Bloomfield Public Schools
Bloomfield, New Jersey 07003

Curriculum Guide
Environmental Science Honors
Grade 9

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Conforms to the Next Generation Science Standards and NJSLS Standards – Standards Revision

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Grade 9

Introduction: Students in the State of New Jersey and enrolled in Bloomfield High School must successfully complete three year-long science courses in order to meet the state mandated requirements for graduation. *Environmental Science* is a required course for all 9th grade students.

Environmental Science is a multidisciplinary field that draws from all others sciences, including: chemistry, biology, ecology, geography and Earth sciences, to help achieve practical goals. Such goals include the conservation and protection of natural resources on local, state and global levels through environmental education and research. Environmental science helps us to understand the connection between humans and the world in which we live. This course will allow students to identify and analyze environmental problems both natural and man-made, identify threats associated with these problems, and develop valid solutions to prevent these problems from reoccurring. Laboratory investigation and analysis as well as projects are an integral part of this course.

This curriculum is aligned with the *Next Generation Science Standards*, the C*ommon Core State Standards for English Language Arts & Literacy in Science, the Common Core State Standards for Math, and the New Jersey Core Curriculum Standards for Technology.*

This document is a tool that will provide an overview as to what to teach, when to teach it, and how to assess student progress. With considerations made for altered pacing, modifications, and accommodations; this document is to be utilized for all students enrolled in this course, regardless of ability level, native language, or classification. It is meant to be a dynamic tool that we, as educators, will revise and modify as it is used during the course of the school year.

Mapping/Sequence: The curriculum is written following the parameters of *Understanding by Design* using the New Jersey Model Curriculum for Environmental Science. The document is written as a series of units containing established transfer goals, enduring understandings, essential questions, and the necessary skills and knowledge a student must attain in a school year. The document includes units of study so that all students that all teachers must follow. Culminating assessments are a method for students to show attainment of set goals.

Pacing: The Environmental Science course focuses on five topics:

Unit 1: Ecosystem Dynamics

Unit 2: Human Sustainability

Unit 3: History of Earth

Unit 4: Earth's Systems

Unit 5: Weather and Climate

Resources: Electronic and text resources are listed in each unit. Teachers will be able to access the curriculum document on the district website.

Textbook: *Environmental Science* by Karen Arms, Holt

Established Goals: New Jersey Student Learning Standards

Science: http://www.nextgenscience.org/next-generation-science-standards

Common Core Math: http://www.state.nj.us/education/aps/cccs/math/

Common Core ELA: http://www.state.nj.us/education/aps/cccs/lal/

Technology: http://www.state.nj.us/education/cccs/2014/tech/

Modifications:
● Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ● Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). ● Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). ● Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). ● Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. ● Use project-based science learning to connect science with observable phenomena. ● Structure the learning around explaining or solving a social or community-based issue. ● Provide ELL students with multiple literacy strategies. ● Collaborate with after-school programs or clubs to extend learning opportunities. ● Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Unit #: 1	Unit Name: Ecosystem Dynamics	Unit Length: 30 days

How and why do organisms interact with their environment and what are the effects of these interactions?

Ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment. Ecosystems are dynamic, experiencing shifts in population composition and abundance and changes in the physical environment over time, which ultimately affects the stability and resilience of the entire system.

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [*Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.*]	**HS-LS2-1 and LS2.A**
2	**Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [*Assessment Boundary: Assessment is limited to provided data.*]	**HS-LS2-2 and HS-LS2.A & HS-LS2.C**
3	**Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy	**HS-LS2-4 and LS2.B**

	flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [*Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.*]	

4	**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.** [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]	**HS-LS2-6 and LS2.C**
5	**Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]	**HS-LS2-7 and LS2.C & LS4.D**
6	**Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]	**HS-LS2-8 and LS2.D**
* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.		

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking (pp. 64-67) ● Students use algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and	**LS2.A: Interdependent Relationships in Ecosystems** (pp. 150-152) • 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	**Cause and Effect** (pp. 87-89) • 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** (pp. 91-94)

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) **Constructing Explanations and Designing Solutions** (pp. 67-71) 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	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** (pp. 152-154) • 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	• 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** (pp. 94-96) • 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** (pp. 98-101) • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7)

on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) **Engaging in Argument from Evidence** (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • 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*** **Scientific Knowledge is Open to Revision in Light of New Evidence**	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** (pp. 154-156) • 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	

• 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)	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) **LS2.D: Social Interactions and Group Behavior** (pp. 156-157) • 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** (pp. 166-167) • Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human	

	activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.(secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.) **ETS1.B: Developing Possible Solutions** (pp. 206-208) • When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.(secondary to HS-LS2-7)	

Connections to other DCIs in this grade-band: **HS.PS3.B** (HS-LS2-4); **HS.PS3.D** (HS-LS2-4); **HS.ESS2.D** (HS-LS2-7);**HS.ESS2.E** (HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **HS.ESS3.A** (HS-LS2-2),(HS-LS2-7); **HS.ESS3.C** (HS- LS2-2),(HS-LS2-7); **HS.ESS3.D** (HS-LS2-2)
Articulation of DCIs across grade-bands: **MS.PS3.D** (HS-LS2-4); **MS.LS1.B** (MS-LS2-8); **MS.LS1.C** (HS-LS2-4); **MS.LS2.A** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6); **MS.LS2.B** (HS-LS2-4); **MS.LS2.C**(HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **MS.ESS3.A** (HS-LS2-1); **MS.ESS3.C** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **MS.ESS3.D** (HS-LS2-7)
Connections to Math and ELA Standards: *ELA/Literacy -* **RI.9-10.1.** Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.(HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-8) **RI.9-10.7.** Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8) **RI.9-10.8.** Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8) **W.9-10.2:** Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. (HS- LS2-1),(HS-LS2-2) **W.9-10.8.** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation**.** (HS-LS2-7) *Mathematics –* **MP.2:** Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),(HS-LS2-7) **MP.4:** Model with mathematics. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4) **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4*),*(HS-LS2-7) **HSN.Q.A.2:** Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7) **HSS-ID.A.1:** Represent data with plots on the real number line. (HS-LS2-6) **HSS-IC.A.1:** Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS- LS2-6) **HSS-IC.B.6:** Evaluate reports based on data. (HS-LS2-6)
Technology Standards: **8.1.12.E.1:** Effective use of digital tools assists in gathering and managing information. **8.2.12.A.3:** Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue. **8.2.12.C.1:** Develop an innovative solution to a complex, local or global problem or issue in collaboration with peers and experts, and present ideas for feedback in an online community. **8.2.12.C.4:** Explain and identify interdependent systems and their functions.

