Escondido Union High School District

Chemistry and Agriscience

EUHSD Board Approval Date: 6/21/16
The EUHSD Chemistry and Agriscience curriculum document identifies what students should be able to know and do in a comprehensive standards-based agricultural science course of study. The curriculum document is updated annually based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD curriculum document contains the following documents and/or information:

A. Course Description
B. Course Guidelines/Requirements - graduation credit information, transcript information, adopted materials, adopted technology, assessment outline
C. Instructional Materials References
D. Scope and Sequence Map with Essential Standards outlined by Unit
E. References to key essential design and implementation documents

The Chemistry and Agriscience curriculum document, upon which this course is designed, was written by a group of California educators and industry professionals as part of the University of California Curriculum Integration (UCCI) project. UCCI is an initiative of Student Affairs, Admissions (High School Articulation Unit), at the UC Office of the President, with funding administered by the California Department of Education. The UCCI program is dedicated to supporting California high school students as they work to prepare for success in college and in life. As part of the UC’s system wide High School Articulation unit, the UCCI program focuses on assisting high schools with the development and implementation of integrated courses that unite academic study with Career Technical Education. [http://ucci.ucop.edu]

The EUHSD Agriculture program is designed to meet both the California Content Standards for specific disciplines and to address key California Career Technical Education standards for specific industry sector pathways. The Chemistry and Agriscience course was designed as a key course within the Agriculture and Natural Resources pathway, but also serves as a foundational “d” laboratory science course in the agriculture program with an emphasis in the physical sciences. The curriculum document was written to address both pathway and overarching anchor standards as well as key Next Generation Science Standards and practices.

**Escondido Union High School District – Instructional Focus**

A comprehensive course of study and/or program is designed so that all students have access to the rigorous curriculum necessary to graduate high school college and career ready. Student-Centered learning provides opportunity for collaboration, communication, and a robust learning environment and provides opportunities for all students to meet the goals of the district’s Instructional Focus at the time of this writing: “All students communicate their thinking, ideas and understanding by effectively using oral, written and/or non-verbal expression.”

**Curriculum Design Resources**

A detailed list of resources around which the EUHSD curriculum is designed is as follows:

2. [http://www.cde.ca.gov/pd/ca/sc/ngssintrod.asp](http://www.cde.ca.gov/pd/ca/sc/ngssintrod.asp) - CA Next Generation Science Standards document
Chemistry and Agriscience is a year-long physical and chemical science course that examines content through the study of soil as well as the relationships between soil, plants, animals, and agricultural practices. Students examine properties of soil and land and their connections to plant and animal production. Using knowledge of scientific protocols as well as course content, students develop an Agriscience research project to be conducted throughout the first semester of the course. To complete that whole project, each student will investigate and test an Agriscience research question by formulating a scientific question related to the course content, formulating a hypothesis, collecting quantitative data, and forming a conclusion based on analysis of the data. The result of this research program will be an in-depth research and experimentation paper that is technically written, based on scientific protocols, and cited using APA formatting. Students will also develop and present a capstone soil management plan for agricultural producers, using the content learned throughout the course. **Students are expected to participate in a supervised agriculture experience program as part of their enrollment in this course.**

### Course Requirements

**Course Length:** Year Long  
**Grade Level:** 9-12  
**UC/CSU Requirement:** Approved as UC “d” lab science by UCCI  
**Graduation Requirement:**  
Meets EUHSD Physical Science Requirement or  
Meets EUHSD Elective Credit or CTE Requirement

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<thead>
<tr>
<th>Course Numbers (Semester A)</th>
<th>Transcript Abbreviations (Semester A)</th>
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<tbody>
<tr>
<td>(P) 5744</td>
<td>5744: CHEM AG SCI P A</td>
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<td>(SE) 5746</td>
<td>5746: CHEM AG SCI SE A</td>
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<tr>
<th>Course Numbers (Semester B)</th>
<th>Transcript Abbreviations (Semester B)</th>
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<tr>
<td>(P) 5745</td>
<td>5745: CHEM AG SCI P B</td>
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<td>(SE) 5747</td>
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<th>Credits (Semester A)</th>
<th>5 Physical Science</th>
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<td>Credits (Semester B)</td>
<td>5 Physical Science</td>
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**Required Prerequisite/s:** Completion or concurrent enrollment in Algebra 1 or Math 1 (Integrated)  
**Recommended Prerequisite/s:** Sustainable Agricultural Biology

**Board Approval Date (Curriculum):** 6/21/16  
**Board Approval Date (Materials):** 6/21/16

**Technology Resource/s:**  
- Chromebook cart

**Assessment/s:**  
- End of unit assessments  
- Comprehensive final exam for each semester
## District Approved Instructional Resources

### Core Textbooks

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<th>Title</th>
<th>Edition</th>
<th>Author</th>
<th>Publisher</th>
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### Secondary Texts

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### Supplemental Materials

- Website for FFA organization: [http://www.calaged.org](http://www.calaged.org)
- Supervised Agriculture Experience Handbook and Resources: [http://www.calaged.org/sae_resources](http://www.calaged.org/sae_resources)
- Lab Safety PPNT and Exam – available in UCCI Unit Resources folder: [http://ucci.ucop.edu/integrated-courses/agriculture-and-soil-chemistry.html](http://ucci.ucop.edu/integrated-courses/agriculture-and-soil-chemistry.html)
- Visit the following URL in order to access UCCI resources: [https://drive.google.com/a/euhsd.net/folder/view?id=0B5sJzC55D7MEWGltQkNlO0FtYkk&usp=sharing](https://drive.google.com/a/euhsd.net/folder/view?id=0B5sJzC55D7MEWGltQkNlO0FtYkk&usp=sharing)
- Visit the following URL in order to access specific UCCI Soil and Chemistry resources: [https://drive.google.com/a/euhsd.net/folder/view?id=0B5sJzC55D7MEWGltQkNlO0FtYkk&usp=sharing](https://drive.google.com/a/euhsd.net/folder/view?id=0B5sJzC55D7MEWGltQkNlO0FtYkk&usp=sharing)
The Scope and Sequence Guide is a California standards based document that delineates the standards based skills students are expected to know and do in order to meet College and Career Readiness expectations outlined within the California standards for a particular course of study. Each unit of study in the Scope and Sequence document is designed to build upon the previous unit and/or prerequisite coursework in support of student mastery of specific standards based skills. The Scope and Sequence document provides the framework of understanding for key assignments, key assessments, and instructional resources and strategies that serve to assist students in meeting unit learning objectives. Teachers will meet annually to refine the course expectations. Students in a comprehensive “d” lab based science course receiving college preparatory credit are required to participate in a curriculum that provides at least 20% of its classroom time participating in hands-on lab experiences where students interact with and demonstrate their learning and build understanding of content. Specific lab experiences are outlined within the scope and sequence document and will be reviewed on an annual basis.

The Chemistry and Agriscience course is organized into six major sections or units of study.

- Unit 1 Agriscience Practices
- Unit 2 The Nature of Soil
- Unit 3 Water and Soil Management
- Unit 4 Plants and Soil Management
- Unit 5 Animals and Soil Management
- Unit 6 Soil Sustainability

In coursework requiring reading and writing, the following standards are not specifically stated in any one unit of study, but are the result of implementation throughout the curriculum as students participate in reading, writing, and speaking/listening standards based activities.

