PCTVS PASSAIC COUNTY TECHNICAL-VOCATIONAL SCHOOLS

AP Environmental Science

Course #0176

5 Credits

December 2019

I. Course Description:

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. The AP Environmental Science course has been developed with the intention to enable students to undertake, as first-year college students, a more advanced study of topics in environmental science. 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.

II. Units:

<table>
<tr><td>Content Area:</td><td>AP Environmental Science</td><td>Grade(s)</td><td>11, 12</td></tr>
<tr><td>Unit 1:</td><td colspan="3">The Living World: Ecosystems</td></tr>
<tr><td colspan="4">Learning Objectives</td></tr>
<tr><td colspan="4">ERT-1.A Explain how the availability of resources influences species interactions.
ERT-1.B Describe the global distribution and principal environmental aspects of terrestrial biomes
ERT-1.C Describe the global distribution and principal environmental aspects of aquatic biomes.
ERT-1.D Explain the steps and reservoir interactions in the carbon cycle.
ERT-1.E Explain the steps and reservoir interactions in the nitrogen cycle.
ERT-1.F Explain the steps and reservoir interactions in the phosphorus cycle.
ERT-1.G Explain the steps and reservoir interactions in the hydrologic cycle.
ENG-1.A Explain how solar energy is acquired and transferred by living organisms.
ENG-1.B Explain how energy flows and matter cycles through trophic levels.
ENG-1.C Determine how the energy decreases as it flows through ecosystems.
ENG-1.D Describe food chains and food webs, and their constituent members by trophic level.</td></tr>
</table>

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking 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, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	**LS2.A: Interdependent Relationships in Ecosystems** • 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, competition, and disease. Organisms would have the capacity to produce populations of	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8) **Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale,

- 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)

Constructing Explanations and Designing Solutions
Students construct explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories.

- 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)

Engaging in Argument from Evidence
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.

- 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)

Connections to Nature of Science

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)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- 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)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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.

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)

Energy and Matter

- 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)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6) (HS-LS2-7)

Scientific Knowledge is Open to Revision in Light of New Evidence • 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 evidence that may result in revision of an explanation. (HS-LS2-6) (HS-LS2-8)	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) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to consider a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (HS-LS2-7)	

NJSLS Standards Addressed

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.

Essential Questions

How does energy change forms?
How old is the water you drink?

Anchor Text

Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292

Informational Texts

Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association.
Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman.

The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.	
Short Texts	
Suggested Formative & Summative Assessments	
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions	
Resources (websites, Blackboard, documents, etc.)	
Canvas Instructure Learning Management System, The College Board Website, Khan Academy	
Labs	
Carolina Investigations for AP Environmental Science	
Suggested Time Frame:	3 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 2:	**The Living World: Biodiversity**		
Learning Objectives			
ERT-2.A Explain levels of biodiversity and their importance to ecosystems. **ERT-2.B** Describe ecosystem services. **ERT-2.C** Describe the results of human disruptions to ecosystem services. **ERT-2.D** Describe island biogeography. **ERT-2.E** Describe the role of island biogeography in evolution. **ERT-2.F** Describe ecological tolerance **ERT-2.G** Explain how natural disruptions, both short and long-term, impact an ecosystem. **ERT-2.H** Describe how organisms adapt to their environment. **ERT-2.I** Describe ecological succession. **ERT-2.J** Describe the effect of ecological succession on ecosystems.			

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking 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, represent, and model data.	**Social Interactions and Group Behavior** • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **LS4.D: Biodiversity and Humans**	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS2-8)

Simple computational simulations are created and used based on mathematical models of basic assumptions. • 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) **Constructing Explanations and Designing Solutions** Students construct explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories. • 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) **Engaging in Argument from Evidence** 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. • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)	• Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (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) (HS-LS4-6) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to consider a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (HS-LS2-7)	**Scale, Proportion, and Quantity** • 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) **Energy and Matter** • 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) **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6) (HS-LS2-7)

• Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (HS-LS2-8) *Connections to Nature of Science* **Scientific Knowledge is Open to Revision in Light of New Evidence** • 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 evidence that may result in revision of an explanation. (HS-LS2-6) (HS-LS2-8)		

NJSLS Standards Addressed

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.