Unit Plan
Essential Question(s): *How do organisms interact with their environment? Why do organisms rely on other organisms for survival? What are the effects of organism interactions? How does knowing cycles in nature provide us with a better understanding of natural processes that influence our environment?*

Content Vocabulary	**Academic Vocabulary**	**Required Resources**

abiotic component biotic component respiration competition decomposer ecosystem food web invasive species photosynthesis producer resource speciation biogeochemical cellular community consumer reproduction energy-flow group-behavior migration predation renewable-	dominant isolation parameters survival interdependent mutually beneficial pollination variation	Environmental Science by Karen Arms, Holt http://www.hhmi.org/ http://www.nature.org/ http://www.ecology.com/ http://www.nationalgeographic.com/ http://www.nextgenscience.org

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Lorax http://sciencespot.net/Media/Loraxvideowkst.pdf http://www.lpscience.fatcow.com/jwanamaker/download/Lorax.pdf http://www.sjsd.k12.mo.us/cms/lib3/MO01001773/Centricity/Domain/2490/The%20Lorax.pdf	5 Engaging in argument from evidence
	Truax http://woodfloors.org/truax.pdf https://sciencecandoit.edublogs.org/2014/08/28/the-lorax-vs-the-truax/	5 Engaging in argument from evidence
	Environmental Simulation http://www.biologycorner.com/worksheets/environmentalaction.html	5 Asking questions and defining problems
	Easter Island reading/activity https://www.khanacademy.org/partner-content/big-history-project/what-is-big-history/what-are-disciplines/a/activity-easter-island-mystery	4
	Personal ecological footprint quiz Online http://www.earthday.org/take-action/footprint-calculator/?gclid=Cj0KEQjwjIy5BRClh8m_9Zu64d8BEiQAtZsQf_Gpo18GUuESMErBHBRnQv4nxE5Z4462Ieypilcr3zwaArJk8P8HAQ Paper http://www.greenfaith.org/files/ground-for-hope-long-island/ecological-footprint-worksheet/view	5 Asking questions and defining problems Using mathematics and Computational thinking

		Constructing explanations and designing solutions
	United Streaming Video-"More is Better-Biodiversity Story" www.discoveryeducation.com/	2,6
	Krakatoa Worksheet https://www.coursehero.com/file/13515629/79-Succession/	3 Analyzing and interpreting data
	"Life After People" video (History Channel)	3, 5
	Butterfly Mimicry http://www.anapsid.org/pdf/camoflage.pdf	6
	Succession computer simulation http://www.mrphome.net/mrp/succession.swf	3
EXPLORE	**Examples of Exploring Activities:**	
	Ecological Footprint (Holt Environmental Science Ancillary)	5 Asking questions and defining problems Using mathematics and Computational thinking Constructing explanations and designing solutions

	Owl Pellet (Holt Environmental Science Ancillary)	1-5
	Tragedy of the Commons (Goldfish Lab) http://earthwatch.org/Portals/0/Downloads/Education/Lesson-Plans/Go_Fish.pdf	5 Constructing explanations and designing solutions
	Kaibab Deer population graph http://www.biologycorner.com/worksheets/kaibab.html	1 ,2 Using mathematics and Computational thinking Analyzing and interpreting data Constructing explanations and designing solutions
	Calculating Land Area Use (Holt Environmental Science Ancillary)	5 Asking questions and defining problems Using mathematics and Computational thinking Analyzing and interpreting data

		Constructing explanations and designing solutions
	Human population graph file:///C:/Users/mstatham/Downloads/Population_Growth_Activity-2012.pdf	1 ,2 Using mathematics and Computational thinking Analyzing and interpreting data Constructing explanations and designing solutions
	Endangered species graph	1, 2 Using mathematics and Computational thinking Analyzing and interpreting data Constructing explanations and designing solutions
	Land to Mouth Graph http://fhs.dearbornschools.org/wp-content/uploads/sites/265/2014/09/From-land-to-mouth-graphing.pdf	3 Using mathematics and Computational thinking

		Analyzing and interpreting data Constructing explanations and designing solutions
	Myth of the Tragedy of the Commons reading http://climateandcapitalism.com/2008/08/25/debunking-the-tragedy-of-the-commons/	5 Engaging in argument from evidence
	Create Diagrams of the Cycles of the Earth (Holt Environmental Science Textbook)	3 Developing and using models

EXPLAIN	Examples of Explaining Activities:	
	Ecological Succession of Pond Ecosystem http://www.waterfordvalleyhigh.ca/staff/johnwalsh/courses/2200/ecosystems/successionworksheet.htm	3,5 Constructing explanations and designing solutions
	"How Ecosystems Change" Active reading (Holt Environmental Science Ancillary)	3
	"How Species Interact with One Another" Active reading (Holt Environmental Science Ancillary)	6
	Reading: Activity Mount St. Helens: A Succession Story https://www.plt.org/stuff/contentmgr/files/1/47089543432aae6ee76a2c1d9fd698cf/files/focus_on_forests_activity_2_sp_1_mount_st_helens.pdf	3 Asking questions and defining problems
ELABORATE	**Examples of Elaborating Activities:**	
	Tragedy of the Commons Debate	5 Engaging in argument from evidence
	Predation vs. Starvation of Deer and Wolf Population http://www.biologycorner.com/worksheets/predator_prey_graphing.html	1 , 2 Using mathematics and Computational thinking Analyzing and interpreting data

		Constructing explanations and designing solutions
	Random sampling lab https://www.biologycorner.com/worksheets/random_sampling.html	1 , 2 Constructing explanations and solutions Obtaining, evaluating, and communicating information Using mathematics and computational thinking Analyzing and interpreting data
	Wetland food web http://imcscience.weebly.com/uploads/2/2/8/3/22830706/food_webs_reading_break_homework.pdf	3 Developing and using models
	Food chain card game http://activities.tpet.co.uk/?resource=289#/ViewResource/id289	3
	Old Field Succession of Foley Field and Upper Memorial Park http://www.sites.ext.vt.edu/virtualforest/pdf/SuccessionActivitySheets.pdf	3 Developing and using a model

	Predator vs Prey (tools) http://www.esi.utexas.edu/files/beakadaptation_grade5.pdf	6 Analyzing and interpreting data Using mathematics and computational thinking
	Species interaction mini project-Students create poster describing different species interactions such as symbiosis, competition, predation, etc and present the information to the class	6 Obtaining, evaluating, and communicating information
	Mark and Recapture lab http://www.mychandlerschools.org/cms/lib6/AZ01001175/Centricity/Domain/735/MarkRecaptureLab.pdf https://www.biologycorner.com/worksheets/estimating_population_size.html	1 , 2 Constructing explanations and solutions Obtaining, evaluating, and communicating information Using mathematics and computational thinking Analyzing and interpreting data
	Quadrant sampling lab	1 ,2

	http://teacherweb.com/VA/MassaponaxHighSchool/FernandaKain/population_samplinglab.pdf	Constructing explanations and solutions Obtaining, evaluating, and communicating information Using mathematics and computational thinking Analyzing and interpreting data

EVALUATE	**Examples of Evaluating Activities:**	
	Forest Food Web activity-students create a food web including organisms that would be found in a forest ecosystem	3
	Old Field Succession of Foley Field and Upper Memorial Park http://www.sites.ext.vt.edu/virtualforest/pdf/SuccessionActivitySheets.pdf https://www.uwsp.edu/cnr.../**Activity**5S.pdf	3 Developing and using models

Unit #: 2	Unit Name: **Human Sustainability**	Unit Length: 55 days

How do Earth's surface processes and human activities affect each other?