- By the end of grade 11, students will read and comprehend literary nonfiction in the grades 11-CCR text completely and proficiently, with scaffolding as needed at the high range. (Reading Informational Text Standard 10)
- Students will write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks and purposes. (Writing Standard 10)
- “To be college and career ready, students must have ample opportunities to take part in a variety of rich and structured conversations – as part of a whole class, in small groups, and with a partner – build around important content in various domains. They must be able to contribute appropriately to conversations, make comparisons and contrasts, and analyze and synthesize a multitude of ideas according to the standards of evidence appropriate to a particular discipline.” (Standards for ELA Anchor Standards for Speaking/Listening)
# Chemistry and Agriscience Scope and Sequence
## Pre Unit – Introduction to Agriculture and the Agriculture Program
### Length: 2 Weeks

**Unit Description:** All students enrolled in the EUHSD’s Agriculture pathway sequence of courses will be expected to participate in the FFA organization and activities as a vital part of the EUHSD agriculture program. This pre unit of study is designed to take approximately one to two weeks and covers the following essential topics: Students should be familiar with the concepts and requirements of the FFA organization from their experience in the year-1 course.
- Introduction to Class
- Introduction to Agriculture/FFA
- Laboratory Safety and Use of Facilities

### English Language Development Bridging Strategies:
- Clearly defining the expectation for communication.
- Model sentence frames and/or put on the board for effective communication.
- Create strategic grouping so that EL’s have EO models in their groups.
- Review the FFA Handbook and clarify vocabulary that may have multiple meanings or provide a completed model.
- Demonstrate tool usage, specifically for those where injury and/or misuse could occur. Consider signs with proper use demonstrated.
- Demonstrate safety and illustrate immediate first aide techniques.

### Learning Objectives:
- Students will be able to:
  - Identify key safety features within the lab setting and utilize key safety equipment when participating in lab activities.
  - State the requirements of participation in the FFA program and the location of key resources such as the FFA Handbook.
  - Use technology appropriately to conduct online research.
  - Synthesize ideas and present to others.
  - Practice time management skills and demonstrate an effective time management strategy.
  - Identify key classroom expectations for learning and participating in individual, small group, and large group activities.

### Instructional Resources:
- [http://www.calaged.org](http://www.calaged.org) - Website for FFA organization
- [http://www.calaged.org/sae_resources](http://www.calaged.org/sae_resources) - website for Supervised Agriculture Experience Handbook and Resources
- Lab Safety PPNT and Exam – available in UCCI Unit Resources folder

### Instructional Strategies:
- Modeling
- Grouping

<table>
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<tr>
<th>Standards Key</th>
<th>Unit Standards</th>
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| HS = High School | **Agriculture & Natural Resources:**
| PE = Performance Expectations | 2.5: Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
| ETS= Engineering & Technology | 3.6: Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society.
| LS=Life Science | 4.1: Use electronic reference materials to gather information and produce products and services.
| PS=Physical Science | 4.7: Demonstrate the use of appropriate tools and technology used in the Agriculture and Natural Resource sector.
| DCI=Disciplinary Core Ideas | 5.4: Interpret information and draw conclusions, based on the best analysis, to make informed decisions.
| CC=Cross Cutting Concepts | 6.2: Interpret policies, procedures, and regulations for the workplace environment, including employer and employee (student/teacher) responsibilities.
| SEP=Science & Engineering Practices | 6.3: Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.
| | 6.4: Practice personal safety.
| | 6.5: Demonstrate how to prevent and respond to accidents or injuries;
this includes demonstrating understanding of ergonomics.

6.6: Maintain a safe and healthful working environment.
7.2: Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.
7.3: Understand the need to adapt to changing and varied roles and responsibilities.
7.4: Practice time management and efficiency to fulfill responsibilities.
9.0: Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the FFA career technical student organization.
10.0: Apply essential technical knowledge and skills common to all pathways in the Agriculture and Natural Resource sector, following procedures when carrying out experiments or performing technical tasks.

| Key Unit Assignments:                                                                                                                                    | Key Unit Assessments:                                                                                     |
|                                                                                                                                                    |                                                                                                           |
| - Students will participate in an introductory exploration of the historical background of the FFA organization and share their understanding with their peers. Students in Year 2 of the FFA program will be able to complete this task in a shorter period of time. Students will utilize the FFA online website to conduct research on all of the requirements of participation in the FFA program; including a comprehensive review of the FFA Handbook Requirements. Students will set up their handbook electronically. Regardless of year 1 or 2, all students will need to complete this assignment. Students will review all of the lab spaces within the classroom and outside spaces and identify key equipment and the safety features for operation. Students will identify the key lab safety requirements and be able to articulate the required safety features for participating in any lab or use of equipment. The lab safety test is required each year in order for students to participate in the indoor and outdoor lab activities. **Course Portfolio** - The course portfolio will provide evidence of real-world agriculture application of scientific research done throughout this course. The portfolios will highlight student work from throughout the course to show a progression of learning, experimentation, and application of course content. Items that will be included in the portfolio are student lab reports, the Agriscience Research paper, and their Soil Management Plan. Students will review technology use requirements and create an online portfolio location, as required by the teacher, for purpose of storing and uploading their various tasks and assignments due throughout the course. All students are required to complete this task regardless of years in the program. | - Complete a lab and equipment safety test with 100% accuracy – may repeat until 100%. Creating online FFA Handbook and Portfolio – rubric for analysis to be utilized in each unit as assignments are completed. |

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Chemistry and Agriscience Scope and Sequence
Unit 1 - Agriscience Practices
Length:  4 weeks

**Unit Description:** This introductory unit will focus on proper methods of Agriscience inquiry. Through a series of 5 mini-lab experiences based on the course content, students will learn to ask questions and define problems, conduct research to form a hypothesis, determine the experimental design and conduct experimentation, analyze and interpret data, develop conclusions and then communicate their findings in lab reports. Not only will the students learn to utilize proper scientific method protocol through conducting these mini-labs, they will also learn what topics will be taught throughout the year in order to guide them in selecting the problem/question for their individual Agriscience project. Through these mini-lab experiences and unit content, students will be provided with the skills and knowledge to successfully establish the idea they will pursue in their Agriscience Project. By the end of this unit, students will complete the Agriscience Project Research Proposal for their on-going science experiment that will be conducted throughout the first semester of this course.

### Unit Standards

#### Standards Key:
- HS = High School
- PE = Performance Expectations
- ETS= Engineering & Technology
- LS=Life Science
- PS=Physical Science
- DCI=Disciplinary Core Ideas
- CC=Cross Cutting Concepts
- SEP=Science & Engineering Practices

#### Key High School Physical Science Performance Expectations:
- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS-ETS1-1)
- Design a solution to a complex real-world problem by breaking it down into smaller more manageable problems that can be solved through engineering. (HS-ETS1-2)
- Evaluate a solution to a complex real world problem based on prioritized criteria and trade-offs that account for arrange of constraints, including cost, safety, and reliability, and aesthetics as well as possible social, cultural, and environmental impacts. (HS-ETS1-3)

#### Key Disciplinary Core Ideas:
- ETS1.A:  Defining and Delimiting Engineering Problems: Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and

### English Language Development Bridging Strategies:
- Vocabulary definitions may need to be clarified. Provide a glossary and/or references to a glossary.
- Group according to language needs, recognizing the importance of strategic grouping for EO models.
- Students may need to work in pairs when conducting research and analyzing data.
- Model lab report and clarify expectations.
- Students may need examples of proposals and review criteria for written proposal. May consider revising in smaller sections for revision considerations.
- Review APA formatting and steps for completing a research project.
- Teachers should review ELD standards for Beginning, Expanding, and Bridging proficiency levels or seek additional EL supports for students who may be CELDT levels 1-3.

### Learning Objectives:

#### Students will be able to:
- Use content appropriate vocabulary when analyzing and discussing soil composition.
- Use a variety of mathematical weight, measurement, and equation principles to state, solve, and illustrate problems.
- Summarize details and present findings.
- Design and conduct an experiment using proper scientific method procedures.
- Correctly follow multi step procedures in performing a basic lab (scientific method).
- Break down a problem into smaller more manageable parts.

### Instructional Resources:
- Visit the following URL in order to access all of the UCCI resources: [http://ucci.ucop.edu/integrated-courses/agriculture-and-soil-chemistry.html](http://ucci.ucop.edu/integrated-courses/agriculture-and-soil-chemistry.html)
- Visit the following URL in order to access specific UCCI Soil and Chemistry resources: [https://drive.google.com/a/euhd.net/folderview?id=0B5szC557MEWGhQKNI0FDYkk&usp=sharing](https://drive.google.com/a/euhd.net/folderview?id=0B5szC557MEWGhQKNI0FDYkk&usp=sharing)

### Unit Planning Strategies:
- Students will be expected to complete 5 mini labs and create their end of unit proposal.
- Introduce end of unit proposal first.
- Set up digital portfolio early so that students can add information as they progress through the units.

