Environmental Literacy Unit Plan
Grade**: HS Chemistry**
Title: ***Evaluating Proposed Solutions in DC's Sustainability Plan***
Authors: **Michele Baskin**, Duke Ellington; **Diana Gibson**, Cesar Chavez; **Leslie Maddox**, Wilson; **Molly Smith**, Cardozo

NGSS Unit Plan

Title of Unit	Evaluating Proposed Solutions in DC's Sustainability Plan	**Grade Level**	11-12
Curricular Theme	*Chemistry*	**Time Frame**	~ 720 min
Essential Question(s) to be Addressed	What evaluation can be made about the health of the District and its residents based on a cross section of data?		

Background Information and Context

NGSS Performance Task Expectations: Students who demonstrate understanding can:

- **HS-ETS1-3.** Evaluate a solution to a complex real-world problem, based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

NGSS Performance Expectations: Students who demonstrate understanding can:

- **HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
  - **HS-PS1-2.** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
  - **HS-PS1-6.** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
- **HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- **HS-ESS2-2.** Analyze geosciences data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
  - **HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Applicable Common Core Standards (CCSS ELA and CCSS Math)

ELA/Literacy

- **RST.9-10.7.** Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically.
- **RST.11-12.1.** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes to any gaps or inconsistencies in the account.
- **RST.11-12.2.** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **RST.11-12.7.** Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

- **RST.11-12.8.** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- **RST.11-12.9.** Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- **WHST.9-12.7.** Conduct short as well as more sustained research projects to answer a 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.
- **WHST.11-12.8**. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitation plagiarism and overreliance on any one source and following a standard format for citation.
- **WHST.9-12.9.** Draw evidence from informational texts to support analysis, reflection and research.
- **SL11-12.5.** Make strategic use of digital media in presentations to enhance understandings of findings, reasoning, and evidence, and to add interest.

Mathematics

- **MP.2.** Reason abstractly and quantitatively.
- **MP.4.** Model with mathematics.
- **HSN-Q.A.1.** Use units as a way to understand problems and a guide to 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.
- **HSN-Q.A.2**. Define appropriate quantities for the purpose of descriptive modeling.
- **HSN-Q.A.3**. Choose a level of accuracy appropriate to the limitations on measurement when reporting quantities.

Prior Understandings

Prior Middle School Content:

- **PS1.A.** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2, MS-PS1-3)
- **PS1.B.** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2, MS-PS1-3, MS-PS1-5)
- **ETS1.B.** There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (MS-ETS1-2, MS-ETS1-3), (secondary to MS-PS3-3 and MS-LS2-5)

Prior Chemistry Content (topics)**:**

Molar mass, conservation of matter, *stoichiometry*, balanced equations, ions, ionic compounds, plants use CO_2 and release O_2, H_2O as universal solvent, and mixtures.

Note: *The unit can be tailored for students who have not yet learned stoichiometry. While this content is not mandatory, its coverage will allow students to predict and quantify results.*

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Community Connections: Sustainability Initiative

Anacostia River water sampling field experience: Coordinate with the Aquatic Resources Education Center for the ***Halfsies Program.*** Contact the Department of Energy and Environment for details and scheduling; http://doee.dc.gov/service/arec-programs-and-partners.

Performance Task

Performance Task Description:

Using DC's ***Sustainability Plan***, evaluate the effectiveness of the proposed solutions to air, water, and soil quality in the District of Columbia.

The purpose of this performance task is to allow students to synthesize the various data sets they have collected during the unit lessons for air, water and soil, and actually make comparisons to acceptable levels, as well as prior levels in DC. They will then have to assess whether or not the ***Sustainable DC Plan*** seems to be having a positive, negative or neutral impact on the environmental and human health using their data as evidence. Flexibility is built into the task so that students will create both a narrative and a graphical component that can be altered for complexity. The focus of the task should primarily be on evaluating the ***Sustainable DC Plan*** using evidence as this will directly measure the Engineering, Technology and Applications of Science performance expectation, **HS-ETS1-3**.