Earth's surface processes affect and are affected by human activities. Humans depend on all of the planet's systems for a variety of resources, some of which are renewable or replaceable and some which are not. Natural hazards and other geologic events can significantly alter human populations and activities. Human activities, in turn, can contribute to the frequency, and intensity of some natural hazards.

The Storyline for Middle School Earth and Space Sciences provides a summary of the understandings that students developed by the end of 8th grade.

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
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.** *[Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]*	**HS-ESS3-1**
2	**Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** *[Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural*	**HS-ESS3-2**

	soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]	
3	**Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** *[Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.]* [Assessment Boundary: Assessment for computational simulations is limited to using provided multi- parameter programs or constructing simplified spreadsheet calculations.*]*	**HS-ESS3-3**
4	**Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** *[Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large- scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]*	**HS-ESS3-4**
5	**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** *[Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.]* [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*]*	**HS-ESS3-6**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking (pp. 64-67) Students use algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical 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) **Constructing Explanations and Designing Solutions** (pp. 67-71)	**ESS2.D: Weather and Climate** (pp. 186-189) ● 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) **ESS3.A: Natural Resources** (pp. 191-192) ● 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	**Cause and Effect** (pp. 87-89) • 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** (pp. 91-94) • 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** (pp. 98-101) • 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)

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) **Engaging in Argument from Evidence** (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments	technologies and social regulations can change the balance of these factors. (HS-ESS3-2) **ESS3.B: Natural Hazards** (pp. 192-194) ● 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** (pp.194-196) ● 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** (pp. 196-198)	• 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)

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 (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)	• 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) **ETS1.B: Developing Possible Solutions** (pp. 206-208) • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS3-2),(secondary HS-ESS3-4)	• 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** • 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)

Connections to other DCIs in this grade-band: **HS.PS1.B** (HS-ESS3-3); **HS.PS3.B** (HS-ESS3-2); **HS.PS3.D** (HS-ESS3-2); **HS.LS2.A** (HS-ESS3-2),(HS-ESS3-3); **HS.LS2.B** (HS-ESS3-2), (HS-ESS3-3),(HS-ESS3-6); **HS.LS2.C**(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.LS4.D** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.ESS2.A** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); **HS.ESS2.E**(HS-ESS3-3)
Articulation of DCIs across grade-bands: **MS.PS1.B** (HS-ESS3-3); **MS.PS3.D** (HS-ESS3-2); **MS.LS2.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.LS2.B** (HS-ESS3-2),(HS-ESS3-3); **MS.LS2.C** (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.LS4.C** (HS-ESS3-3); **MS.LS4.D** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS2.A** (HS-ESS3-1),(HS-ESS3-3),(HS-ESS3- 4),(HS-ESS3-6);**MS.ESS2.A** HS-ESS3-1),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.ESS2.C** (HS-ESS3-6); **MS.ESS3.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS3.B** (HS-ESS3-1),(HS-ESS3-4); **MS.ESS3.C** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.ESS3.D** (HS-ESS3-4),(HS-ESS3-6)
Connections to Math and ELA Standards: *ELA/Literacy -* **RI.9-10.1.** Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.(HS-ESS3-1),*(*HS-ESS3-2),(HS-ESS3-4)

RI.9-10.8. Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning.(HS-ESS3-2),(HS-ESS3-4) **W.9-10.2:** Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. (HS- ESS3-1) *Mathematics –* **MP.2:** Reason abstractly and quantitatively. (HS-ESS3-1),(HS- ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6) **MP.4:** Model with mathematics. (HS-ESS3-3),(HS-ESS3-6) **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6) **HSN.Q.A.2:** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6) **HSN.Q.A.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)
Technology Standards: **8.1.12.E.1:** Effective use of digital tools assists in gathering and managing information. **8.2.12.A.3:** Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue. **8.2.12.C.1:** Develop an innovative solution to a complex, local or global problem or issue in collaboration with peers and experts, and present ideas for feedback in an online community. **8.2.12.C.4:** Explain and identify interdependent systems and their functions.

Unit Plan
Essential Question(s): *How do man's activities impact our environment and future on Earth? How do we ensure that we don't run out of natural resources? What can you do to help maintain a stable Earth?*

Content Vocabulary	**Academic Vocabulary**	**Required Resources**

agriculture arable land commerce deforestation natural hazard consumption pollutant recycle sustainability alternative energy biodiversity conservation disease per-capita variation population-growth rural urbanization	computational model cost-benefit analysis extraction prototype risk-assessment solution value yield constraint economics optimal regulation simulation technology waste	*Environmental Science* by Karen Arms, Holt *Environmental issues* by K. Miller NJDEP suggestions for environmental problems – endangered species act and wetland protection laws http://www.nj.gov/dep/ Concord Consortium (sample lessons) http://concord.org/stem-resources/grade-level/high-school http://www.ene.com/ NJ Vertical Farm reading: http://gizmodo.com/the-worlds-largest-indoor-vertical-farm-is-being-built-1717140120 http://www.nextgenscience.org

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Lab-Cookie Mining https://www.epcc.edu/InstructionalPrograms/geologicalsciences/Geology%201102%20Lab/1102%20Lab%20Cookie%20Mining.pdf	1 Planning and carrying out investigations

		Analyzing and interpreting data
	Lab-Modeling the Mining Process (Holt Environmental Science Ancillary)	1 Planning and carrying out investigations Analyzing and interpreting data
	Timeline of human revolutions (HG, agricultural, industrial, technological) and impact on environment and society (cause/effect) using the textbook and the internet	1
Explore		
	Renewable/Nonrenewable activity (Holt Environmental Science Textbook)	1
	Map Activity- Miner Production in the US (Holt Environmental Science textbook p 464)	2
	Energy Sources in the United States graphic organizer	2
	Creating a Land Use Model (Holt Environmental Science Ancillary) http://kistlerd.weebly.com/uploads/1/3/9/9/13990404/lab_creating_a_land_use_model.pdf	3 Developing and using models Constructing explanations and designing solutions