### Reading Standards in CTE:
- Cite specific evidence from text.
stated in such a way that one can tell if any given design meets them. (HS-ETS1-1)

- **ETS1.A:** Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

- **ETS1.B: Developing Possible Solutions:** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HSET1S1-3)

- **ETS1.C: Optimizing the Design Solution** – Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)

**Science and Engineering Practices:**

- **Planning and Carrying Out Investigations:** Planning and carrying out investigations in grades 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematics, physical, and empirical models.

- **Constructing Explanations and Designing Solutions:** Plan and conduct 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, costs, risk, time), and refine the design accordingly.

**Cross Cutting Concept:**

- **System and System Models:** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

**Agriculture Standards:**

- Evaluate the role of agriculture in the CA economy. (C1.0)
- Describe how CA agriculture affects the quality of life. (C1.2)

**Writing Standards in CTE:**

- Produce clear and coherent writing.
- Use technology to produce and/or publish.
- Conduct short research to solve a problem or answer a question, including demonstrating understanding.
- Gather relevant information from multiple sources, integrate information.
- Draw evidence from text.
- Research the economic impact of leading CA agricultural commodities. (C1.4)
- Assess the economic impact of major natural resources in CA. (C1.5)
- Describe how technology affects the logistics of moving an agricultural commodity from producer to consumer. (C3.1)
- Understand how technology influences factors such as labor, efficiency, diversity, availability, mechanization, and communication. (C3.2)
- Integrate use of technology when collecting and analyzing data. (C3.5)
- State the steps of the scientific method. (C13.1)
- Analyze an agricultural problem and devise a solution based on the scientific method. (C13.2)

**Key Unit Assignments:**

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<thead>
<tr>
<th>Mini Lab (1) Soil Structure and Composition Mini-Lab – Calgon Testing:</th>
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<tbody>
<tr>
<td>Students will learn that soil is composed of different size particles at varying percentages by conducting an experiment where students separate, examine and identify the major components of soil to better understand how these components give soil its unique physical characteristics. Students will learn to measure the percentage of sand, silt, and clay in a soil sample. Soil samples should be collected in the course of a walking field trip where students will take samples from varying locations on the walk. Students will mix one cup of soil sample with laundry detergent powder in a mason jar in order to dissolve the soil aggregates and keep the individual particles separated. Once the soil sample mixture sits for three days, students will measure and determine the percentage of each particle within their specific soil sample. Students will write a lab report to summarize what occurred throughout the experiment, their data, and analysis/conclusion.</td>
<td>Key Unit Assessments:</td>
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<tr>
<td>• Written Lab Report – Soil Structure &amp; Composition Mini Lab</td>
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<td>• Experimental Design Proposal – Water and Soil Management Mini Lab</td>
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<tr>
<td>• Written Lab Report – Plant and Soil Management Mini Lab</td>
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<tr>
<td>• Written Lab Report – Animal and Soil Management Mini Lab</td>
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<tr>
<td>• Written Lab Report – Technology Mini Lab</td>
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<tr>
<td>• Written Proposal for Agriscience Project</td>
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<tr>
<td>• All labs will be uploaded to student portfolio</td>
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<tr>
<th>Mini Lab (2) Water and Soil Management Mini-Lab – Water Percolation:</th>
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<tr>
<td>Students will learn how to design a scientific experiment through proper scientific method and how to develop a research proposal. Students will be put into groups to produce a mini-proposal which will include the specific water percolation problem/question they will research for this lab, three literary research references, a hypothesis and scientific procedure. Students will also learn how soil composition impacts the speed of water percolation or amount of water absorption by conducting the experiment they designed. Students will create a lab report that includes their data and analysis/conclusion. The lab not only develops student’s ability to write a proposal and a scientific experiment, but exposes them to the relationship between water and soil management.</td>
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<tr>
<th>Mini Lab (3) Plant and Soil Management Mini-Lab – Nutrient Uptake:</th>
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<tbody>
<tr>
<td>Students will learn that plants utilize nutrients in soil to grow and develop. Each student will bring in a soil sample from their yard to utilize in this lab. They will divide the sample into two pots, one that will be a control sample and the other will be amended with animal manure compost. They will test the nutrients of these two pots of soil with a standard soil testing kit in order to record the levels of Nitrogen, Phosphorus, and Potassium in their control and amended samples. A bean seed will be planted in each pot of soil to germinate and grow over the course of a two week period. Throughout the period, the students will monitor the growth of the bean plants and record their data on a chart. The charts will be used to analyze the nutrient uptake of the plants and determine which pot had the most nutrients. Students will write a lab report to summarize what occurred throughout the experiment, their data, and analysis/conclusion.</td>
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the two weeks, students will be recording quantitative data on seed germination, plant growth, and soil nutrients. After analyzing their data, students will determine how much of each nutrient was utilized by the bean plant. A lab report will be written to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

- **Mini Lab (4) Animal and Soil Management Mini-Lab – Animal Manure Amendment**: To build on to the learning of nutrient uptake in the previous lab, students will extend their data analysis to make conclusions on why the bean plant in the amended soil sample had more optimal growth over the past two weeks than the bean plant in the controlled soil sample. This extended analysis of their data will allow the students to learn that animal waste can be composted and used as a soil amendment to increase soil nutrients for optimal plant growth. A lab report will be written to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

- **Mini Lab (5) Technology Mini-Lab – Soil Moisture Testing**: Building on the learning of soil composition in the Calgon lab, in this mini-lab, students will learn that the moisture levels in soil vary depending on the soil composition through the use of soil moisture sensing equipment. Students will learn how to operate a soil moisture sensor by testing the moisture levels in various soils. Students will return to the locations where soil samples were collected for the Calgon testing lab in order to test the moisture levels of those specific soils. They will use their data from the Calgon testing lab alongside the data from the soil moisture tests to determine how the composition of the soil impacts the soil moisture levels. A lab report will be written to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

- **Mini Lab (6) Agriscience Research Project Proposal** - The curriculum development team recommends introducing this lab first so that students understand the structure of the course. The key assignment for this introductory unit will be writing a research proposal for the student’s planned Agriscience Project. To guide the students in deciding their agriscience research questions/problem, the mini lab experiences completed in this unit should be utilized. The written proposal will include their chosen problem/question that they will be researching and investigating, five pieces of literary references, and the steps to complete for their research project. This assignment marks the first in a series of assignments that will be necessary for students to complete in order to successfully complete their agriscience research project.
Unit Description: Students will use the methods of scientific inquiry, developed in the previous unit, to investigate the composition of the physical world, and discover how matter and energy change forms through biogeochemical cycles. Students will understand where soil originates by investigating the role of the rock cycle in soil formation. Students will learn how the electron configurations of different elements, present in the parent material, give them unique physical and chemical properties, and will further investigate how these properties impact soil characteristics. Students will identify how the climate, weather, and environment impact the soil properties, and will examine the role erosion plays in soil science. Students will collect soil samples from a variety of sources, and will use industry methods to determine the chemical composition of the soil and how this composition affects its physical and chemical characteristics. Students will connect to prior knowledge of life science by looking at how biotic factors impact soil type, composition and texture through investigation and experimentation. Students will use the results of their soil testing and the locations from which they took their samples to create a soil map of their local area. Students will compare their map to existing soil maps and analyses, and analyze the similarities and differences with the previous research.

Unit Standards

Key High School Physical Science Performance Expectations:
- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)
- 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. (HS-PS1-3)
- Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (HS-PS1-8)
- Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (HS-ESS2-5)
- Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth. (HS-ESS2-7)
- Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems. (HS-ESS2-2)

Key Disciplinary Core Ideas:
- PS1.A: Structure and Properties of Matter – Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this

English Language Development Standards Alignment:
- When conducting labs, suggest that students work in pairs whenever possible.
- Students may benefit from occasional support as necessary in initiating and sustaining dialogue on specific grade level content.
- Students can comprehend detailed information with fewer contextual clues, but may benefit from building additional vocabulary awareness for unfamiliar words.
- When reading technical documents, students may need to review text features for responding to informational text.
- Teachers should review ELD standards for Beginning, Expanding, and Bridging proficiency levels or seek additional EL supports for students who may be CELDT levels 1-3.

