the Disciplinary Core

Ideas. Students can achieve this goal by engaging in the Science and Engineering Practices and applying the Crosscutting Concepts.

4. Engineering and the Nature of Science is integrated into science: Some unique aspects of engineering (e.g., identifying problems) are incorporated throughout the NJSL-S. In addition, unique aspects of the nature of science (e.g., how theories are developed) are also included throughout the NJSL-S as practices and crosscutting concepts.

Science is connected to math and literacy: The NJSL-S not only provide for coherence in science instruction and learning but the standards also connect science with mathematics and English Language Arts. This meaningful and substantive overlapping of skills and knowledge affords all students equitable access to the learning standards.

Unit One: Earth Systems and Resources (10–15%)

Essential Questions: How do people reconstruct and date events in Earth’s planetary history?
 Earth scientists use the structure, sequence, and properties of rocks, sediments, and fossils, as well as locations of current and past ocean basins, lakes, and rivers, to reconstruct events in Earth’s planetary history.

NGSS Performance Expectations: (Students who demonstrate understanding can:)
HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history.
HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks
HS-ESS2-1 Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.
HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
 Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)	Instructional Actions			
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
ESS1.C: The History of Planet Earth (pp. 177-179) <ul style="list-style-type: none"> Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5) 	<u>Developing and Using Models</u> (pp. 56-59) Students use, synthesize, and develop models to predict and show relationships among variables between systems and	Patterns (pp. 85-87) <ul style="list-style-type: none"> Empirical evidence is needed to identify patterns. (HS-ESS1-5) <u>Stability and Change</u> (pp. 98-101)	Math <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs 	Formative Assessments: Diagnostic pre- and post- assessments. Class Discussions

Unit One: Earth Systems and Resources (10–15%) - (cont.)

<p>• Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history. (HS-ESS1-6)</p> <p><u>ESS2.A: Earth Materials and Systems</u> (pp. 179-182)</p> <p>• Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), <i>(Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2.)</i></p> <p><u>ESS2.B: Plate Tectonics and Large-Scale System Interactions</u> (pp. 182-183)</p> <p>• Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s surface and provides a framework for understanding its geologic history. <i>(ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5),</i>(HS-ESS2-1) Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth’s crust. <i>(ESS2.B Grade 8 GBE)</i> (HS-ESS2-1)</p>	<p>their components in the natural and designed worlds.</p> <ul style="list-style-type: none"> • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1) <p><u>Constructing Explanations and Designing Solutions</u> (pp. 67-71) Students construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> • Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6) <p><u>Engaging in Argument from Evidence</u> (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</p>	<ul style="list-style-type: none"> • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6), (HS-ESS2-7) • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1) <p><u>Cause and Effect</u> (pp. 87-89)</p> <ul style="list-style-type: none"> • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-5) 	<p>History</p> <ul style="list-style-type: none"> • Environmental legislation and policy • Maps/Geography and topography <p>Engineering & STEM</p> <ul style="list-style-type: none"> • Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> • Probes • Discovery Tech Book • Student Mac books • Online simulations 	<p>Worksheets with teacher feedback Drafts of lab reports with teacher feedback.</p> <p>Summative Assessments: Quizzes Tests Performance Assessments /Laboratory Investigations Research / Lab Reports</p>
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Unit One: Earth Systems and Resources (10–15%) (cont.)

<p>ESS2.D: Weather and Climate (pp. 186-189)</p> <ul style="list-style-type: none"> • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7) <p>ESS2.E Biogeology (189-190)</p> <ul style="list-style-type: none"> • The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. (HS-ESS2-7) <p>PS1.C: Nuclear Processes (pp. 111-113)</p> <ul style="list-style-type: none"> • Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.(secondary to HS-ESS1-5),(secondary to HS-ESS1-6) <p>LS4.C: Adaptation (pp. 164-166)</p> <ul style="list-style-type: none"> • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5) • Species become extinct because they 	<ul style="list-style-type: none"> • Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5), (HS-ESS2-7), (HS-LS4-5) <p><i>Connections to Nature of Science</i></p> <p>Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</p> <ul style="list-style-type: none"> • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-6) • Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. 			
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Unit One: Earth Systems and Resources (10–15%) cont.

