Lindenwold Public Schools

Environmental Science Unit 3: Water and Water Pollution

25 instructional days

Content Standards

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [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-ESS2-5: 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-ESS2-6: 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.]

HS-ESS2-7: Construct an argument based on evidence about the simultaneous co-evolution 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 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.]

Science and Engineering Practices

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-6)

Planning and Carrying Out Investigations

- 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 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

- 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

- Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2)

ESS2.C: The Roles of Water in Earth's Surface Processes

- 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 viscosities and melting points of rocks. (HS-ESS2-5)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)(HS-ESS2-4)
- 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),(HS-ESS2-4)

ESS2.E Biogeology

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

Crosscutting Concepts

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)

Structure and Function

- 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

- 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)

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 a critical aspect of decisions about technology. (HS-ESS2-2)

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Rationale and Transfer Goals :

Water is recycled, but the amount of clean water can be considered a finite resource. Clean water is also unevenly distributed throughout the world, and this can lead to advantages and disadvantages for different societies across the globe. Lack of clean water can be associated with poor health and spread of disease. Students should see that the amount of clean water available to everyone is a small % of the total water on Earth. Water pollution doesn't just affect one small area, because water can move through the water table (underground) and cover large areas. There are different types of pollution, and in the US we have laws requiring farmers and industry to monitor what chemicals are released that may affect local water sources. We also have our drinking water monitored to check for different pollutants and pathogens that may be in the water. Not every country has these standards in place. On a local level, students should realize that the small ponds and lakes in Lindenwold are connected to larger systems, such as the Timber Creek Watershed, which in turn is connected to the Delaware River. Pollution in one area can trickle to other areas, since all water is part of a cycle. We will become familiar with the different parts of the water cycle, and how this affects the movement of different types of pollutants that enter the water cycle. The value of clean water will be discussed, and how dirty water can have large consequences on health, jobs and the economy. We will look at the oil spill in the gulf as an example.

Enduring Understandings:

- Clean water is a finite resource, even though water is recycled through the water cycle.
- Water can travel through the ground, so pollutants can be spread.
- Pollution is caused by humans and products that we use.
- Pollution can spread over large areas, and can have an impact on human health and the health of other species, can affect the food chain and can ultimately affect the economy.
- Water needs to be monitored and conserved to ensure that future generations will also have access to clean water.

Essential Questions:

- How do the properties and movements of water shape Earth's surface and affect its systems?
- How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere?
- How do living organisms alter Earth's processes and structures?

Content/Objectives	Instructional Actions

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Content ***What students will know***	**Skills** ***What students will be able to do***	**Activities/Strategies** ***How we teach content and skills***	**Evidence (Assessments)** ***How we know students have learned***
• 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. • The 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 viscosities and melting points of rocks. • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.	• Be able to name and explain all parts of the water cycle (evaporation, precipitation, transpiration, condensation) • Describe freshwater sources that are available. • Map out the local watershed for Lindenwold, and connect our watershed to its source, the Delaware River. • Simulate how water can move through different layers of the ground, and how a pollutant can also travel, move and spread through these same layers. • Create and simulate a wastewater treatment center that cleans and treats dirty wastewater.	• 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 tools such as SKYPE, experts from the community helping with a	• Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. • Develop a model based on evidence to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. • Develop a model based on evidence to illustrate the biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere, providing the foundation for living organisms. • Construct an argument based on evidence about the simultaneous

• Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. • The total amount of energy and matter in closed systems is conserved. • The total amount of carbon cycling among and between the hydrosphere, atmosphere, geosphere, and biosphere is conserved. • 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.	• Examine a bird's feather that has been covered in oil. Deduct how this affects their ability to thermoregulate and how it affects their ability to fly. • Simulate an oil spill, and try different methods to contain the oil, and clean it up. Relate to what is happening in the Gulf. • Be able to differentiate between a sorbent and a dispersant in oil spill clean ups. • Analyze the effects of pollutants on human health and on other organisms. (Ex: effect of acid rain on plant growth, or the effect of lead or mercury on human health) • Identify the main types of water pollution: thermal, chemical pollution, wastewater/sewage, eutrophication. Examine	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 understanding. • 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.	coevolution of Earth's systems and life on Earth. • Environmental Benchmark #2

	their source, and methods that are in place to prevent these pollutants in the first place, and then available clean up methods in the event of an accident. ● Be able to test for dissolved oxygen. Correlate increased water temperature with lower DO, and describe impacts on fish and other aquatic organisms. ● Examine various ways to conserve water, and implement them at home, at school, and in your community. (EX: we will be selling clear water thermoses to discourage people from buying so much bottled water)	● Collaborate with after-school programs or clubs to extend learning opportunities.	

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
● The total amount of energy and matter in closed systems is conserved.	● Organisms, and populations of organisms, are dependent	● Resources from the Holt Environmental Science Text:

● 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. ● 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. ● The total amount of carbon cycling among and between the hydrosphere, atmosphere, geosphere, and biosphere is conserved. ● Analyze the effects of pollutants on human health and on other organisms. (Ex: effect of acid rain on plant growth, or the effect of lead or mercury on human health)	on their environmental interactions both with other living things and with nonliving factors. ● In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. Growth of organisms and population increases are limited by access to resources. ● Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. ● Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is	○ Using the Figure: Watersheds of the World ○ Case Study: The Ogallala Aquifer ○ Interpreting Statistics: Bar Graphs ○ Graphic Organizer: Comparison Table ○ MathPractice: Israeli Agriculture ○ Skill Builder: Vocabulary ○ Career: Water Management ○ MathPractice: Parts per Millions ○ Using the Figure: Sources of Groundwater Pollution ○ Using the Figure: Oil Spills ○ Student Opportunities: Beach Sweeps ○ Points of View: The Three Gorges Dam

	often used as a measure of its health. ● Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.	

Key resources:

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.

Climate Reanalyzer: Students use the Environmental Change Model of the Climate Reanalyzer to study the feedbacks in the climate system.

USGS Real Time Water data and Climate data: Students create and run an investigation to determine the relationship between streamflow and precipitation data, or another parameter.

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 the effect of glass panes. Zoom in and see how light interacts with molecules. Do all atmospheric gases contribute to the greenhouse effect?

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21st Century Life & Careers:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.

9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

Career Readiness, Life Literacies, & Key Skills:

9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.

9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.

9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.

Interdisciplinary Connections/Companion Standards:

NJSLS Mathematics

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-ESS2-6)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-6)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. ((HS-ESS2-2), (HS-ESS2-5), (HS-ESS2-6)

NJSLS ELA

RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-ESS2-2)

RST.11-12.2 Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)

WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS2-7)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)

Companion Standards for ELA in Science and Technical Subjects: Reading

RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Companion Standards for ELA in Science and Technical Subjects: Writing

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WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating an understanding of the subject under investigation.