		Obtaining, evaluating, and communicating information
	Eutrophication lab (Holt Environmental Science textbook p 204-205)	4
	Groundwater filter lab (Holt Environmental Science textbook Pg. 320-1)	4
Explain		
	Energy Resources Writing Prompt (Holt Environmental Science textbook p 489)	2 Obtaining, evaluating, and communicating information
	Reading activity and writing prompt: Making a Difference: Restoring the Range (Holt Environmental Science textbook p 404-405)	4
	Essay on why man is his own worst enemy as related to our environment	5 Asking questions and defining problems Obtaining, evaluating, and communicating information
	How will Human population grow? (Holt Environmental Science textbook pg. 254-5)	3 Analyzing and interpreting data

		Using mathematics and computational thinking
	Graphic organizer of pros and cons of environmental problems	4, 5 Obtaining, evaluating, and communicating information
	Reading: Coral Reefs at Risk http://coralreef.noaa.gov/aboutcrcp/strategy/reprioritization/wgroups/resources/climate/resources/reefsatrisk.pdf	5
Elaborate		
	Lab-Identifying Sustainable Rainforest Products (Holt Environmental Science Ancillary)	1
	Protecting the Amazon activity http://education.nationalgeographic.org/activity/protecting-biodiversity-amazon-rain-forest/	4 Asking questions and defining problems
	Webquest-Interaction with in the Earth's Atmosphere http://education.nationalgeographic.org/activity/interactions-earths-atmosphere/	5
	Geopolitical relationships: environment and Law – choose an environmental law to evaluate. Using a 5-paragraph essay to describe the nature of the law, what it was meant to protect, and the ramifications of the law.	2 Obtaining, evaluating, and communicating information
	Schoolyard Biodiversity http://www.fishwildlife.org/files/ConEd-Schoolyard-Biodiversity-Guide.pdf	5

		Developing and using models
Evaluate		
	Project- Looking at Different resources that are available in different biomes	1 Obtaining, evaluating, and communicating information
	Reading And writing prompt-Colton and the War in the Congo (Holt Environmental Science textbook p 465)	1 Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Lab-Your Household Energy Consumption (Holt Environmental Science ancillary)	1 Analyzing and interpreting data Constructing explanations and designing solutions

		Obtaining, evaluating, and communicating information
	Evaluating Land Use (Holt Environmental Science ancillary)	3 Analyzing and interpreting data Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Lab-Modifying packaging to be eco-friendly (Holt Environmental science ancillary)	4 Asking and defining problems Constructing explanations and designing solutions Obtaining, evaluating, and communicating information

	Identify one current human activity which has directly led to a debilitating disease. Discuss the pros and cons of the activity. Write a position paper supporting one view, for or against, and use evidence for support.	2 Asking questions and defining problems Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Lab-Analyzing Water Use (Holt Environmental science ancillary)	4 Asking questions and defining problems Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Research a lost population and write an essay to describe the community and environment. Provide scientific evidence to support your theory as to why the civilization disappeared (Holt Environmental Science textbook pg. 257)	1, 2 Asking questions and defining problems Constructing explanations and designing solutions

		Obtaining, evaluating, and communicating information
	Make a sustainable resort https://www.teachengineering.org/view_curricularunit.php?url=collection/van_/curricular_units/van_biomimicry_curricularunit/van_biomimicry_curricularunit.xml	1, 2, 3, 4, 5 Asking questions and defining problems Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Stabilization wedges game http://cmi.princeton.edu/wedges/game.php	2
	Land and People: Finding a Balance http://www.earthsciweek.org/classroom-activities/land-and-people-finding-balance	4 Asking questions and defining problems Analyzing and Interpreting data Constructing explanations and designing solutions

		Obtaining, evaluating, and communicating information

Unit #: 3	Unit Name: **History of Earth**	Unit Length: 35 days

Essential Question: How do people reconstruct and date events in Earth's planetary history?

Earth scientists use the structure, sequence, and properties of rocks, sediments, and fossils, as well as locations of current and past ocean basins, lakes, and rivers, to reconstruct events in Earth's planetary history.

The Storyline for Middle School Earth and Space Sciences provides a summary of the understandings that students developed by the end of 8th grade.

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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.** *[Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]*	**HS-ESS1-6**
2	**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.** *[Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).]*	**HS-ESS1-5**
3	**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.** *[Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and*	

	plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] *[Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.]*	**HS-ESS2-1**

4	**Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** *[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.]* *[Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]* *Teacher Note: This PE is used in both units 1 and 2. The emphasis of the PE is slightly different in each unit. The focus of HS-ESS2-7 in Unit 1 is on the how the diversity of organisms found in our fossil evidence as recorded over geologic time provides evidence for changing environments. The focus HS-ESS2-7 in Unit 2 is on how the chemical changes in the various Earth Systems have lead to the evolution of life over time.*	**HS-ESS2-7**
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.** *[Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.* *Teacher Note: Within this unit the focus of this SLO is on the relationship of various life forms found in the fossil record over geologic time and the environmental conditions within the Earth system which may have precipitated the changes in life forms.*	**HS-LS4-5**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59) 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** (pp. 67-71) Students construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ● 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)	**ESS1.C: The History of Planet Earth** (pp. 177-179) ● 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** (pp. 179-182) ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), *(Note:*	**Patterns** (pp. 85-87) ● Empirical evidence is needed to identify patterns. (HS-ESS1-5) **Stability and Change** (pp. 98-101) ● 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** (pp. 87-89) ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-5)

Engaging in Argument from Evidence (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ● 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	*This Disciplinary Core Idea is also addressed by HS-ESS2-2.)* **ESS2.B: Plate Tectonics and Large-Scale System Interactions** (pp. 182-183) ● 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. *(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** (pp. 186-189) ● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7) **ESS2.E Biogeology** (189-190)	

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)	● 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** (pp. 111-113) ● 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** (pp. 164-166) ● 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)	

Connections to other DCIs in this grade-band: **HS.PS2.A** (HS-ESS1-6); **HS.PS2.B** (HS-ESS1-6),(HS-ESS2-1); **HS.PS3.B** (HS-ESS1-5); **HS.ESS2.A** (HS-ESS1-5); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.C** (HS-ESS2-7);**HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-7); **HS.LS4.D** (HS-ESS2-7) **HS.LS2.A** (HS-LS4-5); **HS.LS2.D** (HS-LS4-5); **HS.LS3.B** (HS-LS4-5); **HS.ESS2.E** (HS-LS4-5); **HS.ESS3.A** (HS-LS4-5)
Articulation of DCIs across grade-bands: **MS.PS2.B** (HS-ESS1-6),(HS-ESS2-1); **MS.LS2.B** (HS-ESS2-1); **MS.ESS1.B** (HS-ESS1-6); **MS.ESS1.C** (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1); **MS.ESS2.A** (HS-ESS1-5),(HS- ESS1-6),(HS-ESS2-1); **MS.ESS2.B** (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1); **MS.ESS2.C** (HS-ESS2-1); **MS.ESS2.D** (HS-ESS1-1); **MS.LS2.A** (HS-ESS2-7); **MS.LS2.C** (HS-ESS2-7); **MS.LS4.A** (HS-ESS2-7); **MS.LS4.B** (HS-ESS2-7); **MS.LS4.C** (HS-ESS2-7); **MS.ESS1.C** (HS-ESS2-7); **MS.ESS2.A** (HS-ESS2-7); **MS.ESS2.C** (HS-ESS2-7); **MS.ESS3.C** (HS- ESS2-7) **MS.LS2.A** (HS-LS4-5); **MS.LS2.C** (HS-LS4-5); **MS.LS4.C** HS-LS4-5); **HS.ESS3.C** (HS-LS4-5)
Connections to Math and ELA Standards: ELA/Literacy -