<p>can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p>				
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Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access.

Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces. Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions. Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion. Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms. : Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits.

Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface. *Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems*

Unit Two: The Living World (10–15%)

Essential Questions: How and why do organisms interact with their environment and what are the effects of these interactions?
 Ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment. Ecosystems are dynamic, experiencing shifts in population composition and abundance and changes in the physical environment over time, which ultimately affects the stability and resilience of the entire system.

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-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
 HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
 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-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
 Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)			Instructional Actions	
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
LS2.A: Interdependent Relationships in Ecosystems (pp. 150-152) <ul style="list-style-type: none"> Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, 	Using Mathematics and Computational Thinking (pp. 64-67) Students use algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical	Cause and Effect (pp. 87-89) <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8) 	Math <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs History <ul style="list-style-type: none"> Environmental legislation and policy 	Formative Assessments: Diagnostic pre- and post- assessments. Class Discussions Worksheets with teacher feedback Drafts of lab reports with teacher

Unit Two: The Living World (10–15%) cont.

<p>competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)</p> <p>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems (pp. 152-154)</p> <ul style="list-style-type: none"> Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) 	<p>analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none"> Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1) Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2) Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) <p>Constructing Explanations and Designing Solutions (pp. 67-71)</p> <p>Students construct explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) 	<p>Scale, Proportion, and Quantity (pp. 91-94)</p> <ul style="list-style-type: none"> The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) <p>Energy and Matter (pp. 94-96)</p> <ul style="list-style-type: none"> Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4) <p>Stability and Change (pp. 98-101)</p> <ul style="list-style-type: none"> Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7) 	<ul style="list-style-type: none"> Maps/Geography and topography <p>Engineering & STEM</p> <ul style="list-style-type: none"> Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> Probes Discovery Tech Book Student Mac books Online simulations 	<p>Feedback.</p> <p>Summative Assessments</p> <p>Quizzes</p> <p>Tests</p> <p>Performance Assessments</p> <p>/Laboratory Investigations</p> <p>Research / Lab Reports</p>
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Unit Two: The Living World (10–15%) cont.

<p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience (pp. 154-156)</p> <ul style="list-style-type: none"> • A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2) (HS-LS2-6) • Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) <p>LS2.D: Social Interactions and Group Behavior (pp. 156-157)</p> <ul style="list-style-type: none"> • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic 	<p>Engaging in Argument from Evidence (pp. 71-74)</p> <p>Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</p> <ul style="list-style-type: none"> • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6) • Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (HS-LS2-8) <p>Connections to Nature of Science</p> <p>Scientific Knowledge is Open to Revision in Light of New Evidence</p> <ul style="list-style-type: none"> • Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2) • Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and 			
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Unit Two: The Living World (10–15%) cont.

<p>relatives. (HS-LS2-8)</p> <p>LS4.D: Biodiversity and Humans (pp. 166-167)</p> <ul style="list-style-type: none"> • Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.(secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.) <p>http://www.nap.edu/openbook.php?record_id=13165&page=128</p> <p>ETS1.B: Developing Possible Solutions (pp. 206-208) When evaluating solutions it is important to take into account a range</p>	<p>evidence that may result in revision of an explanation. (HS-LS2-6) (HS-LS2-8)</p>			
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Unit Two: The Living World (10–15%) cont.

<p>of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.(secondary to HS-LS2-7)</p>				
<p>Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access.</p> <p>Instructional Adjustments: Modifications, student difficulties, possible misunderstandings</p> <p>Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets. Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data. Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem. Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise. Examples of human activities can include urbanization, building dams, and dissemination of invasive species. Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.</p> <p>Assessment Boundary: <i>Assessment does not include deriving mathematical equations to make comparisons. Assessment is limited to provided data. Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy,</i></p>				

Unit Three: Population (10–15%)

Essential Questions: How do human population dynamics impact the environment?
 Humans alter natural systems. Humans have had an impact on the environment for millions of years. Technology and population growth have enabled humans to increase both the rate and scale of their impact on the environment.

NGSS Performance Expectations: (Students who demonstrate understanding can:)
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-ESS3-3 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.