Learning Objectives:
- Students will be able to:
  - Use the periodic table.
  - Plan and conduct investigations using scientific method.
  - Follow simple and more complex lab procedures.
  - Plan and carry out an investigation.
  - Construct an argument based on evidence.
  - Analyze a claim and counter claim.
  - Complete a lab report following multi step procedures and identifying details of results of a scientific experiment.
  - Conduct a variety of scientific tests on soils utilizing a variety of elements.
  - Check their hypothesis against their research and identify findings.
  - Plan and conduct research on both short and long term projects, including presenting a proposal for a research project.

Instructional Resources:
- See Unit 1 for specific URLs to UCCI resources.

Unit Planning Strategies:
- There are 7 possible labs in Unit 2.
- Labs 3 & 5 go with the end of year final project and should be completed outside the school day.
- The analyzing Data and Investigation lab is from Unit 3 in the UCCI resources. The 2016 curriculum team recommends completing this in Unit 2.
table reflect patterns of outer electron states. (HS-PS1-1)

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

- ESS2.C: The Roles of Water on 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)

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7)

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

**Science and Engineering Practices:**

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

- 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)

- Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

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

- **Obtaining, Evaluating, and Communicating Information:** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.
- **Asking Questions and Defining Problems:** Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

**Agriculture Standards:**
- Recognize the major soil components and types. (C10.1)
- Summarize how soil texture, structure, pH, and salinity affect plant growth. (C10.2)
- Assess water delivery and irrigation system options. (C10.3)
- Differentiate among the types, uses, and applications of amendments and fertilizers. (10.4)
- Demonstrate techniques used to classify soils. (E3.1)
- Explain the reasons for, and importance of, soil conservation. (E3.2)
- Analyze soils found in different natural resource management areas. (E3.3)
- Prepare and amend soils, implement soil conservation methods, and compare results. (F5.3)

**Key Unit Assignments:**
- **Lab (1) - Sedimentary Rock Lab** - In this activity students will model how sedimentary rock is formed by simulating weathering and erosion. Because sedimentary rock is the parent material for major components of many high quality soils, students will investigate the physical and chemical processes which create sedimentary rock. In this lab, students will use brown sugar to simulate the effect of water on soluble rock, show how water can dissolve various minerals, show how freezing water can crack porous rock, show the effects of water’s impact by pouring water on sand, and use a hairdryer and sand to simulate wind erosion on copper sulfate crystals. Students will turn in a lab report that details the results of the lab and that identifies which processes are examples of physical change (water expanding in cracks to break rocks, sand particles wearing away rock, etc.), and which processes are examples of chemical change (slightly acidic water dissolving limestone, oxidation of minerals to create metal oxides, etc.).

**Key Unit Assessments:**
- Completed lab reports for Labs 1, 2, 4, 6, and 7.
- Completed data analysis from Extra Lab
- End of Semester Capstone Project
Lab (2) - Collect and Test Soil Samples - Physical Properties (figure out what elements might be in
them based on chemical properties): In this lab, students will learn how to test the physical
characteristics of soil, so that they can learn how these characteristics affect a soil’s capabilities in later
units. They will be able to assess and amend a soil to achieve a specific agricultural application.
Students will collect soil samples from a variety of locations around their community. After receiving
instruction in lab safety protocols, students will choose appropriate lab testing and safety equipment,
and will carry out a battery of industry standard tests to determine what physical characteristics the soil
samples possess. After receiving instruction in what physical properties of matter are measured in soil
testing, students will use the ribbon test, and also look at physical factors such as soil texture,
composition, and particle size. Students will examine the soil for presence of living organisms, such as
nematodes. Based on these properties, students will hypothesize what chemical elements are present in
the soil. Students will research what chemicals are prominent in the soil in their test areas, and check
their hypotheses against this research. Students will turn in an annotated bibliography detailing the
major findings of their research. Students will give a presentation on their annotated bibliography, and
give details on where their soil came from, the lab tests they performed, the results of the tests, their
data analysis, and how that analysis compared to their research.

Lab (3) - Background Scholarly Research and Forming a Hypothesis - This lab is completed
outside of the classroom and accompanies the end of semester final project. As they begin work
on their semester-long research project, students use skills in research and forming hypotheses
developed in the previous units to develop a hypothesis for their agriscience research project. Students
will use credible sources to conduct background research on the agricultural issue they are
investigating by reading and deconstructing scholarly journal articles to identify the key components of
their agriscience research project. They will use this research to generate a testable hypothesis related
to the scientific problem they have identified. The hypothesis developed by the student will be
constructed with the independent and dependent variables in mind, and ultimately reviewed by the
instructor.

Lab (4) - Test Soil Samples - Chemical Properties In this lab, students will learn how to test the
chemical characteristics of soil, so that as they learn how these characteristics affect a soil’s
capabilities in later units, they will be able to assess and amend soil to achieve a specific agricultural
application. Students will test the soil samples that they collected for the previous lab to determine the
chemical properties of the samples. After receiving instruction in lab safety protocols, students will
choose appropriate lab testing and safety equipment. After learning what chemical characteristics of
soil are commonly tested, what reactions occur in the testing process, and how these tests are
performed, students will carry out a battery of industry standard tests to determine chemical
characteristics, such as pH, nitrogen levels, potassium levels, phosphorous levels and presence of
micronutrients. Students will use their chemical tests to compare what chemical elements they found in
the soil with what they hypothesized based on physical characteristics, and what they found in their
research. Students will turn in a lab report which details where their soil came from, the lab tests they performed, the results of their tests, and the analysis of their results as compared to their findings in the previous assignment.

- **Lab (5) Experimental Design and Conducting Experimentation** - This lab is completed outside of the classroom and accompanies the end of semester final project. Students continue work on their semester-long agriscience project by constructing an experimental design to test the hypothesis they developed earlier in this unit. A written experimental design should be constructed consistent with scientific protocols using the systematic approach outlined in the previous units. Students will have their experimental designs reviewed by professional contacts (industry experts, agricultural instructors, local growers/producers, researchers or university representatives). After validating the design using the peer review process, students will move to the experimentation phase of their research. Experimental designs should include replicates, control groups, and determine the variables to be controlled and how. Additionally, a determination should be made as to the type of data that will be collected and in what ways, with the emphasis placed on quantitative data or quantifying data that is qualitative in nature. Students will use their experimental design to test their hypothesis. Raw data should be recorded using a field book.

- **Lab (6) Creating Soil Maps** - Students will take the soil analysis results from the previous assignments to construct a soil map of their local area. Based on the physical properties, such as soil texture, composition and particle size, the chemical properties, such as pH, nitrogen levels, micronutrient levels, etc., and the specific location from which the soils came, students will categorize the soil samples and the class will construct a comprehensive soil map of the local area. Students will then compare their map to existing soil maps, and analyze the similarities and differences with the previous USDA-NRCS maps.

- **Lab (7) Soil Management Project** - The soil management project, which students begin in unit 2, will be ongoing throughout the length of the course. The teacher will procure samples of soil from a variety of local farms and these samples will be kept as individual soil plots, or can be kept in plastic containers. Students will perform a variety of tests on these soil samples throughout the course in order to determine the characteristics that the individual samples possess, to analyze how these characteristics impact agricultural outcomes, and how amendments can be made to the soil samples in order to achieve a desired outcome. In this unit students will use the skills they learned in the previous labs to test and record the physical and chemical characteristics of the soil, and identify organisms living in the soil. Students will keep ongoing records of the data they collect during each of the units learning labs. This data will include information about the physical and chemical characteristics of their soil sample, results from testing pH, moisture, nutrient levels, water holding capacity, ability to grow target crops, and other factors in subsequent units.

- **Extra Lab - Analyzing data, interpreting data and forming conclusions.** This lab has been added from the UCCI course Unit 3. Due to pacing, this lab must be completed as part of the semester.
**long Agriscience Project** - Students will determine the best methods for organizing the data from their semester-long Agriscience Project by creating data tables. The skills in analyzing and interpreting data used during Key Assignments One and Two in this unit will be applied to the final agriscience research project. Students will make similar determinations on their Agriscience research. Students will use mathematical principles to synthesize their data, calculating a mean. Furthermore, a statistical analysis of the data will help the student determine if the results are due to chance or the independent variable that was tested. Students will choose the best way to present their data using graphs they believe will most effectively demonstrate their findings, and will further summarize what each graph shows. Finally, students will interpret the data and formulate conclusions based on the results. In the written conclusion, students will use their data to either accept or reject the original hypothesis. Conclusions should be directly supported by the data and by previous research. Students will also identify the limitations of their research, improvements that could be made to the experimental design, as well as future studies that may be conducted that relate the study at hand.