RI.9-10.1. Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain. (HS-ESS1-5),(HS-ESS1-6), (HS-LS4-4)
RI.9-10.8. Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning. (HS-ESS1-5),(HS-ESS1-6), (HS-LS4-5)
W.9-10.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. B. Develop claim(s) and counterclaims avoiding common logical fallacies, propaganda devices, and using sound reasoning, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.(HS-ESS1-6); (HS-ESS2-7)
W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. (HS-ESS1-2), (HS-ESS1-5), (HS-LS4-4)
W.9-10.9. Draw evidence from literary or nonfiction informational texts to support analysis, reflection, and research**.**(HS-LS4-4),(HS-LS4-5)
SL.9-10.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. (HS-ESS2-1)

Mathematics –
MP.2: Reason abstractly and quantitatively. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1),(HS-LS4-4),(HS-LS4-5)
MP.4: Model with mathematics. (HS-ESS2-1)
HSN-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)
HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)
HSN-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)
HSF-IF.B.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)
HSS-ID.B.6b: Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology. (HS-ESS1-6)

Technology Standards:
8.1.12.E.1: Effective use of digital tools assists in gathering and managing information.
8.2.12.A.3: Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.
8.2.12.C.1: Develop an innovative solution to a complex, local or global problem or issue in collaboration with peers and experts, and present ideas for feedback in an online community.
8.2.12.C.4: Explain and identify interdependent systems and their functions.

Unit Plan

Essential Question(s): *What is the importance of knowing Earth's history? How do people reconstruct & date events in Earth's planetary history? In order to solve environmental problems we must first understand how Earth works and identify solutions based on that.*

Content Vocabulary		Academic Vocabulary		Required Resources
absolute-age	asteroid	accumulation	affect/effect	*Environmental Science* by Karen Arms, Holt • Chapters 1 &2
coevolution	convection	analysis	billion	
density	epoch	catastrophic	concentration	http://www.nasa.gov/
era	erode	controls	decipher	
evolution	extinction	evidence	generation	http://www.usgs.gov/
feedback-effect	fossil-record	morphological	phenomenon	
geologic age	glaciation	physiological	stable/stability	http://www.nextgenscience.org
isotope	magnetic field	variable		
mantle-convection	matter			
meteorite	organism			
period	plate-tectonics			
probe	radioactive decay			
relative age	sediment			
spatial scale	temporal scale			
thermal convection				

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Big bang theory simulation http://www.dailymail.co.uk/sciencetech/article-2622616/Virtual-world-tops-cosmic-charts-scale-rigor.html	1
	Video-Forces that Shape the Earth (United Streaming) www.discoveryeducation.com/	3
	EarthViewer (IPAd or Android) or for Chrome browsers: Students explore the co-evolution of the geology and biology found on Earth to develop arguments from evidence for the co-evolution of geology and biology found on Earth. If IPads, Androids or Chrome browsers are not available, similar interactives may be found at this link, and this link. https://www.hhmi.org/biointeractive/classroom-activities-earthviewer	4 ,5 Engaging in argument from evidence Obtaining, evaluating, and communicating information
	Understanding large numbers activity http://mathforum.org/sanders/geometry/GP10BillionEtc.html	1 Using mathematics and computational thinking
EXPLORE	**Examples of Exploring Activities:**	

	A model of floor spreading activity http://joidesresolution.org/sites/default/files/Seafloor_Spreading.pdf	3 Developing and using models
	Hotspot Lesson http://serc.carleton.edu/sp/erese/hotspot-theory-plate-velocities.html	2 Analyzing and interpreting data Using mathematics and computational thinking Obtaining, evaluating and communicating information
	Unraveling Earth's Early History (NGSS Sample Task) http://www.nextgenscience.org/sites/ngss/files/HS-ESS_EarlyEarth%20Nov%202014.pdf	1 Developing and using modeling Using mathematics and computational thinking Constructing explanations and designing solutions Obtaining, evaluating, and communicating information

	Plate tectonics activity file:///C:/Users/Michelle/Downloads/dinos_plate_tectonics.pdf	2 Developing and using models Constructing explanations and designing solutions
EXPLAIN	**Examples of Explaining Activities:**	
	Plate tectonics puzzle activity (Pangaea) file:///C:/Users/mstatham/Downloads/dinos_plate_tectonics.pdf	2 Constructing explanations and designing solutions
	Life cycle of a star webquest http://www.ck12.org/earth-science/Life-Cycles-of-Stars/lesson/The-Life-Cycle-of-a-Star-PPC/	1
	Radiometric dating lab http://www.nsta.org/images/news/legacy/scope/0604/jordanradiometrics.pdf	2 Using Mathematics and computational thinking
	The Decay Curve of Twizzlers http://www.biologycorner.com/worksheets/decay_twizzlers.html	2 Using Mathematics and computational thinking
ELABORATE	**Examples of Elaborating Activities:**	
	IRIS - Measuring the Rate of Plate Motion: Students compare GPS data of plate motion to determine the rate at which tectonic plates move. Alternatively, students use real-time plate motion data from UNAVCO to determine the rate at which plates move. http://www.iris.edu/hq/programs/education_and_outreach/animations/14	2 Analyzing and interpreting data
EVALUATE	**Examples of Evaluating Activities:**	

	Construct an account of Earth's formation and early history using fossil evidence, relative dating, and radiometric dating http://serc.carleton.edu/NAGTWorkshops/time/activityposter/11569.html	1 Analyzing and interpreting data

Unit #: 4	Unit Name: **Earth's Systems**	Unit Length: 35 days

How and why is Earth constantly changing?

Earth's surface is a complex and dynamic set of interconnected systems- principally the geosphere, hydrosphere, atmosphere, and biosphere – that interact over a wide range of temporal and spatial scales. All of the Earth's processes are the result of energy flowing and matter cycling within and among these systems.

The Storyline for Middle School Earth and Space Sciences provides a summary of the understandings that students developed by the end of 8th grade.