Essential Questions

Can an invasive species be considered a native species if it occupies a place for a long time?

Anchor Text

Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292

Informational Texts

Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association.
Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman.
The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House.
Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.

Short Texts

Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	2.5 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 3:	**Populations**		

Learning Objectives
ERT-3.A Identify differences between generalist and specialist species. **ERT-3.B** Identify differences between K- and r-selected species. **ERT-3.C** Explain survivorship curves. **ERT-3.D** Describe carrying capacity. **ERT-3.E** Describe the impact of carrying capacity on ecosystems. **ERT-3.F** Explain how resource availability affects population growth. **EIN-1.A** Explain age structure diagrams. **EIN-1.B** Explain factors that affect total fertility rate in human populations. **EIN-1.C** Explain how human populations experience growth and decline. **EIN-1.D** Define the demographic transition.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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	**ESS3.A: Natural Resources** • Resource availability has guided the development of human society. (HS-ESS3-1) **ESS3.B: Natural Hazards** • Natural hazards and other geologic events have shaped the course of human history; [they] have Significantly altered the sizes of	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3- 1) **Stability and Change** • Change and rates of change can be quantified and modeled over very

based on mathematical models of basic assumptions. • 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) **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. • 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)	human populations and have driven human migrations. (HS-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** • 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) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to consider a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary HS-ESS3-4)	short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** • 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) *Connections to Nature of Science* **Science is a Human Endeavor** • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

NJSLS Standards Addressed
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-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Essential Questions
How do changes in habitats influence changes in species over time? How is educational opportunity for women connected to human population changes?
Anchor Text
Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292
Informational Texts
Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association. Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	2.5 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 4:	**Earth Systems and Resources**		
Learning Objectives			
ERT-4.A Describe the geological changes and events that occur at convergent, divergent, and transform plate boundaries. **ERT-4.B** Describe the characteristics and formation of soil. **ERT-4.C** Describe similarities and differences between properties of different soil types. **ERT-4.D** Describe the structure and composition of the Earth's atmosphere. **ERT-4.E** Explain how environmental factors can result in atmospheric circulation.			

ERT-4.F Describe the characteristics of a watershed.
ENG-2.A Explain how the sun's energy affects the Earth's surface.
ENG-2.B Describe how the Earth's geography affects weather and climate.
ENG-2.C Describe the environmental changes and effects that result from El Niño or La Niña events (El Niño–Southern Oscillation).

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1) **Constructing Explanations and Designing Solutions** 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. • 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) **Engaging in Argument from Evidence** 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. • Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5) (HS-ESS2-7) (HS-LS4-5)	**ESS1.C: The History of Planet Earth** • 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) • 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) **ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1) (HS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • 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. (HS-ESS1-5) (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. (HS-ESS2-1)	**Patterns** • Empirical evidence is needed to identify patterns. (HS-ESS1-5) **Stability and Change** • 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) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-5)

Connections to Nature of Science **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • 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.	**ESS2.D: Weather and Climate** • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7) **ESS2.E Biogeology** • 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) **PS1.C: Nuclear Processes** • 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. (HS-ESS1-5) (HS-ESS1-6) **LS4.C: Adaptation** • 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 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)	
NJSLS Standards Addressed		

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.
Essential Questions
How does energy from the sun influence the weather? How can earthquakes be predicted?
Anchor Text
Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292
Informational Texts
Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association. Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	2.5 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 5:	**Land and Water Use**		
Learning Objectives			
EIN-2.A Explain the concept of the tragedy of the commons.			

EIN-2.B Describe the effect of clearcutting on forests.
EIN-2.C Describe changes in agricultural practices.
EIN-2.D Describe agricultural practices that cause environmental damage.
EIN-2.E Describe different methods of irrigation.
EIN-2.F Describe the benefits and drawbacks of different methods of irrigation.
EIN-2.G Describe the benefits and drawbacks of different methods of pest control.
EIN-2.I Describe the benefits and drawbacks of different methods of meat production.
EIN-2.J Describe causes of and problems related to overfishing.
EIN-2.K Describe natural resource extraction through mining.
EIN-2.L Describe ecological and economic impacts of natural resource extraction through mining.
EIN-2.M Describe the effects of urbanization on the environment.
EIN-2.N Explain the variables measured in an ecological footprint.
STB-1.A Explain the concept of sustainability.
STB-1.B Describe methods for mitigating problems related to urban runoff.
STB-1.C Describe integrated pest management.
STB-1.D Describe the benefits and drawbacks of integrated pest management (IPM).
STB-1.E Describe sustainable agricultural and food production practices.
STB-1.F Describe the benefits and drawbacks of aquaculture.
STB-1.G Describe methods for mitigating human impact on forests.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking 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, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions**	**ESS3.C: Human Impacts on Earth Systems** • 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) **ESS3.D: Global Climate Change** • 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)	**Systems and System Models** • 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) **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) *Connections to Engineering, Technology, and Applications of Science*