- **Semester One Capstone Project** - Students will submit their agriscience research in a written paper, and it will include the following components: problem/purpose, background research, hypothesis, methodology, results/data, and discussion/conclusion. The paper will be written using skills associated with technical and scientific writing, for example, refraining from the use of personal pronouns or keeping discussion limited to what the research and data suggest rather than personal opinion and bias. APA format will be utilized to reference and cite sources. The project and its findings will be shared with the class in an oral presentation.
### Chemistry and Agriscience Scope and Sequence

#### Unit 3 - Water and Soil Management

**Length:** 8 weeks

**Unit Description:** Using knowledge accessed from previous units on the physical and chemical properties of soil, students will analyze how the water cycle impacts soil based on its soil type (sand, silt, clay) soil location (geographic and topographic), vegetative state and natural slope of land. In order to understand how water becomes available for plant growth, students will explain the movement of water through soil with respect to how intermolecular forces impact percolation, capillary action, pore size, cohesion and adhesion. Furthermore, students will address how the concentration of organic matter in soil impacts the movement of water. Students will explain the impact that soil has on the quality of their water and will use water analysis tests to determine the safe and appropriate levels for potable water. Students will also be able to provide solutions to possible contaminations and/or toxic levels of residues/nutrients in the water samples. Students will determine how different irrigation, tillage and planting practices will impact the soil and surrounding area by testing water quality, pH and checking for possible contaminants due to leaching. Students will determine proper and efficient irrigation practices based on the chemistry behind the soil and the way water moves through the soil particles. Students will use GPS to enable students to more accurately analyze watersheds in their area and rationalize how the drought can impact both water quality and quantity as well as soil composition.

### Unit Standards

<table>
<thead>
<tr>
<th>Standards Key</th>
<th>Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS = High School</td>
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</tr>
<tr>
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<tr>
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<tr>
<td>CC=Cross Cutting Concepts</td>
<td></td>
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<tr>
<td>SEP=Science &amp; Engineering Practices</td>
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</tbody>
</table>

### Key High School Physical Science Performance Expectations:

- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)
- 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. (HS-PS1-3)
- 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-PS1-2)
- Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (HS-PS1-4)

### English Language Development Standards

- Use the periodic table.  
- Plan and conduct investigations using scientific method.  
- Follow simple and more complex lab procedures.  
- Plan and carry out an investigation.  
- Construct an argument based on evidence.  
- Analyze a claim and counter claim.  
- Complete a lab report following multi step procedures and identifying details of results of a scientific experiment.  
- Conduct a variety of scientific tests on soils utilizing a variety of elements.  
- Check their hypothesis against their research and identify findings.  
- Plan and conduct research on both short and long term

### Instructional Resources:

- See Unit 1 for specific URLs to UCCI resources.

### Unit Planning Strategies:

- Unit 3 marks the beginning of the 2nd semester. Recommend reviewing the end of year assignment and spending time focusing on research strategies and practices for the culminating written research paper and proposal project.
- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. *(HS-PS1-6)*
- Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. *(HS-PS1-7)*
- Create a computational simulation to illustrate the relationships among management of natural resources, and the sustainability of human populations, and biodiversity. *(HS-ESS3-3)*

### Key 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. *(HS-PS1-3)*
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. *(HS-PS1-1)*
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. *(HS-PS1-1)*
- The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions. *(HS-PS1-2), (PS1-7)*
- Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. *(HS-PS1-4)*

**PS1.B: Chemical Reactions** – Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. *(HS-PS1-4)*
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction and the reverse reaction determines the numbers of all types of molecules present. *(HS-PS1-6)*

**ESS3.C: Human Impacts on Earth Systems** – The projects, including presenting a proposal for a research project.
- Understand and correctly use content specific terminology associated with the unit of study.
- Present findings to small and large groups both orally and through use of technology such as a multi-media presentation.

### Writing Standards in CTE:
- Produce clear and coherent writing.
- Write a proposal.
- Use technology to produce and/or publish.
- Conduct short research to solve a problem or answer a question, including demonstrating understanding.
- Gather relevant information from multiple sources, integrate information.
- Draw evidence from text.

### Reading Standards in CTE:
- Cite specific evidence from text.
- Explain central idea of text.
- Follow a multi-step procedure.
- Determine key terms and their meanings.
- Analyze relationships among concepts and key terms.
- Translate quantitative or technical information into visual form.
- Compare and contrast findings.
sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

Scientific and Engineering Practices:
- **Asking Questions and Defining Problems** – Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
- **Developing and Using Models** – Modeling in 9-12 builds on K-8 experiences and progresses to using synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
- **Analyzing and Interpreting Data** – Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
- **Engaging in Argument from Evidence** – Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Crosscutting Concepts:
- System and System Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

Agriculture Standards:
- Summarize the different types of aquatic resources. (E6.1)
- Analyze the relationship between water quality and aquatic species habitat. (E6.4)
- Experiment with the factors that influence plant growth, including water, nutrients, light, soil, air, and climate. (F2.4)
• Explain how basic soil science and water principles affect plant growth. (F5.1)
• Illustrate basic irrigation design and installation methods. (F5.2)
• Prepare and amend soils, implement soil conservation methods, and compare results. (F5.3)
• Research major issues related to water sources and water quality. (F5.4)
• Explain the components of soilless media and test the uses of those media in various types of containers. (F5.5)
• Research how soil biology affects the environment and natural resources. (G6.4)
• Research and describe the local, state, and federal agencies that regulate water quality and availability in CA. (G8.2)
• Define the definition of watershed and explain how it is used to measure water quality. (G8.3)
• Explain effective water management and conservation practices, including the use of tidewater ponds. (G8.4)
• Use water-testing standards and perform bioassay and macro-invertebrate protocols to assess water quality. (G8.5)

Key Unit Assignments:

• **Lab (1) - Soil Erosion and Runoff Lab** - Using soil plots from the previous labs, students will analyze how soils with vegetation (including organic matter) have a greater water holding capacity and less runoff than soils without vegetation by collecting runoff water from each plot and testing not only the amount of water collected from each plot, but also the percent of solids collected from runoff from each of those plots. Students will complete their lab write up to emphasize their understanding of these key concepts. Students’ lab reports should include qualitative and quantitative observations of the composition of runoff from the soil plots. They should analyze this data to draw conclusions about the water holding capacity of the soils and should discuss the intermolecular interactions which allow soil to hold water at the molecular level. This assignment prepares them for decisions that will be made in their capstone project of creating a soil management plan.

• **Lab (2) - Water Quality Testing** - Students will begin by examining properties of subatomic particles and will create models to illustrate bonding of hydrogen and oxygen, accounting for the polarity of the water molecule. The focus of this unit will continue to develop an understanding of how hydrogen bonds give water a number of properties that allow it to percolate through soil, adhere to pollutants and transpire through plants. The teacher resources contains a link to the lab where students will test water samples from various sources throughout their community to determine the quality of the water. They will test and record data on pH, phosphates, nitrates, dissolved oxygen, and turbidity. Students will then

Key Unit Assessments:

• Lab 1 – Lab Report
• Lab 2 – Class Presentation (Summary of Lab Report)
• Lab 3 - Completed in Unit 2
• Lab 4 – Written Report 1-3 Pages
• Lab 5 – Multi-Media Presentation
• Lab 6 – Lab Write Up
analyze this data to draw conclusions on what can be done to improve the quality of the water. Students should also indicate what steps can be made in agriculture to protect water quality and ensure a safe water source for the community. Students will make a presentation to the class that summarizes their lab procedure, results, and conclusions. To extend learning, the group that has the most thorough presentation can present their findings to the School Board, local Farm Bureau, or any other local organization.