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** *[Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]*	**HS-ESS2-2**
2	**Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.** *[Clarification Statement: Emphasis is on both a one-dimensional model of*	

	Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.]	**HS-ESS2-3**
3	**Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** *[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]*	**HS-ESS2-5**
4	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** *[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]* *Teacher Note: HS-ESS2-6 appears in units 2 and 3. The focus of HS-ESS2-6 in Unit 2 is on the cycling of carbon among all of Earth's spheres including the residence time and spatial distribution of carbon in each of these spheres. The focus HS-ESS2-6 in Unit 3 is on link between the carbon cycle and our climate system including residence time and spatial distribution of carbon in each of these spheres.*	**HS-ESS2-6**
5	**Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** *[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land*	

	increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.*]* *Teacher Note: HS-ESS2-7 initially appears in Unit 1. In this unit the focus of HS-ESS2-7 is on how the chemical changes in the various Earth Systems have led to the evolution of life over time.*	**HS-ESS2-7**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59) Students use, synthesize, and develop 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-ESS2-3),(HS-ESS2-6) **Planning and Carrying Out Investigations** (pp.59-61) Students plan and carrying out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations	**ESS2.A: Earth Materials and Systems** (pp. 179-182) ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) ● Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational	**Energy and Matter** (pp. 94-96) ● The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) ● Energy drives the cycling of matter within and between systems. (HS-ESS2-3) **Structure and Function** (pp. 96-98) ● The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5) **Stability and Change** (pp. 98-101) ● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7) ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5) **Analyzing and Interpreting Data** (pp. 61-63) Students analyze data using 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) **Engaging in Argument from Evidence** (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	movement of denser materials toward the interior. (HS-ESS2-3) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** (pp. 182-183) ● The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) **ESS2.C: The Roles of Water in Earth's Surface Processes** (pp. 184-186) ● The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the	--- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS2-3) **Influence of Engineering, Technology, and Science 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

● Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7) -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based on empirical evidence. (HS-ESS2-3) ● Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-ESS2-3) ● Science includes the process of coordinating patterns of evidence with current theory. (HS- ESS2-3)	viscosities and melting points of rocks. (HS-ESS2-5) **ESS2.D: Weather and Climate** (pp. 186-189) ● The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2) ● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) ● Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) **ESS2.E Biogeology** (189-190) ● 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)	a critical aspect of decisions about technology. (HS-ESS2-2)

Connections to other DCIs in this grade-band: **HS.PS1.A** (HS-ESS2-5),(HS-ESS2-6); **HS.PS1.B** (HS-ESS2-5),(HS-ESS2-6); **HS.PS2.B** (HS-ESS2-3); **HS.PS3.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5); **HS.PS3.D** (HS-ESS2-3),(HS-ESS2-6); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS2-6); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.B** (HS-ESS2-2),(HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2),(HS-ESS2-7);**HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-7); **HS.LS4.D** (HS-ESS2-2),(HS-ESS2-7); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-6)
Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6); **MS.PS1.B** (HS-ESS2-3); **MS.PS2.B** (HS-ESS2-3); **MS.PS3.A** (HS-ESS2-3); **MS.PS3.B** (HS-ESS2-3) **MS.PS3.D** (HS-ESS2-2),(HS-ESS2-6); **MS.PS4.B** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **MS.LS2.A** (HS-ESS2-7); **MS.LS2.B**(HS-ESS2-2),(HS-ESS2-6); **MS.LS2.C** (HS-ESS2-2),(HS-ESS2-7); **MS.LS4.A** (HS-ESS2-7); **MS.LS4.B** (HS-ESS2-7); **MS.LS4.C** (HS-ESS2-2),(HS-ESS2-7); **MS.ESS1.C** (HS-ESS2-7); **MS.ESS2.A** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS- ESS2-6),(HS-ESS2-7); **MS.ESS2.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS2.D** (HS-ESS2-2),(HS- ESS2-5); **MS.ESS3.C** (HS-ESS2-2),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS3.D** (HS-ESS2-2),(HS-ESS2-6)
Connections to Math and ELA Standards: *ELA/Literacy -* **RI.9-10.1.** Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain. (HS-ESS2-2),(HS-ESS2-3) **RI.9-10.2.** Determine a central idea of a text and analyze how it is developed and refined by specific details; provide an objective summary of the text. (HS-ESS2-2) **W.9-10.1:** Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. B. Develop claim(s) and counterclaims avoiding common logical fallacies, propaganda devices, and using sound reasoning, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.(HS-ESS2-7) **W.9-10.8.** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation**.**

(HS-ESS2-5) **SL.9-10.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. (HS-ESS2-3) *Mathematics –* **MP.2:** Reason abstractly and quantitatively. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6) **MP.4:** Model with mathematics. (HS-ESS2-3),(HS-ESS2-6) **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6) **HSN.Q.A.2:** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-3),(HS-ESS2-6) **HSN.Q.A.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6)
Technology Standards: **8.1.12.E.1:** Effective use of digital tools assists in gathering and managing information**.** **8.2.12.A.3:** Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue. **8.2.12.C.1:** Develop an innovative solution to a complex, local or global problem or issue in collaboration with peers and experts, and present ideas for feedback in an online community. **8.2.12.C.4:** Explain and identify interdependent systems and their functions.

Unit Plan
Essential Question(s): *How and why is Earth constantly changing? Where does matter come from? How does matter and energy affect our daily lives?*

Content Vocabulary		Academic Vocabulary	Required Resources
atmosphere	biogeology	adaptation	*Environmental Science* by Karen Arms, Holt
biosphere	climate	alteration	• Chapter 3, 6, & 7
crystallization	current	combustion	
earthquake	ecosystem	cycling	www.sciencedirect.com
geosphere	global-carbon	geography	
cycle	weather	interaction	www.serc.carlton.edu
hydrosphere	landform	seasonal	
lithosphere	mid-ocean ridge		http://www.nextgenscience.org
nutrient cycling	plate-boundaries		
plateau	precipitation		
reservoir	salinity		
subduction	unifying theory		
volcano			

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Video-What is the water Cycle? (United Streaming) www.discoveryeducation.com/	3
	Graphing and lab report: Analyzing global climate change using sea ice extent data http://seagrant.uaf.edu/marine-ed/curriculum/grade-8/investigation-1.html	1 Analyzing and interpreting data Using mathematics and computational thinking
	Greenhouse Effect: Students explore the atmosphere during the ice age and today. What happens when you add clouds? Change the greenhouse gas concentration and see how the temperature changes. Then compare to the effect of glass panes. Zoom in and see how light interacts with molecules. Do all atmospheric gases contribute to the greenhouse effect? https://phet.colorado.edu/en/simulation/greenhouse	2,4 Asking questions and defining problems Constructing explanations and designing solutions Obtaining, evaluating, and communicating information

