Passaic County Technical Institute

Wayne, NJ

Environmental Science Curriculum

August 2015

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I. Course Description

Environmental Science is a full year course designed to help show students how Earth's systems function and how we influence these systems, giving us a big-picture understanding of the world and our place within it. Studying environmental science helps one comprehend the problems that have been created, and it illuminates ways to fix those problems and create a movement toward a sustainable society.

This course covers the basic concepts of Environmental science including environmental policy, interdependence and ecology, humans and the environment and green technology.

II. Course Objectives/Outline

Content Area:	**Environmental Science**		**Grade(s)**	**11-12**
Unit Plan Title:	**Earth History**	**Time Frame**	**3 Weeks**	
Learning Objectives				
• **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-ESS1-6** • **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-ESS1-5** • **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.** *Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.* **HS-ESS2-1** • **Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. HS-ESS2-7** • **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-LS4-5		
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	**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), *(Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2.)* **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • Plate tectonics is the unifying theory	**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)

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) - ***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. (HS-ESS1-6)	that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE) (secondary to 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. *(ESS2.B Grade 8 GBE)* (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** • 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.(secondary to HS-ESS1-5),(secondary to 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)	
Common Core		
• **Common Core Reading Standards** RST.10-12.1, RST.10-12.2, RST.10-12.3, RST.10-12.4, RST.10-12.6, RST.10-12.8, RST.10-12.9, RST.10-12.10 • **Common Core Writing Standards** WHST.10-12.1, WHST.10-12.2, WHST.10-12.4, WHST.10-12.6, WHST.10-12.9		

Content Area:	**Environmental Science**		**Grade(s)**	**11-12**
Unit Plan Title:	Ecosystem Dynamics	Time Frame	12 Weeks	
Learning Objectives				

- **Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** *Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.* **HS-LS2-1**
- **Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** *Assessment Boundary: Assessment is limited to provided data.* **HS-LS2-2**
- **Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. HS-LS2-3**
- **Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. HS-LS2-4**
- **Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. HS-LS2-5**
- **Evaluate 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-LS2-6**
- **Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS2-7**
- **Evaluate evidence for the role of group behavior on individuals and species chances to survive and reproduce. HS-LS2-8**

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 how relationships among variables between systems and their components in the natural and designed worlds • Develop and model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-	**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 non-living resources and from such challenges as predation, competition, and disease. Organisms would have the	**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)

5) **Using Mathematical 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. • 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 or revise explanations. (HS-LS2-2) • Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) **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 multiple and	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 of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Photosynthesis and cellular respiration provide most of the energy for life processes. (HS-LS2-3) • Plants or algae from 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	• 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) **Systems and System Models** • Models can be used to simulate systems and interactions-including energy, matter, and information flows-within and between systems at different scales. (HS-LS2-5) **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) • Energy drives the cycling of matter within and between systems. (HS-LS2-3) **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)

independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct and revise 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-LS2-3) • 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** 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 the natural and designed world. Arguments may also come from current scientific or historical episodes in science. • Evaluate the claims, evidence, and	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) • Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological and biological processes. (HS-Ls2-5) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • A complex set of interactions with in the 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 more or less to its original status, 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 resource and habit availability. (HS-LS2-2), (HS-LS2-6)	

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) **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), (HS-LS2-3) • 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)	• 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) **LS2.D: 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** • 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. (HS-LS2-7), (HS-LS4-6) **PS3.D: Energy in Chemical Processes** • The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (HS-LS2-5) **ETS1.B: Developing Possible Solutions** • When evaluating solutions it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics and to consider social, cultural, and environmental impacts. (HS-LS2-7)	

Common Core

- **Common Core Reading Standards**
  RST.10-12.1, RST.10-12.2, RST.10-12.4, RST.10-12.5, RST.10-12.6, RST.10-12.7, RST.10-12.8, RST.10-12.9, RST.10-12.10
- **Common Core Writing Standards**
  WHST.10-12.2, WHST.10-12.3, WHST.10-12.5, WHST.10-12.8

Content Area:	Environmental Science		Grade(s)	
Unit Plan Title:	Weather and Climate	Time Frame	3 Weeks	