- **Lab (3) was moved to Unit 2.**
- **Lab (4) Tillage Practices and the Impact they have on Runoff, Erosion and Soil Chemistry - Students** will explore how chemical bonding, chemical reactions and chemical equilibrium are demonstrated through the relationship between tilled soil and water runoff. Students build upon their knowledge of atomic structure to explore the various forms of chemical bonding that takes place between atoms of different elements as well as the role of valence electrons. To deepen understanding of chemical interactions, students will investigate both the physical and chemical changes that take place during tillage. Students will utilize locally sourced soil samples at both pre-tillage and post-tillage intervals to compare the effects of tillage on the physical and chemical nature of soil. Ideally, multiple tillage types will be examined including conventional tillage, deep ripping tillage and conservation tillage. Soil pH, effective cation exchange capacity, soil organic carbon, and soil nutrient levels will be measured in addition to an analysis of the physical structure of the soil. Examination of the physical structure can allow students to predict potential erosion and runoff issues. Students will then develop suggestions for best tilling practices by using GPS and topographic maps to determine the natural slope of a given plot of land. They will be asked to design the most efficient “tillage” for this plot to conserve water, prevent soil erosion and cause the least disturbance to soil and water bonding. Students must explain in a written report, including a detailed diagram, why they selected the design they did and how it will be the most beneficial for the environment using conservation techniques for the soil and water as learned in this unit. They will also explain why the alternative designs would be poor choices.

- **Lab (5) - Ground Water Contamination and Aquifer Lab - Students will demonstrate how aquifers filter different contaminants by constructing a model of an aquifer and testing how groundwater contamination occurs by using common agricultural contaminants. They will analyze two different types of aquifers and determine which type they would want to place a well into and why. Students will explain how the size of the pores affects the intermolecular interactions between contaminated water and the rock, and how this in turn impacts how well an aquifer can filter out contaminants. Students will examine how the pH of different solutions is directly affected by soil type and aquifer porosity. Students will model this by capturing water that comes through their aquifer model. Students will then determine the concentration of this type of solution through a standardized titration experiment. Once they have used their models as a means of understanding how easily groundwater can be contaminated, they will complete their conclusion and create a multimedia production in the form of a TED talk or Infomercial that educates their community on what agriculturists do and can do to improve water
quality in their local area. They will present their productions to a panel of judges and the winners will have their video/multimedia presentation broadcast school-wide.

- **Lab (6) - Irrigation Practices in Agriculture** - Students will understand how evaporation (due to temperature) and soil type plays a huge role in the irrigation methods and practices employed in the agriculture industry. Students will be given 3 different soil types. Students will divide these 3 soil types into 9 different samples; 3 of each in a different setting, but they will receive the same amount of water to simulate “irrigation”. Students will hypothesize what they think will happen based on soil type and temperature with regard to moisture retention and how this will impact decisions in irrigation selection. In the control group the 3 soil samples will be placed outside. In test group #1, 3 samples will be placed under a heat lamp to simulate an environment with a hotter ambient temperature. In test group #2, 3 samples will be placed in a location cooler than your outside temperature. In all 3 of the test locations students will water all of the samples with equal amounts of water. The following day students will test the moisture content of all soil samples using a Kelway Soil Acidity and Moisture Meter to determine the effects that temperature and soil type had on moisture retention. Using this data, students will then complete the lab write up and finish a conclusion by summing up how this lab impacts irrigation practices.
Unit Description: Building on knowledge acquired from the previous units on the physical and chemical properties of water and soil, students will begin to determine the effects of plant, soil and water interactions with respect to maintaining or restoring environmental health and structure. Students will model how nutrients cycle through the environment, analyze how pH affects nutrient availability by changing chemical equilibrium, determine water holding capacity with respect to water availability for plant growth, and identify possible nutrient deficiencies based on plant observations. Students will apply this learning to developing knowledge of soil nutrients and their role in the environment by testing and analyzing soil samples for optimal soil structure, nutrient value and availability and determining possible soil amendments and practices to improve soil quality.

Unit Standards

Standards Key:
HS = High School
PE = Performance Expectations
ETS= Engineering & Technology
LS=Life Science
PS=Physical Science
DCI=Disciplinary Core Ideas
CC=Cross Cutting Concepts
SEP=Science & Engineering Practices

Key High School Physical Science Performance Expectations:
- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)
- 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. (HS-PS1-3)
- 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-PS1-2)
- Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (HS-PS1-4)
- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*(HS-PS1-6)
- Use mathematical representations to support the claim that

English Language Development Standards Alignment:
- Students may need assistance in building background knowledge of unfamiliar terminology – including benefit of use of glossary.
- Use of a model lab report and clarification of rubric expectations.
- Consider forming pair groups and/or tri groups of lab experiments.
- Students should be able to write and verbalize their ideas and produce writing on a variety of topics. They may need assistance with structure.
- For written proposal, consider providing examples of completed proposals and clarifying expectations periodically.

Learning Objectives:
Students will be able to:
- Use the periodic table.
- Plan and conduct investigations using scientific method.
- Follow simple and more complex lab procedures.
- Plan and carry out an investigation.
- Construct an argument based on evidence.
- Analyze a claim and counter claim.
- Complete a lab report following multi step procedures and identifying details of results of a scientific experiment.
- Conduct a variety of scientific tests on soils utilizing a variety of elements.
- Check their hypothesis against their research and identify findings.
- Plan and conduct research on both short and long term projects, including presenting a proposal for a research

Instructional Resources:
- See Unit 1 for specific URLs to UCCI resources.
- USDA Website

Unit Planning Strategies:
- Examine rubrics from Unit resources for writing proposals. Review rubric expectations with students and consider providing examples/models.
atoms, and therefore mass, are conserved during a chemical reaction. (HS-PS1-7)
- Create a computational simulation to illustrate the relationships among management of natural resources, and the sustainability of human populations, and biodiversity. (HS-ESS3-3)
- Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. (HS-PS1-5)

**Key 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. (HS-PS1-3)
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating pattern of this table reflect patterns of outer electron states. (HS-PS1-1)(HS-PS1-2)
- The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (PS1-7)
- Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)
- **PS1.B: Chemical Reactions** – Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4), (HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction and the reverse reaction determines the numbers of all types of molecules

**Writing Standards in CTE:**
- Understand and correctly use content specific terminology associated with the unit of study.
- Present findings to small and large groups both orally and through use of technology such as a multi-media presentation.

**Reading Standards in CTE:**
- Cite specific evidence from text.
- Explain central idea of text.
- Follow a multi-step procedure.
- Determine key terms and their meanings.
- Analyze relationships among concepts and key terms.
- Translate quantitative or technical information into visual form.
- Compare and contrast findings.
The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (PS1-7)  

ES3.C: Human Impacts on Earth Systems – The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

Science and Engineering Practices:

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

- 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)

- Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

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

- Engaging in Argument from Evidence – Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
### Key Agriculture Standards:

- Practice local cultural techniques, including monitoring, pruning, fertilization, planting, irrigation, harvest treatments, processing, and packaging practices for various tree, grain, hay, and vegetable classes. (G10.1)
- Research how changing technology, such as micro-propagation, biological pest controls, plant production, yields, and management. (G11.1)
- Understand soil types, soil texture, structure, and bulk density and explain the US Department of Agriculture (USDA) soil-quality rating procedure. (G6.1)
- Analyze soil properties necessary for successful plant production, including pH, electrical conductivity (EC), and essential nutrients. (G6.2)
- Explain soil biology and diagram the cycles in nature as related to the soil food chain. (G6.3)
- Research how soil biology affects the environment and natural resources. (G6.4)
- Research the factors that influence plant growth, including water, nutrients, light, soil, air, and climate. (G3.4)

### Key Unit Assignments:

- **Lab (1) - Plant Requirements from Soil Lab** - Students will demonstrate their knowledge of plant growth requirements by creating a controlled experiment to compare the difference between natural and synthetic fertilizers on plant growth. Students will make qualitative and quantitative observations of plant growth and analyze their data in order to draw conclusions regarding the availability of nutrients and the practical application for crop growers. Fertilizers are identified with particular isotopes and as part of the assignment, students will describe nuclear processes and radiation, describing their methods of use in determining fertilizer application in commercial agriculture. Students will then create a written recommendation to a local crop producer regarding which type of fertilizer to use for their farm in order to achieve production goals, highlighting chemistry concepts as a fundamental part of the assignment. Optional extension: Students can analyze the amounts of fertilizers needed in order to reach the desired amount necessary for plant growth and determine whether the addition of fertilizers is cost effective.