The applicable portions of the ***Sustainable DC Plan*** that can be assessed by students include the following Goals: Climate and Environment Goal 1, Nature Goals 1 and 2, Transportation Goal 4, and Water Goals 1 and 2. http://www.sustainabledc.org/

Goal	Your goal is to use data for several parameters (air, soil, water), collected from multiple sources, to evaluate the Sustainable DC Plan.
Role	You are an analyst who has been asked to review and evaluate data to determine if DC's environmental plan is effectively addressing environmental health.
Audience	Your clients are citizens of the District of Columbia. The target audience is the DC government. You need to convince the DC government to continue implementing or revise the ***Sustainable DC Plan*** as necessary.
Situation	An urban environment composed of multiple districts where health is impacted by environmental pollutants.
Product/ Performance	Prepare and present a written or verbal narrative (report or presentation) using data to support claims (e.g., infographic).
Other Evidence	Graphic representations of data, mini-performance tasks throughout unit (used as evidence for final product).

Grouping Strategies:	Groups of 2 for computer based research

Materials and Equipment Required

- WASA report that comes with water bill
  - Usage plus chemical testing
    http://www.dcwater.com/waterquality/test_results.cfm

- Air quality reports EPA "Air Compare"
  - http://www.epa.gov/aircompare/

- Washington Post articles
  - Weather page for air quality, historical temperature data (for global warming connections) http://www.washingtonpost.com/weather/
    Scroll down to weather almanac, weather meters for air quality, etc.

- Historical weather data reports to see global warming connections
  - http://www.nws.noaa.gov/climate/index.php?wfo=lwx

- Graphing data points by location (wards, watershed, etc. -- possible GIS connections)
  - Chesapeake Bay Chemical contaminants by watershed
    http://www.cbf.org/about-the-bay/maps/pollution/chemical-contamination
  - Anacostia subwatersheds map http://www.anacostiaws.org/explore/maps

- Compare to baseline "safe" data from EPA or NOAA in order to make judgments about District health from our data
  - http://water.epa.gov/scitech/swguidance/standards/handbook/chapter03.cfm
  - http://water.epa.gov/scitech/swguidance/ <surface water standards for direct sampling from Anacostia/Potomac rivers
  - http://water.epa.gov/scitech/swguidance/standards/index.cfm
  - http://www.epa.gov/reg3wapd/anacostia_2012.html
  - http://www.epa.gov/reg3wapd/tmdl/303list.html
  - http://doee.dc.gov/service/water-quality-regulations
  - http://doee.dc.gov/publication/integrated-report-epa-and-us-congress-regarding-dcs-water-quality
  - http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=21-1101
  - http://doee.dc.gov/service/anacostia-and-potomac-river-monitoring-program

Comments:

- Resources for helping students create infographics**:**
  - http://www.freetech4teachers.com/2013/12/advice-on-creating-infographics-from.html#.U8AvbdyR82E

- http://www.freetech4teachers.com/2013/12/five-good-online-tools-for-creating.html#.U8AvmtyR82E
- http://dzineblog.com/2009/10/27-beautiful-examples-of-infographics.html
- *Sustainable DC Plan*: http://sustainable.dc.gov/finalplan

See ***Performance Task Rubric***, next page

Performance Task Rubric

	4 Exceeds Expectations	3 Meets Expectations	2 Developing	1 Novice
Baseline Data	Acceptable baseline levels for more than 2 chemicals each for water, air, and soil quality are presented.	Acceptable baseline levels for at least 2 chemicals each for water, air, and soil quality are presented.	Acceptable baseline levels for only 1 chemical each for water, air, and soil quality are presented.	Does not provide acceptable baseline levels for chemicals for each of the categories of water, air, or soil quality.
Data Comparisons	Current levels for more than 2 chemicals each for water, air, and soil quality are compared to the appropriate baseline levels.	Current levels for at least 2 chemicals each for water, air, and soil quality are compared to the appropriate baseline levels.	Current levels for only 1 chemical each for water, air, and soil quality are compared to the appropriate baseline levels.	Does not provide baseline comparisons for each of the current levels for chemicals for the categories of water, air, or soil quality.
Representing Graphical Data	Appropriate graphical representation for data created with proper units for each type of data, and includes additional features like legends, captioning, or multiple representations of data.	Appropriate graphical representation for data created with proper units for each type of data.	Appropriate graphical representation for data created without proper units.	Chosen graphical representation for data is inappropriate and unclear.