Learning Objectives

- **Construct scientific arguments using data to support claims that spatial and temporal patterns in weather and climate found around the Earth are created by complex global, regional, and local interactions involving sunlight, and all of the Earth's spheres. 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.** *Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.* **HS-ESS2-4**
- **Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere as it relates to our climate system. HS-ESS2-6**
- **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-ESS3-5**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Students use, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6) **Analyzing and Interpreting Data** Students use more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	**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	**Patterns** • Empirical evidence is needed to identify patterns. (SLO-1) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) **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-ESS3-5)

• Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5) • 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. (SLO-1) --- ***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) • New technologies advance scientific knowledge. (HS-ESS3-5) **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based on empirical evidence. (HS-ESS3-5) • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4),(HS-ESS3-5)	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 re-radiation into space. (HS-ESS2-4) (SLO 1) • 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),(HS-ESS2-4)	

	ESS3.D: Global Climate Change • 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)	

Common Core

- **Common Core Reading Standards**
  RST.10-12.1, RST.10-12.2, RST.10-12.4, RST.10-12.6, RST.10-12.8, RST.10-12.9, RST.10-12.10
- **Common Core Writing Standards**
  WHST.10-12.3, WHST.10-12.5, WHST.10-12.7, WHST.10-12.9

Content Area:	Environmental Science		Grade(s)	11-12
Unit Plan Title:	Human Sustainability and Law/Policy	Time Frame	12 Weeks	

Learning Objectives

- **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-ESS3-1**
- **Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resource based on cost-benefit ratios. HS-ESS3-2**
- **Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. HS-ESS3-3**
- **Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-4**
- **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's systems. HS-ESS3-5**
- **Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. HS-ESS3-6**
- **Analyze the role the scientific community has in changing social and political conditions. ETS1.A**
- **Evaluate the environmental policy process described, from identification of a problem, through the enactment of federal laws. ETS1.A**

- **Construct an explanation based on the conflict and collaboration between individual interests and governmental agencies affect environmental policy. ETS1.A**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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 computational models in order to make valid and reliable scientific claims. (HS-ESS3-5) **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 non-linear functions, including trigonomic 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)	**ESS2.D Weather and Climate** • 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. (HS-ESS3-6) **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**	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about 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 Engineering,***

• 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 and 9-12 builds 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) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9-	• 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 require 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 the magnitudes of human impacts are greater than they have been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) • Through computer simulations and other studies, important discoveries are still being made about how the ocean, atmosphere,	***Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science 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) • Analysis of costs and benefits is a critical aspect of decisions about technology. (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**

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 the natural and designed world. 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 and principles, empirical evidence, and logical arguments regarding relevant factors (economic, societal, environmental, ethical considerations) (HS-ESS3-2)	and biosphere interact and are modified in response to human activities. (HS-ESS3-6) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell is a given design meets them. (HS-ETS1-1) • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy resources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ESS3-2) (HS-ESS3-	• Science and technology may rise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) • Scientific 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)

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Common Core

- **Common Core Reading Standards**
  RST.10-12.1, RST.10-12.2, RST.10-12.4, RST.10-12.5, RST.10-12.6, RST.10-12.8, RST.10-12.9, RST.10-12.10
- **Common Core Writing Standards**
  WHST.10-12.4, WHST.10-12.5, WHST.10-12.7, WHST.10-12.9, WHST.10-12.10

Content Area:	Environmental Science		Grade(s)
Unit Plan Title:	Green Technology	Time Frame	10 Weeks

Learning Objectives

- **Analyze and determine the wide scale impacts of how renewable energy, efficient energy management, and the use of sustainable construction materials impact our society, different cultures, and global community. *ETS1.A***
- **Make and defend a claim based on the wide scale adoption of emerging technologies presenting environmental risks and benefits. *ETS1.B***
- **Analyze and evaluate areas of green technologies that show the most potential in terms of positively affecting our initiative towards global environmental sustainability. *ETS1.B***
- **Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. *HS-ETS1-1***
- **Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. *HS-ETS1-2***
- **Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. *HS-ETS1-3***
- **Use a computer simulation to model the impact of proposed solutions to a complex real –world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. HS-ETS1-4**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions	**ETS1.A: Defining and Delimitating Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation	**Systems and System Models** • Models (e.g., physical, mathematical, computer) can be used to simulate systems and interactions-including energy, matter and information flows-