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. • 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)	**ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to consider 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) **ESS3.A: Natural Resources** • Resource availability has guided the development of human society. (HS-ESS3-1)	**Influence of Science, Engineering, and Technology on Society and the Natural World** • 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) *Connections to Nature of Science* **Science is a Human Endeavor** • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

NJSLS Standards Addressed

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.

Essential Questions

How does your use of natural resources impact the world?
Why are sustainable practices difficult to implement?

Anchor Text

Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292

Informational Texts

Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association.
Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman.
The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House.

Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	4 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 6:	**Energy Resource and Consumption**		

Learning Objectives

ENG-3.A Identify differences between nonrenewable and renewable energy sources.
ENG-3.B Describe trends in energy consumption.
ENG-3.C Identify types of fuels and their uses.
ENG-3.D Identify where natural energy resources occur.
ENG-3.E Describe the use and methods of fossil fuels in power generation.
ENG-3.F Describe the effects of fossil fuels on the environment.
ENG-3.G Describe the use of nuclear energy in power generation.
ENG-3.H Describe the effects of the use of nuclear energy on the environment.
ENG-3.I Describe the effects of the use of biomass in power generation on the environment.
ENG-3.J Describe the use of solar energy in power generation.
ENG-3.K Describe the effects of the use of solar energy in power generation on the environment.
ENG-3.L Describe the use of hydroelectricity in power generation.
ENG-3.M Describe the effects of the use of hydroelectricity in power generation on the environment.
ENG-3.N Describe the use of geothermal energy in power generation.
ENG-3.O Describe the effects of the use of geothermal energy in power generation on the environment.
ENG-3.P Describe the use of hydrogen fuel cells in power generation.
ENG-3.Q Describe the effects of the use of hydrogen fuel cells in power generation on the environment.
ENG-3.R Describe the use of wind energy in power generation.
ENG-3.S Describe the effects of the use of wind energy in power generation on the environment.

<table>
<tr><td colspan="3">ENG-3.T Describe methods for conserving energy.</td></tr>
<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th></tr>
<tr><td>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).
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)
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.
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)
Scientific Knowledge is Based on Empirical Evidence
Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4)
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</td>
<td>ESS2.A: Earth Materials and Systems
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 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)
ESS2.D: Weather and Climate
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 reradiation 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)
SS1.B: Earth and the Solar System
Cyclical changes in the shape of Earth’s orbit around the sun, together with changes</td>
<td>Stability and Change
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) (HS-ESS3-5)
Energy and Matter
The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)
Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) (HS-ESS3-1)
Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-</td></tr>
</table>

multiple and independent student - generated sources of evidence consistent with scientific ideas, principles and theories.

- 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 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)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)

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

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)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to consider a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) (HS-ESS3-2)

PS3.A: Definitions of Energy

- 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)
- 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

ETS1-3) (HS-ESS3-3) (HS-ESS2-2)

- 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)

Connections to Nature of Science

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Science Addresses Questions About the Natural and Material World

- 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)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

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. • 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)	cases, the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **PS3.D: Energy in Chemical Processes** • 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) **ESS3.C: Human Impacts on Earth Systems** • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) **ESS3.A: Natural Resources** • 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. (HSESS3-2) **ESS3.B: Natural Hazards** • 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. (HSESS3-1)	

NJSLS Standards Addressed	
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.	
Essential Questions	
Why are fossil fuels the most widely used energy resources if they are nonrenewable?	
Anchor Text	
Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292	
Informational Texts	
Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association. Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.	
Short Texts	
Suggested Formative & Summative Assessments	
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions	
Resources (websites, Blackboard, documents, etc.)	
Canvas Instructure Learning Management System, The College Board Website, Khan Academy	
Labs	
Carolina Investigations for AP Environmental Science	
Suggested Time Frame:	3.5 weeks