- **Lab (2) - Soil Management Project** - Students will analyze their data collected from unit 2 and determine which crops can be grown based on the current physical and chemical properties of the soil. Students will make recommendations for soil amendments which would increase the nutrient availability of the soil in order to grow a desired crop. Students should consider how pH, and chemical equilibrium will impact the availability of nutrients in the soil in their recommendations. Students will then plant a crop from a given list of cover crops (clover, grasses and legumes) in their soil test plot,

### Key Unit Assessments:

- Lab 1 – Written Proposal
- Lab 2 – Lab Report
- Lab 3 – Lab Report
allow it to grow and then retest the soil to see if there is a difference in the nutrient concentrations. Students will incorporate their knowledge of biogeochemical cycles into their lab report and will provide an explanation of how nutrients are being transferred from the soil to the plants. The research and experimentation conducted in this project will be added to their Soil Management Capstone Project.

- **Lab (3) - Plant and Soil Interactions** Students will compare their nutrient values from the previous project with other groups during a classroom discussion. Students will analyze the data and develop explanations for why there is a difference in the amount of nutrients the plants extracted from the soil. Students will then revisit the Soil Erosion and Runoff Lab from Unit 3 and measure the amount of runoff and soil erosion that occurs on each of the cover crops and compare the data to the data collected from Unit 3. Students will communicate their results in a lab write up.
Chemistry and Agriscience Scope and Sequence

Unit 5 - Animals and Soil Management

Length: 3 weeks

**Unit Description:** Using knowledge from previous units about soil nutrient content, students will identify the key macro minerals and micro minerals necessary for normal livestock growth and reproduction. The students will correlate the minerals present in soil with the nutrient content of typical livestock concentrate and roughage feeds. Using local resources, the students will identify mineral deficiencies or toxicities in the soil and relate the deficiencies or toxicities to livestock health. Students will identify crop and range management practices to improve the nutrient content of soil, and will explain what reactions take place at the molecular level to improve nutrient content. Students will identify various methods of using animal waste and the environmental impacts including the use of animal waste as soil amendments and fertilizers. Students will relate the units of concentration used in agriculture practice to units used in chemistry labs, as they identify problems and contaminants associated with livestock waste disposal and related health and safety regulations.

<table>
<thead>
<tr>
<th>Unit Standards</th>
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<tbody>
<tr>
<td><strong>Standards Key:</strong></td>
</tr>
<tr>
<td>HS = High School</td>
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<tr>
<td>PE = Performance Expectations</td>
</tr>
<tr>
<td>ETS = Engineering &amp; Technology</td>
</tr>
<tr>
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<td>PS = Physical Science</td>
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<tr>
<td>DCI = Disciplinary Core Ideas</td>
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<tr>
<td>CC = Cross Cutting Concepts</td>
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<tr>
<td>SEP = Science &amp; Engineering Practices</td>
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**Key High School Physical Science Performance Expectations:**
- 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. (HS-PS1-3)
- Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (HS-PS1-4)
- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.* (HS-PS1-6)
- Create a computational simulation to illustrate the relationships among management of natural resources, and the sustainability of human populations, and biodiversity. (HS-ESS3-3)
- 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-PS1-2)

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<tr>
<th>English Language Development Standards Alignment:</th>
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<td>Students may need assistance in building background knowledge of unfamiliar terminology – including benefit of use of glossary.</td>
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<td>Use of a model lab report and clarification of rubric expectations.</td>
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<td>Consider forming pair groups and/or tri groups of lab experiments.</td>
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<td>Students should be able to write and verbalize their ideas and produce writing on a variety of topics. They may need assistance with structure.</td>
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<tr>
<td>For oral presentation, consider providing examples of completed proposals and clarifying expectations periodically.</td>
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<tr>
<td>Students may benefit from sentence frames and/or starters and even a model presentation or having someone model prior to an EL presentation.</td>
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<tr>
<td>Final written proposal may require additional information on citation, clarifying academic expectations in technical writing, etc. This is due in Unit 6, but discussed here.</td>
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<tr>
<th>Learning Objectives:</th>
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<td>Plan and conduct investigations using scientific method.</td>
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<td>Complete a lab report following multi step procedures and identifying details of results of a scientific experiment.</td>
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<tr>
<td>Conduct a variety of scientific tests on soils utilizing a variety of elements.</td>
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<td>Check their hypothesis against their research and identify findings.</td>
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<td>Plan and conduct research on both short and long term projects, including presenting a proposal for a research project.</td>
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<td>Understand and correctly use</td>
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<tr>
<th>Instructional Resources:</th>
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<td>See Unit 1 for specific URLs to UCCI resources.</td>
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**Unit Planning Strategies:**
- There are 4 labs in Unit 5.
- Key assignments 1 and 4 connect directly to the end of year final project.
Key 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. (HS-PS1-3)
  
- **Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.** (HS-PS1-4)

- **PS1.B: Chemical Reactions** - In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
  
- **The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions.** (HS-PS1-2)

- **ESS3.C: Human Impacts on Earth Systems** – The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

Science and Engineering Practices:

- **Planning and Carrying Out Investigations**: Planning and carrying out investigations in grades 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematics, physical, and empirical models.

Key Agriculture Standards:

- Evaluate a rangeland and identify methods of rangeland improvement used in an effective animal production program. (D7.1)
  
- Summarize how rangeland management practices affect pasture production, erosion control, and the general balance of the ecosystem. (D7.2)

- Evaluate a plan to balance rangeland use for animal grazing and for wildlife habitat. (D7.4)

- **Assess treatment and disposal management systems for animal waste.** (D8.1)
  
- **Compare various methods for using animal waste and the content specific terminology associated with the unit of study.**

  - Present findings to small and large groups both orally and through use of technology such as a multi-media presentation.
  - Utilize mathematics to illustrate and verify data sets.

Writing Standards in CTE:

- **Produce clear and coherent writing.**
- **Write a proposal.**
- **Use technology to produce and/or publish.**
- **Conduct short research to solve a problem or answer a question, including demonstrating understanding.**
- **Gather relevant information from multiple sources, integrate information.**
- **Draw evidence from text.**

Reading Standards in CTE:

- **Cite specific evidence from text.**
- **Explain central idea of text.**
- **Follow a multi-step procedure.**
- **Determine key terms and their meanings.**
- **Analyze relationships among concepts and key terms.**
- **Translate quantitative or technical information into visual form.**
- **Compare and contrast findings.**
- Research the health and safety regulations that are an integral part of properly managed animal waste systems. (D8.3)
- Formulate and implement optimum requirements for diet, genetics, habitat, and behavior in the production of large and small animals. (D10.1)
- Assess the flow of nutrients from the soil, through the animal, and back to the soil. (D2.1)
- Explore the principles for providing proper balanced rations for a variety of production stages in ruminants and monogastrics. (D2.2)

**Key Unit Assignments:**

- **Lab (1) - Nutrient Deficiencies in Livestock** - Students will examine the correlation between soil and plant nutrient levels with health problems in livestock. Using their knowledge of solutions and concentration, students will identify soil nutrient deficiencies in a geographic area. They will relate the nutrient deficiencies with livestock diseases. For example, if an area has a deficiency in selenium, students will identify problems such as white muscle disease in calves and lambs. Working in groups, the students will analyze a case study on selenium deficiencies in cattle and offer a solution and/or design a system to prevent or correct a mineral deficiency in livestock caused by a soil deficiency. Their analysis will be presented in a written report. Optional extension to this assignment could include testing other nutrient deficiencies, such as copper toxicity, and reporting these findings in a group oral presentation using the case study as an example.