	Carbon and Climate: Students run a model of carbon sources and sinks and interpret results to develop their own model of the relationship of the carbon cycle to the Earth's climate. Students can also work through the content of the entire module called Carbon Connections which includes numerous models and interactives to gain a deeper understanding of the role of carbon in the climate system. http://carboncycle.aos.wisc.edu/carbon-budget-tool/	2,4 Developing and using models Analyzing and interpreting data
	Reading: Coevolution of Soil and water conservation policy and human-environment linkages in the Yellow River Basin since 1949 http://www.ncbi.nlm.nih.gov/pubmed/25478653	3
EXPLORE	**Examples of Exploring Activities:**	
	Water-The Universal Solvent Lab Activity www.eastpennsd.org/teacherpages/.../**Universal**%20**Solvent**%20Inquiry%20Lab.doc or http://www.doe.virginia.gov/testing/sol/standards_docs/science/2010/lesson_plans/grade6/matter/sess_6-5a.pdf	3
	Properties of water Lab Activity https://www.lsrhs.net/elenbaasp/Sites/Biology/Biochemistry_files/waterlabbio2.pdf	3 Analyzing and interpreting data
	Properties of water computer simulation http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT10/CT10.html	3
	Graphing and lab report: Analyzing global climate change using sea ice extent data	1

	http://seagrant.uaf.edu/marine-ed/curriculum/grade-8/investigation-1.html	Analyzing and interpreting data Using mathematics and computational thinking Obtaining, evaluating and communicating information
	Stream table / erosion https://www.lsrhs.net/departments/science/faculty/brandesa/handouts4/StreamTableLab.pdf	1, 3
	USGS Realtime Water data and Climate data: Students create and run an investigation to determine the relationship between streamflow and precipitation data, or another parameter. http://waterdata.usgs.gov/nj/nwis/rt	3 Asking question and defining problems Planning and carrying out investigations Analyzing and interpreting data Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Create a 3-d model of the water cycle and describe the step evident	2

	http://www.raftcolorado.org/ideas/Water%20Cycle%20in%203D.pdf	Developing and using models
	Model cycling of matter by thermal convection: 1D of energy, 3D model of tectonics https://www.lsrhs.net/departments/science/faculty/brandesa/handouts3/PlateMovementLab.pdf http://www.education.com/science-fair/article/convection-movement-heat-fluids/	2 Developing and using models
	Weathering Lab http://www.northwestern.k12.oh.us/userfiles/231/Classes/5543/Weathering%20Lab.pdf	1

EXPLAIN	**Examples of Explaining Activities:**	
	Graphing and lab report: Analyzing global climate change using sea ice extent data http://seagrant.uaf.edu/marine-ed/curriculum/grade-8/investigation-1.html	1 Analyzing and interpreting data Using mathematics and computational thinking
	Graphing CO_2 levels http://www.rhfleet.org/sites/default/files/files/lesson-plans/tw_GreenhouseWarmingWhatIsIt.pdf	2,4 Analyzing and interpreting data Using mathematics and computational thinking
ELABORATE	**Examples of Elaborating Activities:**	
	Earth Systems Activity: Students model the carbon cycle and its connection with Earth's climate.	2,4 Developing and using models Analyzing and interpreting data
EVALUATE	**Examples of Evaluating Activities:**	
	Images of change-Students explore these images of the impacts of climate change over time to develop explanations from evidence of how an impact in one component of the Earth system has effects in other components of the Earth system http://climate.nasa.gov/state_of_flux#Lyell-Glacier-1883-2015-930px.jpg	1 Asking questions and defining problems Analyzing and interpreting data

		Constructing explanations and designing solutions
	Carbon Cycle Web based game https://www.windows2universe.org/earth/climate/carbon_cycle.html Carbon cycle paper based game http://oceanservice.noaa.gov/education/pd/climate/teachingclimate/carbon_cycle_game.pdf	4
	Build a Beast Activity http://necsi.edu/projects/evolution/activities/build-a-beast/activities_beast.html	5
	Newspaper Camouflage http://necsi.edu/projects/evolution/activities/newspaper/activities_newspaper.html	5

Unit #: 5	Unit Name: **Weather and Climate**	Unit Length: 25 days

What regulates weather and climate?
Weather and climate are shaped by complex interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions can drive changes that occur over multiple time scales—from days, weeks, and months for weather to years, decades, centuries, and beyond—for climate. The Storyline for Middle School Earth and Space Sciences provides a summary of the understandings that students developed by the end of 8th grade.

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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.** *[Clarification Statement: Emphasis is on interpretation of weather and climate data and data representations that model how weather and climate elements (temperature, pressure, wind, moisture content) are affected by numerous controls of weather and climate such as latitude, distribution of land and water, general circulation of the atmosphere, general circulation of the oceans, altitude, topographic barriers, storms.]*	**HS-ESS2-4**
2	**Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** *[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.]* [Assessment Boundary: Assessment of the results of	**HS-ESS2-4**

	changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]*	
3	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere as it relates to our climate system.** *[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]* ***Teacher Note:*** *HS-ESS2-6 appears in both units 2 and 3. The HS-ESS2-6 in Unit 3 is a link between the carbon cycle and our climate system including residence time and spatial distribution of carbon in each of these spheres.*	**HS-ESS2-6**
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 systems.** *[Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).]* [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.*]*	**HS-ESS3-5**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59) 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).	**ESS1.B: Earth and the Solar System** (pp. 175-176) ● 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	**Patterns** (pp. 85-87) ● Empirical evidence is needed to identify patterns. (SLO-1) **Cause and Effect** (pp.87-89)

- 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** (pp. 61-63) Students use 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) - 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**	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** (pp. 179-182) 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** (pp. 186-189)	- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) **Stability and Change** (pp. 98-101) - 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)

• 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)	• 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** (pp. 196-198) • 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)	