Content Area:	AP Environmental Science	Grade(s)	11, 12
Unit 7:	Atmospheric Pollution		

Learning Objectives

STB-2.A Identify the sources and effects of air pollutants.
STB-2.B Explain the causes and effects of photochemical smog and methods to reduce it.
STB-2.C Describe thermal inversion and its relationship with pollution.
STB-2.D Describe natural sources of CO2 and particulates.
STB-2.E Identify indoor air pollutants.
STB-2.F Describe the effects of indoor air pollutants.
STB-2.G Explain how air pollutants can be reduced at the source.
STB-2.H Describe acid deposition.
STB-2.I Describe the effects of acid deposition on the environment.
STB-2.J Describe human activities that result in noise pollution and its effects.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) (HS-ESS2-6) **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. • 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)	**ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) **ESS2.D: Weather and Climate** • 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 reradiation 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)	**Stability and Change** • 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. (HSESS3-3) **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles and theories.

- 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)
- 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)

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

- 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. (secondary to HS-ESS3-6)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to consider a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ESS3-2)

ESS3.C: Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

ESS3.A: Natural Resources

- 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)

ESS3.B: Natural Hazards

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-3) (HS-ESS2-2)
- 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-ESS3-4) (HS-ESS3-2)

Connections to Nature of Science

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Science Addresses Questions About the Natural and Material World

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)

based on mathematical models of basic assumptions. • 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) **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. • 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)	• 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) **ESS3.D: Global Climate Change** • 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)	• 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) • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS- ESS3-2) **Systems and System Models** • 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)

NJSLS Standards Addressed
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.

Essential Questions
Where does air pollution go once it is airborne?

Anchor Text
Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292
Informational Texts
Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association. Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	2.5 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 8:	**Aquatic & Terrestrial Pollution**		

Learning Objectives
STB-3.A Identify differences between point and nonpoint sources of pollution. **STB-3.B** Describe the impacts of human activities on aquatic ecosystems. **STB-3.C** Describe endocrine disruptors. **STB-3.D** Describe the effects of endocrine disruptors on ecosystems. **STB-3.E** Describe the impacts of human activity on wetlands and mangroves. **STB-3.F** Explain the environmental effects of excessive use of fertilizers and detergents on aquatic ecosystems. **STB-3.G** Describe the effects of thermal pollution on aquatic ecosystems. **STB-3.H** Describe the effect of persistent organic pollutants (POPs) on ecosystems. **STB-3.I** Describe bioaccumulation and biomagnification. **STB-3.J** Describe the effects of bioaccumulation and biomagnification. **STB-3.K** Describe solid waste disposal methods. **STB-3.L** Describe the effects of solid waste disposal methods. **STB-3.M** Describe changes to current practices that could reduce the amount of generated waste and their associated benefits and drawbacks.

STB-3.N Describe best practices in sewage treatment.
EIN-3.A Define lethal dose 50% (LD50).
EIN-3.B Evaluate dose response curves.
EIN-3.C Identify sources of human health issues that are linked to pollution.
EIN-3.D Explain human pathogens and their cycling through the environment.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) (HSESS2-6) **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. • 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) **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.	**ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) **ESS2.D: Weather and Climate** • 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 reradiation 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 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. (secondary to HS-ESS3-6)	**Stability and Change** • 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. (HSESS3-3) **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of

- 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)
- 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)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
- Use a computational representation of phenomena or design solutions to describe

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to consider a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ESS3-2)

ESS3.C: Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

ESS3.A: Natural Resources

- 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)

ESS3.B: Natural Hazards

- 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)

ESS3.D: Global Climate Change

- 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

costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-3) (HS-ESS2-2)

- 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-ESS3-4) (HS-ESS3-2)

Connections to Nature of Science

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Science Addresses Questions About the Natural and Material World

- 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)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS- ESS3-2)

and/or support claims and/or explanations. (HS-ESS3-6) **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. • 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, environmental, ethical considerations). (HS-ESS3-2)	in response to human activities. (HS-ESS3-6)	**Systems and System Models** • 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)

NJSLS Standards Addressed

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.