Performance Task Rubric, continued on next page

Performance Task Rubric, cont'd

	4 Exceeds Expectations	**3 Meets Expectations**	**2 Developing**	**1 Novice**
Visualizing Infographics	Quality of digital media used to enhance understanding of findings, reasoning, and evidence, and to add interest is above and beyond that meets expectation level.	Digital media used to enhance understanding of findings, reasoning, and evidence, and to add interest.	Digital media used to present findings, reasoning, and evidence.	Digital media used to present only findings or reasoning or evidence, but not all 3.
Plan Evaluation	Claim made about the level of success of the Sustainable DC plan for more than 2 chemicals and supported with evidence.	Claim made about the level of success of the Sustainable DC plan for at least 2 chemicals and supported with evidence.	Claim made about the level of success of the Sustainable DC plan for only 1 chemical each and supported with evidence.	Claim made about the level of success of the Sustainable DC plan for chemicals for only 1 of the categories of water, air or soil or claim not supported with evidence.
Citations	Proper MLA or APA citations present from credible sources for all material including graphs, data, and images.	Proper MLA or APA citations present from credible sources for most material, but not all.	Improper MLA or APA citation format used OR unreliable sources used.	No citations provided.
Grammar and Conventions	Contains no surface errors.	Contains few surface errors.	Surface errors distract the reader and cause minor confusion.	Surface errors impede reader understanding.

Learning Plan/Instructional Sequence

*Note: **A series of lessons** (3-10) Explain and Elaborate in this 5E Sequence*

ENGAGE: Lesson 1

Prior Knowledge: molar mass, conservation of matter, stoichiometry, balanced equations, ions, ionic compounds, plants use CO_2 and release O_2, H_2O as universal solvent, mixtures

Narrative: To introduce the unit on the District's environmental and human health, students will engage in a simple water filtration activity. They will be asked to develop a model to "make the water cleaner" by building a filtration system using sand, gravel, cheese cloth, and a liter bottle. While creating the system, students will discuss the kinds of substances that may be removed and which ones may not be removed. In notebooks, students will write down personal reflections on local water experiences they have had and also generate questions about the relationship between water quality and the health and well-being of the District.

EXPLORE: Lesson 2: 40 - 45 min

Science and Engineering Practices

- **Using Mathematics and Computational Thinking.** Use mathematical models to predict the effects of a design solution on systems and/or the interactions between systems.
- **Constructing Explanations and Designing Solutions.** Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- **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 and refine design accordingly.
- **Analyzing and Interpreting Data.** Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

Disciplinary Core Ideas

- **Energy and Matter.** The total amount of energy and matter in closed systems is conserved.
- **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 structures of its reaction determines the numbers of all types of molecules present. The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.
- **ETS1.B. Developing Possible Solutions.** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts

Crosscutting Concepts

- **Energy and Matter.** The total amount of energy and matter in closed systems is conserved.

- **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 structures of its various materials.
- **Interdependence of Science, Engineering, and Technology.** Science and engineering complement each other in the cycle known as research and development. Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.
- **Systems and System Models.** Models can be used to simulate systems and interactions-including energy, matter, and information flows-within and between systems at different scales.
- **Interdependency and Influence of Science, Engineering, and Technology on Society and the Natural World.** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology

Narrative: In this activity students explore a method of removing a contaminant (PO_4^{3-}) from a water system using chemical engineering practices. Students' prior knowledge of ions, ionic ratios in compounds, and molar conversions are applied to an engineering problem: How can an ion that causes an environmental problem be removed from water that is released into the Potomac River? To begin, students will have an opportunity to test a variety of cations to see which ones react with the phosphate ion. They will also conduct a feasibility study by researching cost and safety aspects of the ionic compounds using text and digital sources from a provider such as Sargent-Welch. Students will prioritize and defend choices. Students will be encouraged to choose any alternative with the understanding that there may be other, yet-to-be determined benefits of using a particular cation (reaction rate, solubility).