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
 Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)	Instructional Actions			
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
<p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Resource availability has guided the development of human society. (HS-ESS3-1) <p>ESS3.B: Natural Hazards</p> <ul style="list-style-type: none"> Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven 	<p>Using Mathematics and Computational Thinking</p> <p>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</p>	<p>Cause and Effect</p> <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3- 1) <p>Stability and Change</p> <ul style="list-style-type: none"> Change and rates of change can be quantified and modeled over very short or very long periods of time. 	<p>Math</p> <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs <p>History</p> <ul style="list-style-type: none"> Environmental legislation and policy Maps/Geography 	<p>Formative Assessments:</p> <p>Diagnostic pre- and post- assessments. Class Discussions Worksheets with teacher feedback Drafts of lab reports with teacher feedback</p>

Unit Three: Population (10–15%) cont.

<p>human migrations. (HS-ESS3-1)</p> <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) <p>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. (<i>secondary HS-ESS3-4</i>)</p>	<p>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.</p> <ul style="list-style-type: none"> • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) <p>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 knowledge, principles, and theories.</p>	<p>Some system changes are irreversible. (HS-ESS3-3)</p> <ul style="list-style-type: none"> • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> • Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS-ESS3-4) • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3) <p>Connections to Nature of Science</p> <p>Science is a Human Endeavor</p>	<ul style="list-style-type: none"> • and topography <p>Engineering & STEM</p> <ul style="list-style-type: none"> • Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> • Probes • Discovery Tech Book • Student Mac books • Online simulations 	<p>Summative Assessments:</p> <p>Quizzes Tests Performance Assessments /Laboratory Investigations Research / Lab Reports</p>
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Unit Three: Population (10–15%) cont.

	<ul style="list-style-type: none"> • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-ESS3-1) • Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4) 	<ul style="list-style-type: none"> • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) 		
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Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access.

Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised. Examples of factors that affect human sustainability include agricultural efficiency, levels of

Unit Three: Population (10–15%) cont.

conservation, and urban planning. Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).

Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations. Assessment does not include running computational representations but is limited to using the published results of scientific computational models.

Unit Four: Land and Water Use (10–15%)

Essential Questions: *How do human activities impact the natural resources on Earth?*

Human survival depends on developing practices that will achieve sustainable systems. Humans depend on all of the planet's systems for a variety of resources, some of which are renewable or replaceable and some which are not. A suitable combination of conservation and development is required to achieve sustainable systems. Management of common resources is essential.

NGSS Performance Expectations: (Students who demonstrate understanding can:)

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-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)		Instructional Actions		
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
<p>ESS3.C: Human Impacts on Earth Systems (pp. 194-196)</p> <ul style="list-style-type: none"> The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that 	<p>Using Mathematics and Computational Thinking (pp. 64-67)</p> <p>Students use 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,</p>	<p>Systems and System Models (pp. 91-94)</p> <ul style="list-style-type: none"> When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6) 	<p>Math</p> <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs <p>History</p> <ul style="list-style-type: none"> Environmental legislation and policy 	<p>Formative Assessments:</p> <p>Diagnostic pre- and post- assessments. Class Discussions Worksheets with teacher feedback Drafts of lab reports with teacher feedback.</p>

Unit Four: Land and Water Use (10–15%) cont.

<p>preclude ecosystem degradation. (HS-ESS3-4)</p> <p>ESS3.D: Global Climate Change (pp. 196-198)</p> <ul style="list-style-type: none"> Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) <p>ETS1.B: Developing Possible Solutions (pp. 206-208)</p> <ul style="list-style-type: none"> 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. (secondary to HS-ESS3-2),(secondary HS-ESS3-4) <p>ESS3.A: Natural Resources (pp. 191-192)</p> <ul style="list-style-type: none"> Resource availability has guided the development of human society. (HS-ESS3-1) 	<p>represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none"> Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) <p>Constructing Explanations and Designing Solutions (pp. 67-71)</p> <p>Students construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.</p> <ul style="list-style-type: none"> Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world 	<p>Stability and Change (pp. 98-101)</p> <ul style="list-style-type: none"> Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS-ESS3-4) <p>Connections to Nature of Science</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) 	<ul style="list-style-type: none"> Maps/Geography and topography <p>Engineering & STEM</p> <ul style="list-style-type: none"> Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> Probes Discovery Tech Book Student Mac books Online simulations 	<p>Summative Assessments:</p> <p>Quizzes</p> <p>Tests</p> <p>Performance Assessments /Laboratory Investigations</p> <p>Research / Lab Reports</p>
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Unit Four: Land and Water Use (10–15%) cont.

operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1)

- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access.

Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised. Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen. Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning. Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean). Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere (frozen water), geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.

Assessment Boundary: *Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations. Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*

Unit Five: Energy Resources and Consumption (10–15%)

Essential Question: *How do Earth's surface processes and human energy needs affect each other?*

Energy conversions underlie all ecological processes. Energy cannot be created; it must come from somewhere. As energy flows through systems, at each step more of it becomes unusable. Humans depend on all of the planet's systems for a variety of resources, some of which are renewable or replaceable and some which are not.

NGSS Performance Expectations: (Students who demonstrate understanding can:)

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-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

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.

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 positions of particles (objects).

HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Unit Assessment:(What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)	Instructional Actions			
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
ESS2.A: Earth Materials and Systems <ul style="list-style-type: none"> Earth's systems, being dynamic and interacting, cause feedback effects that 	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and	Stability and Change <ul style="list-style-type: none"> Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) 	Math <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs 	Formative Assessments: Diagnostic pre- and post- assessments. Class Discussions

Unit Five: Energy Resources and Consumption (10–15%) cont.

<p>can increase or decrease the original changes. (HS-ESS2-2)</p> <ul style="list-style-type: none"> The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-2) Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6)(HS-ESS2-7) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) 	<p>developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).</p> <ul style="list-style-type: none"> Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2)(HS-ESS2-6) Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) <p>Analyzing and Interpreting Data</p> <p>Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.</p> <ul style="list-style-type: none"> Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) 	<ul style="list-style-type: none"> Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5) <p>Energy and Matter</p> <ul style="list-style-type: none"> The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) <p>Cause and Effect</p> <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) (HS-ESS3-1) <p><i>Connections to Engineering, Technology, and Applications of Science</i></p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> 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) 	<p>History</p> <ul style="list-style-type: none"> Environmental legislation and policy Maps/Geography and topography <p>English</p> <ul style="list-style-type: none"> APA formatting Critical reading Practice writing free response <p>Engineering & STEM</p> <ul style="list-style-type: none"> Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> Probes Discovery Tech Book Student Mac books Online simulations 	<p>Worksheets with teacher feedback Drafts of lab reports with teacher feedback.</p> <p>Summative Assessments: Quizzes Tests Performance Assessments /Laboratory Investigations Research / Lab Reports</p>
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Unit Five: Energy Resources and Consumption (10–15%) cont.

<p>SS1.B: Earth and the Solar System</p> <ul style="list-style-type: none"> Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the tilt of the planet’s axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> 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)(HS-ESS3-2) <p>PS3.A: Definitions of Energy</p> <ul style="list-style-type: none"> Energy is a quantitative property of a system that depends on the motion and 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) 	<p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4) <p>Constructing Explanations and Designing Solutions</p> <p>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.</p> <ul style="list-style-type: none"> Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3), (HS-PS3-3) Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer 	<p>(HS-ETS1-3) (HS-ESS3-3) (HS-ESS2-2)</p> <ul style="list-style-type: none"> Modern civilization depends on major technological systems. (HS-ESS3-1) Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3) (HS-ESS3-2) <p>Connections to Nature of Science</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) <p>Science Addresses Questions About the Natural and Material World</p> <ul style="list-style-type: none"> Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2) 		
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Unit Five: Energy Resources and Consumption (10–15%) cont.

<p>PS3-2)</p> <ul style="list-style-type: none"> At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3) 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) <p>PS3.D: Energy in Chemical Processes</p> <ul style="list-style-type: none"> Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. 	<p>review) 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. (HS-ESS3-1)</p> <p>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.</p> <ul style="list-style-type: none"> Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) <p>Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and</p>	<ul style="list-style-type: none"> Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2) 		
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Unit Five: Energy Resources and Consumption (10–15%) cont.