Essential Questions

How does pollution impact your health?
How can you decrease your waste?

Anchor Text

Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292

Informational Texts

Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association.

Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	3.5 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 9:	**Global Change**		

Learning Objectives

STB-4.A Explain the importance of stratospheric ozone to life on Earth.
STB-4.B Describe chemicals used to substitute for chlorofluorocarbons (CFCs).
STB-4.C Identify the greenhouse gases.
STB-4.D Identify the sources and potency of the greenhouse gases.
STB-4.E Identify the threats to human health and the environment posed by an increase in greenhouse gases.
STB-4.F Explain how changes in climate, both short- and long-term, impact ecosystems.
STB-4.G Explain the causes and effects of ocean warming.
STB-4.H Explain the causes and effects of ocean acidification.
EIN-4.A Explain the environmental problems associated with invasive species and strategies to control them.
EIN-4.B Explain how species become endangered and strategies to combat the problem.
EIN-4.C Explain how human activities affect biodiversity and strategies to combat the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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	**ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about

variables between systems and their Components in the natural and designed world(s).

- 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)

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.

- 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)

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.

- 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)

- 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)

ESS2.D: Weather and Climate

- 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 reradiation 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 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. (secondary to HS-ESS3-6)

specific causes and effects. (HS-ESS3-1)

Systems and System Models

- 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)

Stability and Change

- 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)

Connections to Nature of Science

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-ESS3-1) (HS-ESS3-3)

- 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)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)

ESS3.C: Human Impacts on Earth Systems

- 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)

ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (HS-ESS3-1)

ESS3.B: Natural Hazards

- 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)

ESS3.D: Global Climate Change

- 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)

ETS1.B: Developing Possible Solutions

- 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)

• New technologies advance scientific knowledge. (HS-ESS3-5) **Scientific Knowledge is Based on Empirical Evidence** • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4) • Science knowledge is based on empirical evidence. (HS-ESS3-5) • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)	• When evaluating solutions, it is important to consider a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts (HS-ESS3-4) **ESS1.B: Earth and the Solar System** • 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) **ESS2.A: Earth Materials and Systems** • 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)	

NJSLS Standards Addressed
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.
Essential Questions
Why are laws created to protect endangered species? How can local human activities have a global impact?
Anchor Text
Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292
Informational Texts
Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association. Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	4 weeks

Content Area:	**AP Environmental Science**	**Grade(s)**	**11, 12**
Unit 10:	**Environmental Science Independent Research**		
Learning Objectives			
ERT-1.A Explain how the availability of resources influences species interactions. **ERT-1.B** Describe the global distribution and principal environmental aspects of terrestrial biomes **ERT-1.C** Describe the global distribution and principal environmental aspects of aquatic biomes. **ERT-1.D** Explain the steps and reservoir interactions in the carbon cycle. **ERT-1.E** Explain the steps and reservoir interactions in the nitrogen cycle. **ERT-1.F** Explain the steps and reservoir interactions in the phosphorus cycle. **ERT-1.G** Explain the steps and reservoir interactions in the hydrologic cycle.			