After the choice has been made, the students will be introduced to gravimetric analysis (isolating the ion by precipitation a quantity of sodium phosphate (Na_3PO_4) to be used and lab partners work through the appropriate calculations to determine the required amount of their chosen "phosphate-removing" compound. A written lab procedure is provided. During the lab session, students will prepare and combine the two solutions (Na_3PO_4 and chosen compound). A sample of the supernatant liquid will be tested for reaction completeness and students will propose an explanation for the results. Observations and ideas will be recorded as a labeled diagram of the reaction events that are taking place "in the beaker".

Later, students filter the mixture and dry the precipitate. Theoretical and percent yield are calculated. As evidence for understanding of the math and chemical concepts, students write narratives of those processes. They discuss the efficiency of their system, propose next steps, and report on the implications for removing the phosphate from water.

EXPLAIN: Lesson 3

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.
- **Analyzing and interpreting Data.** Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution

Disciplinary Core Ideas

- **LS1.C. Organization for Matter and Energy Flow in Organisms.** The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
- **ESS2.A. Earth Materials and System.** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- **PS1.B. Chemical Reactions.** In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

Crosscutting Concepts

- **Systems and System Models**. Models can be used to simulate systems and interactions-including energy, matter, and information flows-within and between systems at different scales.

Narrative: In order to engage with one of the issues related to eutrophication, students will test water samples for level of light transmittance/turbidity using a Secchi disk or light meter. Then, students research artificial eutrophication using digital and text references. Students will discuss, with note-taking, the ways that water quality impacts the economy, environment, and health of the residents of the District of Columbia. Students create a graphic organizer that incorporates the causes and effects of the steps of the process of eutrophication. They also suggest possible solutions to the problem of artificial eutrophication.

ELABORATE: Lesson 4
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.

Disciplinary Core Ideas

- **ESS2.A. Earth Materials and Systems**. Earth's systems, being dynamic and interacting, cause feedback effects that can increase changes.
- **PS1.B. Chemical Reactions**. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- **ESS2.D. Weather and Climate**. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- **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.

Crosscutting Concepts

- **Stability and Change**
  - Much of science deals with constructing explanations of how things change and how they remain stable.
  - Change and rates of change can be quantified and modeled over very short or very long periods of time. Some systems are irreversible.
  - Feedback (negative or positive) can stabilize or destabilize a system.
- **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

Narrative: Teacher helps students extend their knowledge of the nutrient cycles involved in eutrophication. Students add on to their graphic organizers from the previous class by including/linking in the chemical processes involved in eutrophication. Teacher encourages use of labels, chemical symbols/formulas, and new vocabulary. Students then compile data on specific nutrient levels (N, P, etc.) and determine healthy levels vs. nutrient overloaded levels. Emphasis should be on current levels and acceptable guidelines.

EXPLAIN: Lesson 5

Science and Engineering Practices

- **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.
- **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.

Disciplinary Core Ideas

- **ESS2.A. Earth Materials and Systems**. Earth's systems, being dynamic and interacting, cause feedback effects that can increase changes.
- **PS1.B. Chemical Reactions**. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- **ESS2.D. Weather and Climate**. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- **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. (See p. 11, above, for additional content.)

Crosscutting Concepts

- **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.
- **Developing and Using Models**. Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Narrative: Field study on water quality: Students will collect and analyze local water samples. They will determine if local waterways fit the profile of eutrophication as one way to evaluate environmental health. Teachers will refer students to their data sets created in the last class in order to support their findings.

EXPLAIN: Lesson 6

Disciplinary Core Ideas

- **ESS2.D.Weather and Climate**. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- **PS1.B. Chemical Reactions**. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

Crosscutting Concepts

- **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.