Connections to other DCIs in this grade-band: **HS.PS1.A** (HS-ESS2-6); **HS.PS1.B** (HS-ESS2-6); **HS.PS3.A** (HS-ESS2-4); **HS.PS3.B** (HS-ESS2-4),(HS-ESS3-5); **HS.PS3.D** (HS-ESS3-5), (HS-ESS2-6); **HS.LS1.C** (HS-ESS3-5), (HS-ESS2-6); **HS.LS2.B** (HS-ESS2-6); **HS.LS2.C** (HS-ESS2-4); **HS.ESS1.C** (HS-ESS2-4); **HS.ESS2.D**(HS-ESS3-5); **HS.ESS3.C** (HS-ESS2-4), (HS-ESS2-6); **HS.ESS3.D** (HS- ESS2-4), (HS-ESS2-6)
Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-ESS2-6); **MS.PS3.A** (HS-ESS2-4); **MS.PS3.B** (HS-ESS2-4),(HS-ESS3-5); **MS.PS3.D** (HS-ESS2-4),(HS-ESS3-5), (HS-ESS2-6); **MS.PS4.B** (HS-ESS2-4), (HS- ESS2-6); **MS.LS1.C** (HS-ESS2-4); **MS.LS2.B** (HS-ESS2-4), (HS-ESS2-6); **MS.LS2.C** (HS-ESS2-4); **MS.ESS2.A** (HS-ESS2-4), (HS-ESS2-6), (MS-ESS3-5); **MS.ESS2.B** (HS- ESS2-4), (HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-4), (HS-ESS2-6); **MS.ESS2.D** (HS-ESS2-4),(HS-ESS3-5);**MS.ESS3.B** (HS-ESS3-5); **MS.ESS3.C** (HS-ESS2-4), (HS-ESS2-6), (HS- ESS3-5); **MS.ESS3.D** (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5)
Connections to Math and ELA Standards: *ELA/Literacy -* **RI.9-10.1.**Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.(HS-ESS3-5) **RI.9-10.2**. Determine a central idea of a text and analyze how it is developed and refined by specific details; provide an objective summary of the text. (HS-ESS3-5) **RI.9-10.7.** Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.(HS-ESS3-5) **SL.9-10.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest.(HS-ESS2-4) *Mathematics –* **MP.2:** Reason abstractly and quantitatively. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5) **MP.4:** Model with mathematics. (HS-ESS2-4), (HS-ESS2-6) **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas;

choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5) **HSN.Q.A.2:** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5) **HSN.Q.A.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5)
Technology Standards: **8.1.12.E.1:** Effective use of digital tools assists in gathering and managing information**.** **8.2.12.A.3:** Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue. **8.2.12.C.1:** Develop an innovative solution to a complex, local or global problem or issue in collaboration with peers and experts, and present ideas for feedback in an online community. **8.2.12.C.4:** Explain and identify interdependent systems and their functions.

Unit Plan
Essential Question(s): *What regulates weather and climate? What would happen to life on our planet without the sun?*

Content Vocabulary		**Academic Vocabulary**		**Required Resources**
altitude	axis	circulation	computational model	*Environmental Science* by Karen Arms, Holt • Chapter 13
climate change	concentration	tilt	timescale	
forecast	greenhouse effect	equator	intensity	Supplemental readings:
wind	topography	measure	navigation	http://earthobservatory.nasa.gov/Features/BOREASCarbon/
gravitational force	latitude	orientation	phases	http://earthobservatory.nasa.gov/Features/BOREASFire/
orbit	oscillation			
ozone layer	poles			Earth Exploration Toolbook http://serc.carleton.edu/eet/chapters.html
pressure	rotation			
seasonal	temperature			www.climate.gov
tides				

		http://genomicscience.energy.gov http://www.nextgenscience.org

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Using NEO/Nasa to identify the role of snow in climate http://serc.carleton.edu/eet/albedo/index.html	1, 2, 4 Asking questions and solving problems Analyzing and interpreting data Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Calculating Carbon Footprint file:///C:/Users/mstatham/Downloads/calculating_my_carbon_footprint.pdf	4 Analyzing and interpreting data Using mathematics and computational thinking Obtaining, evaluating, and communicating information

	Climate Modeling 101 http://nas-sites.org/climate-change/climatemodeling/page_5_1.php	2 Analyzing and interpreting data Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
	Factors that Affect Climate http://www.esrl.noaa.gov/gmd/infodata/lesson_plans/Factors%20that%20Affect%20Climate.pdf	1, 2 Analyzing and interpreting data Constructing explanations and designing solutions Obtaining, evaluating, and communicating information
EXPLORE	**Examples of Exploring Activities:**	
	Build a model of global air movement http://wwphs.sharpschool.com/common/pages/DisplayFile.aspx?itemId=15612859	1 Developing and using models

		Obtaining, evaluating, and communicating information
	Layers of the Atmosphere lab Virtual lab- http://www.glencoe.com/sites/common_assets/science/virtual_labs/ES14/ES14.html Paper lab- http://www.myips.org/cms/lib8/IN01906626/Centricity/Domain/8123/lab%20-%20new%20layers%20of%20atmosphere.pdf	1 Developing and using models Obtaining, evaluating, and communicating information
	Methyl Bromide: Ozone's Enemy (Holt Environmental Science Ancillary)	4 Asking questions and defining problems Planning and carrying out investigations Constructing explanations and designing solutions
	Relating Ozone and Weather (Holt Environmental Science Ancillary)	4 Asking questions and defining problems Planning and carrying out investigations

		Constructing explanations and designing solutions
	Analyzing Greenhouse Data (Activity 3) http://www.rhfleet.org/sites/default/files/files/lesson-plans/tw_GreenhouseWarmingWhatIsIt.pdf	3 Asking questions and defining problems Engaging n argument from evidence Constructing explanations and designing solutions
	Prevailing Winds Activity http://lwcearthscience.yolasite.com/resources/prevailing%20winds%20activity.pdf and/or http://hhs.helenaschools.org/wp-content/uploads/sites/31/2015/08/WindsH.pdf	2
	Calculating Carbon Footprint file:///C:/Users/mstatham/Downloads/calculating_my_carbon_footprint.pdf	4 Analyzing and interpreting data Using mathematics and computational thinking

		Obtaining evaluating, and communicating information
EXPLAIN	**Examples of Explaining Activities:**	
	Concentration of the Earth's Greenhouse Gases (Holt Environmental Science Ancillary)	3
	Getting to the Core: The Link between Temperature and Carbon Dioxide https://www3.epa.gov/climatechange/kids/documents/temp-and-co2.pdf	4 Analyzing and interpreting data Using mathematics and computational thinking Obtaining evaluating, and communicating information
	Motion in the ocean http://www.marine.usf.edu/pjocean/packets/sp98/om_2.pdf	1
ELABORATE	**Examples of Elaborating Activities:**	
	Greenhouse warming: What is it? (Activity 1) http://www.rhfleet.org/sites/default/files/files/lesson-plans/tw_GreenhouseWarmingWhatIsIt.pdf	3 Analyzing and interpreting data

		Using mathematics and computational thinking Obtaining evaluating, and communicating information
EVALUATE	**Examples of Evaluating Activities:**	
	Global Warming in a Jar (Holt Environmental Science Ancillary) Or http://www.esrl.noaa.gov/gmd/outreach/lesson_plans/Modeling%20the%20Greenhouse%20Effect.pdf	4
	Build a model of global air movement http://wwphs.sharpschool.com/common/pages/DisplayFile.aspx?itemId=15612859	3
	Analyzing Flooding http://www.nextgenscience.org/sites/default/files/HS-ESS_Analyzing_Floods-version2.pdf	2
	Ozone Hole Activity http://mjksciteachingideas.com/pdf/OzoneActivity.pdf or	4

	http://kyscience.pbworks.com/f/ozone+worksheet.pdf	