ENG-1.A Explain how solar energy is acquired and transferred by living organisms.
ENG-1.B Explain how energy flows and matter cycles through trophic levels.
ENG-1.C Determine how the energy decreases as it flows through ecosystems.
ENG-1.D Describe food chains and food webs, and their constituent members by trophic level.
ERT-2.A Explain levels of biodiversity and their importance to ecosystems.
ERT-2.B Describe ecosystem services.
ERT-2.C Describe the results of human disruptions to ecosystem services.
ERT-2.D Describe island biogeography.
ERT-2.E Describe the role of island biogeography in evolution.
ERT-2.F Describe ecological tolerance
ERT-2.G Explain how natural disruptions, both short and long-term, impact an ecosystem.
ERT-2.H Describe how organisms adapt to their environment.
ERT-2.I Describe ecological succession.
ERT-2.J Describe the effect of ecological succession on ecosystems.
ERT-3.A Identify differences between generalist and specialist species.
ERT-3.B Identify differences between K- and r-selected species.
ERT-3.C Explain survivorship curves.
ERT-3.D Describe carrying capacity.
ERT-3.E Describe the impact of carrying capacity on ecosystems.
ERT-3.F Explain how resource availability affects population growth.
EIN-1.A Explain age structure diagrams.
EIN-1.B Explain factors that affect total fertility rate in human populations.
EIN-1.C Explain how human populations experience growth and decline.
EIN-1.D Define the demographic transition.
ERT-4.A Describe the geological changes and events that occur at convergent, divergent, and transform plate boundaries.
ERT-4.B Describe the characteristics and formation of soil.
ERT-4.C Describe similarities and differences between properties of different soil types.
ERT-4.D Describe the structure and composition of the Earth's atmosphere.
ERT-4.E Explain how environmental factors can result in atmospheric circulation.
ERT-4.F Describe the characteristics of a watershed.
ENG-2.A Explain how the sun's energy affects the Earth's surface.
ENG-2.B Describe how the Earth's geography affects weather and climate.
ENG-2.C Describe the environmental changes and effects that result from El Niño or La Niña events (El Niño–Southern Oscillation).
EIN-2.A Explain the concept of the tragedy of the commons.
EIN-2.B Describe the effect of clearcutting on forests.
EIN-2.C Describe changes in agricultural practices.
EIN-2.D Describe agricultural practices that cause environmental damage.
EIN-2.E Describe different methods of irrigation.

EIN-2.F Describe the benefits and drawbacks of different methods of irrigation.
EIN-2.G Describe the benefits and drawbacks of different methods of pest control.
EIN-2.I Describe the benefits and drawbacks of different methods of meat production.
EIN-2.J Describe causes of and problems related to overfishing.
EIN-2.K Describe natural resource extraction through mining.
EIN-2.L Describe ecological and economic impacts of natural resource extraction through mining.
EIN-2.M Describe the effects of urbanization on the environment.
EIN-2.N Explain the variables measured in an ecological footprint.
STB-1.A Explain the concept of sustainability.
STB-1.B Describe methods for mitigating problems related to urban runoff.
STB-1.C Describe integrated pest management.
STB-1.D Describe the benefits and drawbacks of integrated pest management (IPM).
STB-1.E Describe sustainable agricultural and food production practices.
STB-1.F Describe the benefits and drawbacks of aquaculture.
STB-1.G Describe methods for mitigating human impact on forests.
ENG-3.A Identify differences between nonrenewable and renewable energy sources.
ENG-3.B Describe trends in energy consumption.
ENG-3.C Identify types of fuels and their uses.
ENG-3.D Identify where natural energy resources occur.
ENG-3.E Describe the use and methods of fossil fuels in power generation.
ENG-3.F Describe the effects of fossil fuels on the environment.
ENG-3.G Describe the use of nuclear energy in power generation.
ENG-3.H Describe the effects of the use of nuclear energy on the environment.
ENG-3.I Describe the effects of the use of biomass in power generation on the environment.
ENG-3.J Describe the use of solar energy in power generation.
ENG-3.K Describe the effects of the use of solar energy in power generation on the environment.
ENG-3.L Describe the use of hydroelectricity in power generation.
ENG-3.M Describe the effects of the use of hydroelectricity in power generation on the environment.
ENG-3.N Describe the use of geothermal energy in power generation.
ENG-3.O Describe the effects of the use of geothermal energy in power generation on the environment.
ENG-3.P Describe the use of hydrogen fuel cells in power generation.
ENG-3.Q Describe the effects of the use of hydrogen fuel cells in power generation on the environment.
ENG-3.R Describe the use of wind energy in power generation.
ENG-3.S Describe the effects of the use of wind energy in power generation on the environment.
ENG-3.T Describe methods for conserving energy.
STB-2.A Identify the sources and effects of air pollutants.
STB-2.B Explain the causes and effects of photochemical smog and methods to reduce it.
STB-2.C Describe thermal inversion and its relationship with pollution.