Narrative: In this lesson, students move on to study the air quality in DC. Teacher should provide linking context to show how water quality (from previous lessons) and air quality are interconnected. Teacher will provide multimedia and print resources for students to become familiar with and develop explanations for the processes of ozone formation, climate change processes, etc. Students will focus on how ozone is formed and how it affects human health and environmental quality. Students will also explain how climate change processes are related to Sustainable DC's plan to reduce greenhouse gas emissions. Students will research and compile air quality parameters related to these processes for use in the next lesson.

ELABORATE: Lesson 7

Science and Engineering Practices

- **Scientific Knowledge Is Based on Empirical Evidence**.
  - Science knowledge is based on empirical evidence.
  - Science disciplines share common rules of evidence used to evaluate explanations about natural systems.
  - Science includes the process of coordinating patterns of evidence with current theory.

- **Developing and Using Models**
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas

- **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.
- **PS1.A. Structure and Properties of Matter**. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- **ESS2.D. Weather and Climate**. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

Crosscutting Concepts

- **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.

Narrative: Teacher will introduce the steps for creating ozone strips, and the chemical properties of the reactants that enable the treated strips to indicate the presence of ozone. ***Making and Using Schoenbein Paper:*** https://www.ucar.edu/learn/1_7_2_29t.htm. (Includes Materials and Procedures)

EXPLAIN: Lesson 8

Disciplinary Core Ideas

- **PS1.A: Structure and Properties of Matter**. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

Narrative: In this lesson, students will be able to test for ozone in various locations around their school/neighborhood. Students will make their own ozone testing strips in the classroom/lab, and will use them to evaluate air quality based on researched parameters from the previous class. This will provide another piece in the comprehensive data set that students are compiling in order to evaluate the health of the District's environment in their final performance task.

ELABORATE: Lesson 9

Disciplinary Core Ideas

PS1.B: Chemical Reactions

- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Narrative: Teacher will introduce how soil tests work in terms of their chemical reactions to indicate the presence and levels of target substances. Teacher should continue to encourage students to draw connections between water and air quality to soil quality.

ELABORATE: Lesson 10

Science and Engineering Practices

- **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.
- **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.

Narrative: In this lesson, students will conduct laboratory investigations to analyze soil samples. Teacher should continue to encourage students to draw connections between water and air quality to soil quality. Using soil testing kits, students will determine local levels of contaminants and nutrients from soil samples at their school or home. They will then compare their results to the baseline/acceptable levels that they researched in the previous class in order to determine the soil health and overall environmental health of the District.

EVALUATE: Lessons 11 and 12

Science and Engineering Practices

- **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.
- **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.
- **Engaging in Argument from Evidence**. Construct an oral and written argument or counter-arguments based on data and evidence.
- **Asking Questions and Defining Problems.** Analyze complex real-world problems by specifying criteria and constraints for successful solutions.

Crosscutting Concepts

- **Influence of Science, Engineering, and Technology on Society and the Natural World.** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Narrative: Please refer to ***Performance Task*** section of unit plan for additional information.

Universal Access

Supporting English Language Learners

Reading, Writing, or Speaking Activity	Supports for ***Emerging*** Learners	Supports for ***Expanding*** Learners	Supports for ***Bridging*** Learners
Review and evaluate data to determine if DC's environmental plan is effectively addressing environmental health.	Provide graphic organizers to support the following: outline ideas and details from graphic organizers; evaluate information in social and academic contexts; and estimate, make predictions, or pose hypotheses from models.	Provide structured practice formats (i.e. SEEI paragraphs) in order to support student to be able to: analyze content-related tasks or assignments based on oral discourse; and explain content-related issues and concepts.	Provide minimally modified texts and resources so that student can: draw conclusions from different sources of informational text.
Convince the DC government to continue implementing or revise the Sustainable DC plan as necessary.	Provide guiding questions so that emerging learners can: answer questions about explicit information in texts; suggest ways to resolve issues or pose solutions; and sequence processes, cycles, procedures, events.	Provide graphic organizers or sentence stems to create strong connections between concepts so that students can: match cause to effect; and analyze and share pros and cons of choices.	Provide suggested vocabulary for using convincing language with the content vocabulary so that students can: engage in debates on content-related issues using technical language.
Written or verbal narrative (report or presentation) using data to support claims (infographic, etc.).	Provide templates for written report or presentation so that learners can complete reports from templates. Allow for verbal narration so that learners can categorize content-based examples orally.	Provide exemplars and structured pre-writing resources so that students can: compose narrative text for a variety of purposes; take a stance and use evidence to defend it; interpret visually or graphically supported information; produce content-related reports; and evaluate usefulness of data or information	Provide higher-level language complexity exemplars so that students can: interpret cause or effect scenarios from oral discourse; explain, with detail, phenomena, processes, procedures; and give multimedia presentations on grade level material.