and design problems using models and simulations. • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **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 non-linear 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 and basic assumptions. • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **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 multiple and independent student-generated sources of evidence consistent with scientific ideas,	into account, and they should be quantified to the extent possible and stated in such a way that one can tell is a given design meets them. (HS-ETS1-1) • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy resources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3 • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical, and in making a persuasive	within and between systems at different scales. (HS-ETS1-4) 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 soma that were not anticipated. Analysis of cost and benefits is a critical aspect of decisions about technology. (HS-ETS1-1), (HS-ETS1-3)

principals, and theories. • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (HS-ETS1-2)	
Common Core		
• **Common Core Reading Standards** RST.10-12.1, RST.10-12.2, RST.10-12.4, RST.10-12.6, RST.10-12.8, RST.10-12.9, RST.10-12.10 • **Common Core Writing Standards** WHST.10-12.3, WHST.10-12.5, WHST.10-12.7, WHST.10-12.9		

III. Methods of Student Evaluation

Assessment can be divided into two general categories: formal (graded) and informal/classroom-based (both graded and ungraded). The key to effectively assessing a student's mastery of skills is to match the assessment method to the learning objective.

Formal Assessments

- Evaluation
- Class participation
- Creative assignments
- Homework and classwork assignments

- Reports and presentations
- Research methodology
- Technological applications
- Unit tests
- Various speaking and listening assignments
- Multiple choice exams
- Quizzes (announced and unannounced)
- Essays
- Formal lab reports
- Scientific journal reviews
- Projects
- Short answer and problem solving tests
- Tests and quizzes on blackboard
- Case Study analysis

Informal Assessments

- Instructor's observations of note-taking, and organization of notebooks and assignments
- Cooperative learning activities, including labs
- Creative project assignments
- Laboratory behavior
- Observing citizenship and appropriate social responses
- Instructor's observations of time management skills

Mastering of the core proficiencies of Biology shall be evaluated in accordance with the general grading policies as listed in the student handbook:

- Tests – 40%
- Laboratory Reports and Projects – 20%
- Quizzes – 20%
- Class Participation – 10%

- Homework – 10%

IV. Instructional Strategies Based on Instructional Goals

- Graphs and other visuals
- Engaging in discussions
- Reading silently and aloud
- Listening and speaking activities
- Watching and responding to media
- Brainstorming
- Listening
- Mapping
- Revising and editing
- Participating in small and large groups
- Researching to make connections to texts and classroom discussions
- Collaborative projects
- Answering questions (oral and written)
- Summarizing
- Debating
- Analyzing texts, discussions, etc.
- Peer teaching
- Competing in teams/debating
- Playing games
- Creating games
- Note taking and note making
- Writing

V. Scope and Sequence

Key: I – Introduced, D-developed in Depth, R-Reinforced

	Skill to be learned	9	10	11	12
1	Describe two basic concepts of economics. (5.4.12.G.6)			IDR	
2	Describe ways that economics are working toward sustainability. (5.4.12.G.6)			IDR	
3	Explain the purpose of environmental policy. (5.4.12.G.6)			IDR	
4	Describe the history of U.S. environmental policy (5.4.12.G.6)			IDR	
5	Describe the direction of current U.S. environmental policy. (5.4.12.G.6)			IDR	
6	Discuss different approaches to environmental policy. (5.4.12.G.6)			IDR	
7	Explain how logging is managed in U.S. national forests (5.4.12.G.6)			IDR	
8	Discuss the activities of U.S. and international agricultural organizations (5.4.12.G.6)			IDR	
9	Describe ways that mineral use can become more responsible (5.4.12.G.6)			IDR	
10	Explain how the provisions of the Clean Air Act have reduced air pollution in the United States. (5.4.12.G.6)			IDR	
11	Explain the strengths & weaknesses of the Kyoto Protocol. (5.4.12.G.6)			IDR	
12	Describe conventional waste disposal methods (5.4.12.G.6)			IDR	
13	Identify agencies that regulate hazardous waste. (5.4.12.G.6)			IDR	
14	Describe two major ways that Earth's systems interact. (5.4.12.G.7)			IDR	
15	Describe Earth's biosphere & atmosphere. (5.4.12.G.2)			IDR	
16	Describe the five carbon cycle. (5.4.12.G.7)			IDR	