STB-2.D Describe natural sources of CO_2 and particulates.
STB-2.E Identify indoor air pollutants.
STB-2.F Describe the effects of indoor air pollutants.
STB-2.G Explain how air pollutants can be reduced at the source.
STB-2.H Describe acid deposition.
STB-2.I Describe the effects of acid deposition on the environment.
STB-2.J Describe human activities that result in noise pollution and its effects.
STB-3.A Identify differences between point and nonpoint sources of pollution.
STB-3.B Describe the impacts of human activities on aquatic ecosystems.
STB-3.C Describe endocrine disruptors.
STB-3.D Describe the effects of endocrine disruptors on ecosystems.
STB-3.E Describe the impacts of human activity on wetlands and mangroves.
STB-3.F Explain the environmental effects of excessive use of fertilizers and detergents on aquatic ecosystems.
STB-3.G Describe the effects of thermal pollution on aquatic ecosystems.
STB-3.H Describe the effect of persistent organic pollutants (POPs) on ecosystems.
STB-3.I Describe bioaccumulation and biomagnification.
STB-3.J Describe the effects of bioaccumulation and biomagnification.
STB-3.K Describe solid waste disposal methods.
STB-3.L Describe the effects of solid waste disposal methods.
STB-3.M Describe changes to current practices that could reduce the amount of generated waste and their associated benefits and drawbacks.
STB-3.N Describe best practices in sewage treatment.
EIN-3.A Define lethal dose 50% (LD50).
EIN-3.B Evaluate dose response curves.
EIN-3.C Identify sources of human health issues that are linked to pollution.
EIN-3.D Explain human pathogens and their cycling through the environment.
STB-4.A Explain the importance of stratospheric ozone to life on Earth.
STB-4.B Describe chemicals used to substitute for chlorofluorocarbons (CFCs).
STB-4.C Identify the greenhouse gases.
STB-4.D Identify the sources and potency of the greenhouse gases.
STB-4.E Identify the threats to human health and the environment posed by an increase in greenhouse gases.
STB-4.F Explain how changes in climate, both short- and long-term, impact ecosystems.
STB-4.G Explain the causes and effects of ocean warming.
STB-4.H Explain the causes and effects of ocean acidification.
EIN-4.A Explain the environmental problems associated with invasive species and strategies to control them.
EIN-4.B Explain how species become endangered and strategies to combat the problem.
EIN-4.C Explain how human activities affect biodiversity and strategies to combat the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Using Mathematics and Computational Thinking

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, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- 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)
- 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)
- 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

LS2.A: Interdependent Relationships in Ecosystems

- 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, 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)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- 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)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)

Scale, Proportion, and Quantity

- 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)

Energy and Matter

- 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)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6) (HS-LS2-7)

Patterns

- Empirical evidence is needed to identify patterns. (HS-ESS1-5)

Systems and System Models

knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

- 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)

Constructing Explanations and Designing Solutions

Students construct explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories.

- 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)
- 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)

Engaging in Argument from Evidence

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.

- 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)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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)

LS4.C: Adaptation

- 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 can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the

- 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)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- 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)

Connections to Nature of Science

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Science Addresses Questions About the Natural and Material World

- Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5) (HS-ESS2-7) (HS-LS4-5)
- 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)

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence

- 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 evidence that may result in revision of an explanation. (HS-LS2-6) (HS-LS2-8)

Developing and Using Models

Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1)
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) (HS-ESS2-6)

opportunity for the species' evolution is lost. (HS-LS4-5)

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (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) (HS-LS4-6)

ESS1.B: Earth and the Solar System

- 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)

ESS1.C: The History of Planet Earth

- Continental rocks, which can be older than 4 billion years, are generally much older

- 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)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

• Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • 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. **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. • 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) **Scientific Investigations Use a Variety of Methods**	than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5) • 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) **ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1) (HS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • 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. (HS-ESS1-5) (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. (HS-ESS2-1) **ESS2.D: Weather and Climate** • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7) **ESS2.E Biogeology**	

• 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) **Scientific Knowledge is Based on Empirical Evidence** • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4)	• 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) **ESS3.A: Natural Resources** • Resource availability has guided the development of human society. (HS-ESS3-1) **ESS3.B: Natural Hazards** • 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) **ESS3.C: Human Impacts on Earth Systems** • 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) **ESS3.C: Human Impacts on Earth Systems** • 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) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to consider a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (HS-LS2-7) **Social Interactions and Group Behavior** • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **PS1.C: Nuclear Processes** • 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. (HS-ESS1-5) (HS-ESS1-6) **PS3.A: Definitions of Energy** • 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) • 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) **PS3.D: Energy in Chemical Processes** • 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) **SS1.B: Earth and the Solar System** • 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)	

NJSLS Standards Addressed
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.
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.
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-ESS2-2 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-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
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-ESS3-5 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.
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.