		supported visually or graphically.	

Supporting Struggling Learners

Activity	Supports for Students who need ***Minor*** Support	Supports for Students who Need ***Intensive*** Support
Review and evaluate data to determine if DC's environmental plan is effectively addressing environmental health.	Provide pre-selected, edited and/or simplified data sets for ease of graphing and interpretation.	In addition to simplified data sets, provide suggested graphing set ups and formats, assist students in entering data into graphing programs or functions.
Convince the DC government to continue implementing or revise the Sustainable DC Plan as necessary.	Coach students through persuasive arguments and using evidence to support claims.	Allow students to use pictoral/visual representations of concepts in order to make their point more clearly.
Written or verbal narrative (report or presentation) using data to support claims (infographic, etc.).	Provide outlining, planning, and organization of information support verbally.	Provide explicit exemplars, templates, and sentence stems for organization and planning of final product.

Supporting Advanced Learners

Activity	Extensions for Advanced Students
Review and evaluate data to determine if DC's environmental plan is effectively addressing environmental health.	Ask students to plot multiple data sets against each other and discuss correlation v. causation. Evaluate effectiveness and relevancy of several styles of infographics to prove point
Convince the DC government to continue implementing or revise the Sustainable DC Plan as necessary.	Write specific implementation plan for suggested improvements to the Sustainable DC Plan. Analyze the effects on multiple stakeholders (human behavior, taxes, etc) in implementing solution plan.
Written or verbal narrative (report or presentation) using data to support claims (infographic, etc.)	Present information to DC public officials in order to influence planning and involve students in public policy.

Connecting to the Core: NGSS Aligned Performance Task

ELA Connections *(Reading, Writing or Speaking Activity) listed in Learning and Instructional Sequence*

- Communication of implications of data
  - Claim and Evaluation, evidence
  - Conclusions writing and data discussion from any of this data
- Close reading, reading for content/interpretation of currently published documents listed in materials section
- Extension projects
  - Letter to editor to raise awareness on district environmental health
  - Public awareness campaign
  - Action project on proposed legislation
  - Research extension of superfund sites in DC http://www.epa.gov/reg3hscd/super/dc.htm
  - Local programs to reduce stormwater runoff and pollution http://cbf.typepad.com/bay_daily/2012/11/dc-program-pays-residents-to-reduce-stormwater-pollution.html

Math Connections *(Listed in Learning and Instructional Sequence)*

- Recognize and work with different units. Each type of data that students will be collecting and analyzing is measured in sets of units that may or may not be familiar to students.
- Concentration units (ppm, ppt, etc), orders of magnitude and scale.
  - Possible unit conversion in order to be able to compare them meaningfully.
- Graphing data points over time – Weather data in particular can be tracked over time with graphical methods for analysis.

Source for the Science and Engineering Practices
A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) http://www.nap.edu/openbook.php?record_id=13165

Source for the Disciplinary Content and CrossCutting Concepts:
NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.
Web Version: Authors: NGSS Lead States. **Title:** Next Generation Science Standards: For States, By States (insert specific section title(s) being used if not referring to entirety of the NGSS). **Publisher:** Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. **Copyright Date:** 2013. **URL:** www.nextgenscience.org.