<p>(HS-ESS3-3)</p> <p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Resource availability has guided the development of human society. (HS-ESS3-1) All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) <p>ESS3.B: Natural Hazards</p> <ul style="list-style-type: none"> Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) 	<p>sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</p> <ul style="list-style-type: none"> Evaluate competing design solutions to a real-world problem based on scientific ideas, principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, enviro., ethical considerations). (HS-ESS3-2) 			
<p>Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access.</p> <p>Instructional Adjustments: Modifications, student difficulties, possible misunderstandings</p> <p>Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent. Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms. Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations. Emphasis is on both qualitative and</p>				

Unit Five: Energy Resources and Consumption (10–15%) cont.

quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency. Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised. Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen. Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.

Assessment Boundary: *Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students. Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.*

Unit Six: Pollution (25–30%)

Essential Questions: How do human actions and resource usage cause negative impacts on the natural systems of Earth and create risks to sustainable human civilization?

NGSS Performance Expectations: (Students who demonstrate understanding can:)

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-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Unit Assessment:(What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)	Instructional Actions			
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
<p>ESS2.A: Earth Materials and Systems</p> <ul style="list-style-type: none"> Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the 	<p>Developing and Using Models</p> <p>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).</p> <ul style="list-style-type: none"> Develop a model based on evidence to illustrate the relationships between systems 	<p>Stability and Change</p> <ul style="list-style-type: none"> Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3) 	<p>Math</p> <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs <p>History</p> <ul style="list-style-type: none"> Environmental legislation and policy Maps/Geography and topography 	<p>Formative Assessments:</p> <p>Diagnostic pre- and post- assessments. Class Discussions Worksheets with teacher feedback Drafts of lab reports with teacher feedback.</p>

Unit Six: Pollution (25–30%) cont.

<p>atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-2)</p> <ul style="list-style-type: none"> • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6) • Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) • Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (<i>secondary to HS-ESS3-6</i>) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> • 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-ESS3-2) <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> • The sustainability of human 	<p>or between components of a system. (HS-PS3-2) (HS-ESS2-6)</p> <p>Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.</p> <ul style="list-style-type: none"> • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) <p>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.</p> <ul style="list-style-type: none"> • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, 	<p>Energy and Matter</p> <ul style="list-style-type: none"> • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) <p>Cause and Effect</p> <ul style="list-style-type: none"> • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> • 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-ESS3-3) (HS-ESS2-2) • Modern civilization 	<p>Engineering & STEM</p> <ul style="list-style-type: none"> • Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> • Probes • Discovery Tech Book • Student Mac books • Online simulations 	<p>Summative Assessments: Quizzes Tests Performance Assessments /Laboratory Investigations Research / Lab Reports</p>
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Unit Six: Pollution (25–30%) cont.

<p>societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)</p> <p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Resource availability has guided the development of human society. (HS-ESS3-1) All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) <p>ESS3.B: Natural Hazards</p> <ul style="list-style-type: none"> Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) <p>ESS3.D: Global Climate Change</p> <ul style="list-style-type: none"> Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) 	<p>and tradeoff considerations. (HS-PS3-3)</p> <ul style="list-style-type: none"> Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-ESS3-1) Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4) <p>Using Mathematics and Computational Thinking</p> <p>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</p>	<p>depends on major technological systems. (HS-ESS3-1)</p> <ul style="list-style-type: none"> Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-4) (HS-ESS3-2) <p>Connections to Nature of Science</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) <p>Science Addresses Questions About the Natural and Material World</p> <ul style="list-style-type: none"> Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) Science knowledge indicates what can happen in natural 		
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Unit Six: Pollution (25–30%) cont.

	<p>based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none"> • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) <p>Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</p> <ul style="list-style-type: none"> • Evaluate competing design solutions to a real-world problem based on scientific ideas, principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, enviro., ethical considerations). (HS-ESS3-2) 	<p>systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)</p> <ul style="list-style-type: none"> • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2) <p>Systems and System Models</p> <ul style="list-style-type: none"> • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6) 		
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Unit Six: Pollution (25–30%) cont.

Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access.

Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent. Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms. Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations. Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency. Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised. Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen. Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.]

Assessment Boundary: *Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students. Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations. Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*

Unit Seven: Global Change (10–15%)

Essential Questions: To what extent are human caused events damaging the Earth’s atmosphere, climate, and biosphere, and how can we reverse this trend?
NGSS Performance Expectations: (Students who demonstrate understanding can:)

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.
HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
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-ESS3-3 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-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Unit Assessment:(What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
 Labs, activities, and summative assessments.

Student Learning Objectives: (SLO)		Instructional Actions		
Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Activities/Strategies Technology Implementation/ Interdisciplinary Connections	Assessment Check Points
ESS2.A: Earth Materials and Systems <ul style="list-style-type: none"> Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) The geological record shows that changes to global and regional climate can be caused by 	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their Components in the natural and designed world(s).	Cause and Effect <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) 	Math <ul style="list-style-type: none"> Data analysis and collection Interpreting data and graphs 	Formative Assessments: Diagnostic pre- and post- assessments. Class Discussions Worksheets with

Unit Seven: Global Change (10–15%) cont.

<p>interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p> <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> • The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-2) • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6) • Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) • Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global 	<ul style="list-style-type: none"> • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6) • Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) <p>Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.</p> <ul style="list-style-type: none"> • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) • Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5) <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4) 	<p>Systems and System Models</p> <ul style="list-style-type: none"> • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6) <p>Stability and Change</p> <ul style="list-style-type: none"> • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) <p>Connections to Nature of Science</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) 	<p>History</p> <ul style="list-style-type: none"> • Environmental legislation and policy • Maps/Geography and topography <p>Engineering & STEM</p> <ul style="list-style-type: none"> • Finding solutions for real life situations <p>Technology:</p> <ul style="list-style-type: none"> • Probes • Discovery Tech Book • Student Mac books • Online simulations 	<p>Summative Assessments:</p> <p>Quizzes Tests Performance Assessments /Laboratory Investigations Research / Lab Reports</p>
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Unit Seven: Global Change (10–15%) cont.

<p>climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (<i>secondary to HS-ESS3-6</i>)</p> <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) <p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> • Resource availability has guided the development of human society. (HS-ESS3-1) <p>ESS3.B: Natural Hazards</p> <ul style="list-style-type: none"> • Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) 	<p>Constructing Explanations and Designing Solutions</p> <p>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.</p> <ul style="list-style-type: none"> • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3) • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. (HS-ESS3-1) <p>Using Mathematics and Computational Thinking</p> <p>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</p>	<p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> • Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS-ESS3-4) • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3) 		
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Unit Seven: Global Change (10–15%) cont.

<p>ESS3.D: Global Climate Change</p> <ul style="list-style-type: none"> Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> 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-ESS3-4) <p>ESS1.B: Earth and the Solar System</p> <ul style="list-style-type: none"> Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the tilt of the planet’s axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate 	<p>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.</p> <ul style="list-style-type: none"> Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) <p>Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)</p> <p>Connections to Nature of Science</p> <p>Scientific Investigations Use a Variety of Methods</p> <ul style="list-style-type: none"> Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) New technologies advance scientific knowledge. (HS-ESS3-5) <p>Scientific Knowledge is Based on Empirical Evidence.</p> <ul style="list-style-type: none"> Science knowledge is based on empirical evidence. (HS-ESS3-5) 			
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Unit Seven: Global Change (10–15%) cont.

<p>changes. (secondary to HS-ESS2-4)</p> <p>ESS2.A: Earth Materials and Systems</p> <ul style="list-style-type: none"> The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) 	<ul style="list-style-type: none"> Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5) 			
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Resources: Essential materials, supplementary materials, links to best practices, textbooks, computers, data servers, and Internet access. **Instructional**

Adjustments: Modifications, student difficulties, possible misunderstandings

Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth’s surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent. Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth’s orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition. Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth’s surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms. Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised. Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency,

Unit Seven: Global Change (10–15%) cont.

levels of conservation, and urban planning. Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean). Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.

Assessment Boundary: *Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution. Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems. Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations. Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*