Essential Questions

How does energy change forms?
How old is the water you drink?
Can an invasive species be considered a native species if it occupies a place for a long time?
How do changes in habitats influence changes in species over time?

How is educational opportunity for women connected to human population changes? How does energy from the sun influence the weather? How can earthquakes be predicted? How does your use of natural resources impact the world? Why are sustainable practices difficult to implement? Why are fossil fuels the most widely used energy resources if they are nonrenewable? Where does air pollution go once it is airborne? How does pollution impact your health? How can you decrease your waste? Why are laws created to protect endangered species? How can local human activities have a global impact?
Anchor Text
Friedland, A. (2018). *Environmental Science for the AP Course*. New York, NY: W. H. Freeman. ISBN-13: 978-1319113292
Informational Texts
Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association. Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman. The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House. Thorpe, G. S. (2017). *Barrons AP Environmental Science*. Hauppauge, NY: Barrons Educational Series.
Short Texts
Suggested Formative & Summative Assessments
CollegeBoard AP Environmental Science exam, instructor guided laboratory assignments and formal reports, homework, student guided laboratory assignments and formal reports, unit exams, quizzes and tests on Canvas, laboratory-based past exam questions, projects, past free-response test questions
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan Academy
Labs
Carolina Investigations for AP Environmental Science

Suggested Time Frame:	9 weeks

III. Instructional Strategies:

Graphs and other visuals
Engaging in discussions
Reading silently and aloud
Listening and speaking activities
Watching and responding to media
Researching to make connections to texts and classroom discussions
Collaborative projects
Answering questions (oral and written)
Summarizing
Practicing past AP Environmental Science exam questions
Analyzing texts, discussions, etc.
Peer teaching
Note taking and note making
Writing
Brainstorming
Listening
Mapping
Revising and editing
Participating in small and large groups

IV. Scope and Sequence:

SKILL TO BE LEARNED I = Introduced D = Developed in depth R = Reinforced	
Ecosystems are the result of biotic and abiotic interactions.	D, R
Energy can be converted from one form to another.	D, R
Ecosystems have structure and diversity that change over time.	D, R
Population change over time in reaction to a variety of factors.	D, R
Human populations change in reaction to a variety of factors, including social and cultural factors.	D, R
Earth's systems interact, resulting in a state of balance over time.	D, R
Most of the Earth's atmospheric processes are driven by input of energy from the sun.	D, R
When humans use natural resources, they alter natural systems.	D, R
Humans can mitigate their impact on land and water resources through sustainable use.	D, R
Humans use energy from a variety of sources, resulting in positive and negative consequences.	D, R
Human activities have physical, chemical, and biological consequences for the atmosphere.	D, R
Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.	D, R
Pollutants can have both direct and indirect impacts on the health of organisms, including humans.	D, R
Local and regional human activities can have impacts at the global level.	D, R
The health of a species is closely tied to its ecosystem, and minor environmental changes have a large impact.	D, R

V. Course Textbook and Resources:

Friedland, A. (2018). *Environmental Science for the AP Course* (3rd ed.). New York, NY: W. H. Freeman.
978-1-319-11329-2

Evans, G. N. (2016). *AP Environmental Science Crash Course*. Piscataway, NJ: Research & Education Association.
978-0-7386-0931-7

Friedland, A. (2019). *Strive for a 5: Preparing for the AP Environmental Science Exam*. New York, NY: W. H. Freeman.
978-1-319-11434-3

The Princeton Review. (2018). *Cracking the AP Environmental Science Exam*. New York, NY: Penguin Random House.
978-1-5247-5805-9

Thorpe, G. S. (2017). *Barrons AP Environmental Science* (7th ed.). Hauppauge, NY: Barrons Educational Series.
978-1-4380-0865-3

VI. Student Handout:

AP Environmental Science

Course Description: 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. The AP Environmental Science course has been developed with the intention to enable students to undertake, as first-year college students, a more advanced study of topics in environmental science. 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.

Proficiencies: 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.