17	Discuss the factors that influence an organism's niche. (5.3.12.E.3)			IDR	
18	Explain the difference between a producer & consumer. (5.3.12.C.1)			IDR	
19	Describe what happens to a community after a disturbance. (5.3.12C.2)			IDR	
20	Describe how net primary production varies among biomes. (5.3.12.C.1)			IDR	
21	List the major categories of freshwater ecosystems. (5.3.12.C.1)			IDR	
22	Explain two ways in which biodiversity varies across groups or geography. (5.3.12.C.1)			IDR	
23	List the major causes of biodiversity loss. (5.3.12.C.2)			IDR	
24	List the four characteristics used to classify soil. (5.4.12.C.1)			IDR	
25	Discuss how volcanoes affect human lives and property. (5.3.12.C.2)			IDR	
26	Discuss the role of wind patterns in determining climate. (5.4.12.F.1)			IDR	
27	Explain recent trends in population growth. (5.4.12.G.6)			IDR	
28	Describe the demographic transition (5.4.12.G.6)			IDR	
29	List the types of environmental health hazards. (5.3.12.C.2)			IDR	
30	Describe how infectious diseases spread. (5.3.12.C.3)			IDR	
31	Discuss where chemical hazards can be found in the environment. (5.3.12.C.2)			IDR	
32	Describe the environmental impacts of urbanization. (5.4.12.G.5)			IDR	
33	Explain the importance of mass transit options to a city & its residents. (5.4.12.G.5)			IDR	
34	List some of the ecological & economical values of forest resources. (5.4.12.G.6)			IDR	
35	Discuss the beginnings of agriculture. (5.4.12.G.5)			IDR	
36	Explain why the world needs to grow more food & to grow			IDR	

	it sustainably. (5.4.12.G.5)				
37	Describe different methods used for mining. (5.4.12.G.6)			IDR	
38	Relate the causes of surface water depletion to their effects. (5.4.12.G.6)			IDR	
39	Explain why groundwater pollution is difficult to clean up. (5.4.12.G.6)			IDR	
40	Identify evidence of global warming. (5.4.12.F.2)			IDR	
41	Explain how climate change is affecting people. (5.4.12.F.2)			IDR	
42	Explain the characteristics and uses of natural gas. (5.4.12.G.4)			IDR	
43	Differentiate green buildings from conventional buildings. (5.4.12.G.5)			IDR	
44	List ways to reduce greenhouse gases related to the use and generation of electricity. (5.4.12.F.2)			IDR	
45	Describe other strategies for reducing greenhouse gases. (5.4.12.F.2)			IDR	
46	Describe how a nuclear power plant generates electricity. (5.4.12.G.6)			IDR	
47	Contrast nuclear fusion with nuclear fission and explain the issues related to nuclear fusion. (5.4.12.G.6)			IDR	
48	Define biomass energy & explain how it is used. (5.4.12.G.6)			IDR	
49	Explain how river water can be used to generate electricity. (5.4.12.G.4)			IDR	
50	Describe how energy from the ocean can generate electricity. (5.4.12.G.4)			IDR	
51	Analyze the benefits & costs of solar energy. (5.4.12.G.6)			IDR	
52	Describe how hydrogen fuel can be produced. (5.4.12.G.4)			IDR	

VI. Pacing Chart

Unit 1: **Earth History** (*Week 1-3)*

Introduction to Environmental Science: (weeks 1-2) Students will learn how scientists uncover, research and solve environmental problems.

Earth's Environmental Systems: (weeks 3) Students will understand the interaction between the nonliving parts of Earth's systems and how they provide the basic materials to support life.

Unit 2: **Ecosystem Dynamics** *(Week 4-15)*

Population Ecology: (weeks 4-6) Students will learn how changes in population size relate and effect environmental conditions.

Evolution and Community Ecology: (weeks 7-9) Students will learn how organisms affect one another's survival and environment.

Biomes and Aquatic Ecosystems: (weeks 10-12) Students will learn how based on environmental conditions, that the lives of organisms are affected in various ways.

Biodiversity and Conservation: (weeks 13-15) Students will learn the importance of biodiversity for the sustainability of each biological and chemical system.

Unit 3: **Weather and Climate** (week 16-18)

Global Climate Change: (weeks 16-18) Students will learn causes and consequences of a warming Earth.

Unit 4: **Human Sustainability and Law/Policy** (Week 19-30)

Human Population: (week 19) Students will learn how human population affects the environment.

Environmental Health: (week 20) Students will learn the relationship between environmental health and our own health.

Urbanization: (week 21-22) Students will learn ways to balance human needs for housing and jobs with the needs of the environment.

Economics and Environmental Policy: (weeks 23-24) Students will understand how to best balance human interests and needs with the health of the environment by making informed decisions and studying policies.

Waste Management: (week 25) Student will learn the consequences of our choices as consumers and waste producers and how it affects our environment.

Forestry and Resource Management: (week 26) Students will learn Earth's resource sustainability.

Soil and Agriculture: (week 27) Students will learn to find balance for humans growing demand for food with while also protecting the environment.

Mineral Resources and Mining: (week 28) Students will learn mining techniques and focus on the costs of mining to the benefits.

Water Resources: (week 29) Students will learn Earth's available water resources and why we are running out.

The Atmosphere: (week 30) Students will learn about ways to ensure that clean air to breathe will be a sustainable resource.

Unit 5: **Green Technology** (Week 31-40)

Nonrenewable Resources: (weeks 31-32) Students will learn about the uses of nonrenewable energy resources and our energy needs.

Renewable Resources: (weeks 33-34) Students will learn about the potential uses and limitations of renewable energy sources

Renewable Energy Alternatives: (weeks 35-40) Students will learn what innovative technologies are being constructed to harness renewable energy more efficiently and the creation of sustainable cities and societies.

VII. **Proficiencies**

Upon successful completion of the requirements for this course, students will be able to:

1. Describe two basic concepts of economics. (5.4.12.G.6)
2. Describe ways that economics are working toward sustainability. (5.4.12.G.6)
3. Explain the purpose of environmental policy. (5.4.12.G.6)
4. Describe the history of U.S. environmental policy (5.4.12.G.6)
5. Describe the direction of current U.S. environmental policy. (5.4.12.G.6)
6. Discuss different approaches to environmental policy. (5.4.12.G.6)
7. Explain how logging is managed in U.S. national forests (5.4.12.G.6)
8. Discuss the activities of U.S. and international agricultural organizations (5.4.12.G.6)
9. Describe ways that mineral use can become more responsible (5.4.12.G.6)
10. Explain how the provisions of the Clean Air Act have reduced air pollution in the United States. (5.4.12.G.6)
11. Explain the strengths & weaknesses of the Kyoto Protocol. (5.4.12.G.6)
12. Describe conventional waste disposal methods (5.4.12.G.6)
13. Identify agencies that regulate hazardous waste. (5.4.12.G.6)
14. Describe two major ways that Earth's systems interact. (5.4.12.G.7)
15. Describe Earth's biosphere & atmosphere. (5.4.12.G.2)
16. Describe the five carbon cycle. (5.4.12.G.7)
17. Discuss the factors that influence an organism's niche. (5.3.12.E.3)
18. Explain the difference between a producer & consumer. (5.3.12.C.1)
19. Describe what happens to a community after a disturbance. (5.3.12C.2)
20. Describe how net primary production varies among biomes. (5.3.12.C.1)
21. List the major categories of freshwater ecosystems. (5.3.12.C.1)
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26. Discuss the role of wind patterns in determining climate. (5.4.12.F.1)

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41. Explain how climate change is affecting people. (5.4.12.F.2)
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47. Contrast nuclear fusion with nuclear fission and explain the issues related to nuclear fusion. (5.4.12.G.6)
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52. Describe how hydrogen fuel can be produced. (5.4.12.G.4)