- **Lab (2) - Livestock and Water Quality** - Students will examine the nutrients present in animal waste and identify possible environmental contaminants in the waste. To examine the effects of water runoff from livestock facilities, students will design a controlled experiment to test water samples from soils exposed to livestock for nitrates, phosphate, heavy metals, pH, dissolved oxygen and other factors. Students will utilize their previously collected soil samples or soil plot and design a model to simulate water runoff from a livestock production facility. Alternately, students will test water runoff samples from existing livestock facilities. At the conclusion of the experiment, students will provide a written recommendation to a county land use commission with a protocol for the optimal use of the animal effluent.

- **Lab (3) - Livestock Waste Management** - Students will examine the challenges involved with livestock waste management. The problems may include ammonia emissions, phosphorus runoff, nitrate leaching and heavy metal runoff. The instructor will provide a problem and scenario that relates to livestock waste management from an agricultural operation. Students will research the problem and design a system or solution. For example, if a school builds a school farm and raises 10 head of cattle in confinement, how will the waste be handled? The students will consider factors such as environmental

**Key Unit Assessments:**

- Lab 1 – Written Report/Oral Presentation (Optional)
- Lab 2 – Written Recommendation
- Lab 3 – Write Up/Notes Summary
- Lab 4 – Final Written Proposal
concerns, health and safety regulations, amount of waste produced, reactivity of the waste products, uses for the waste, possible cost and labor requirements.

- **Lab (4) - Soil Management Project** - The soil management project, which students begin in unit 2, will be ongoing throughout the length of the course. In this unit, students will identify the nutrient deficiencies or toxicities present in the soil samples that might influence livestock production. Students will develop a written proposal for the tested soil, including soil amendments, fertilizers and application of animal waste or changes in livestock management practices to address these deficiencies or toxicities. As part of the recommendation process, students will examine the use of animal waste as a method of enhancing soil quality, using background knowledge of nuclear processes to describe variability in nutrient availability in uptake. For any toxicities present, students will examine the chemical profiles of the elements and recommend strategies for resolving agricultural issues for those elements. Students will use these soil management profiles as a component of their final course project as well as use them for subsequent units.
Chemistry and Agriscience Scope and Sequence
Unit 6 - Soil Sustainability
Length: 6 weeks

Unit Description: Based on the accumulation of knowledge, examples and research conclusions from throughout the year, students will develop an understanding of sustainable agriculture by employing a Sustainability evaluation tool, “The 3-Pillars of Sustainability, economic, environmental and social impacts” of agriculture. Students will critically evaluate and justify perspectives and determine benefits/concerns based on research and credible information. Students will investigate and evaluate the sustainability of agricultural practices. Students will design and conduct a phytoremediation lab to analyze the efficacy of salt tolerant accumulators to remove saline from the soil. Students will formulate potential solutions using the three pillars of sustainability to soil and land management problems based on agricultural scenarios and debate agricultural issues.

Unit Standards
Standards Key:
HS = High School
PE = Performance Expectations
ETS= Engineering & Technology
LS=Life Science
PS=Physical Science
DCI=Disciplinary Core Ideas
CC=Cross Cutting Concepts
SEP=Science & Engineering Practices

Key High School Physical Science Performance Expectations:
- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (HS-LS2-4)
- Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino and/or other large carbon-based molecules. (HS-LS1-6)
- Create or revise a simulation to test a solution to mitigate adverse impacts on human activity on biodiversity. (HS-LS4-6)
- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.(HS-LS2-7)
- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (HS-LS2-2)
- Design a solution to a complex real-world problem by breaking

English Language Development Standards
Alignment:
- Students may need assistance in building background knowledge of unfamiliar terminology – including benefit of use of glossary.
- Use of a model lab report and clarification of rubric expectations.
- Consider forming pair groups and/or tri groups of lab experiments.
- Students should be able to write and verbalize their ideas and produce writing on a variety of topics. They may need assistance with structure.
- For written proposal and final presentation consider providing examples of completed proposals and clarifying expectations periodically.

Learning Objectives:
- Students will be able to:
  - Plan and conduct investigations using scientific method.
  - Follow simple and more complex lab procedures.
  - Plan and carry out an investigation.
  - Construct an argument based on evidence.
  - Analyze a claim and counter claim.
  - Complete a lab report following multi step procedures and identifying details of results of a scientific experiment.
  - Conduct a variety of scientific tests on soils utilizing a variety of elements.
  - Check their hypothesis against their research and identify findings.
  - Plan and conduct research on both short and long term projects, including presenting a proposal for a research project.
  - Understand and correctly use content specific terminology

Instructional Resources:
- See Unit 1 for specific URLs to UCCI resources.

Unit Planning Strategies:
- There are 5 labs in Unit 6. Lab #5 is their capstone project. This includes a written paper.
- Students will need to review the requirements for writing a research paper, including APA formatting.
- Unit 6 also requires a student presentation and portfolio review.
it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)
- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS-ETS1-1)
- Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS-ETS1-4)

**Key Disciplinary Core Ideas:**

- **LS1.C: Organization for Matter and Energy Flow of Organisms** – The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6)

- **LS2.A: Interdependent Relationships in Ecosystems** – Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any living ecosystem. (HS-LS2-1), (HS-LS2-2)
- **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** – Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are associated with the unit of study.
- Present findings to small and large groups both orally and through use of technology such as a multi-media presentation.
- Utilize mathematics to illustrate and verify data sets.

**Writing Standards in CTE:**

- Produce clear and coherent writing.
- Write a proposal.
- Use technology to produce and/or publish.
- Conduct short research to solve a problem or answer a question, including demonstrating understanding.
- Gather relevant information from multiple sources, integrate information.
- Draw evidence from text.

**Reading Standards in CTE:**

- Cite specific evidence from text.
- Explain central idea of text.
- Follow a multi-step procedure.
- Determine key terms and their meanings.
- Analyze relationships among concepts and key terms.
- Translate quantitative or technical information into visual form.
- Compare and contrast findings.
combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

- **LS4.C: Adaptation** – Changes in 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), (HS-LS4-6)

- **LS4.D: Biodiversity and Humans** – Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6)

### Science and Engineering Practices:

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

  - 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)
  - Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

- **Constructing Explanations and Designing Solutions:**
  Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Engaging in Argument from Evidence – Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Key Agriculture Standards:
- Differentiate among the components of “whole-system management.” (G9.3)
- Integrate the use of technology when collecting and analyzing data. (C3.5)
- Understand how technology influences factors such as labor, efficiency, diversity, availability, mechanization, and communication. (C3.2)
- Identify the important agricultural environmental impacts on soil, water, and air. (C2.1)
- Explain current environmental challenges related to agriculture. (C2.2)
- Summarize how natural resources are used in agriculture. (C2.3)
- Compare and contrast practices for conserving renewable and nonrenewable resources. (C2.4)
- Develop and implement a soil management plan for a natural resource management area. (E3.4)
- Understand how to analyze existing soil surveys to develop effective management plans. (E.35)
- Identify and classify the plants and animals in an agricultural system (as producers, consumers, or decomposers). (G9.1)
- Compare and contrast the elements of conventional, sustainable, and organic production systems. (G9.2)

Key Unit Assignments:
- **Lab (1) - Phytoremediation Lab** - Students will learn about the remediative effects of plants in the uptake of soil contaminants, in this example, reducing soil salinity. Students will research saltwater intrusion causes and implications, research phytoremediation, develop a hypothesis, design an experimental procedure, identify safety procedures specific to this experiment, collect and analyze data, and formulate conclusions. Through these steps, students will determine which types of plants are best in phytoremediation of saline (“halophytic” or salt loving plants) and the maximum amount of saline

Key Unit Assessments:
- Lab 1 – Lab Write Up
- Lab 2 – Poster
- Lab 3 – Group Project/Presentation
- Lab 4 – Debate (complete before last two weeks of school)
- Final Project – Written paper APA Formatting & Presentation Soil Management Plan
- Final Portfolio Submission
which can be removed from the soil in this way.

- **Lab (2) - Tillage Protocols - Impact on Soil Structure and Soil Sustainability Lab** The purpose of this lab is to determine the effects of tillage practices on soil sustainability and plant growth. Using a prepared mini-plot with all three tillage examples (conventional, no-till, and low till) soil structure, students will measure and compare soil fertility, water holding capacity, and percolation. Students will analyze and graph their data, explain the implications of the each of these tillage systems with respect to soil and water sustainability and extrapolate those results to the effect of tillage practices effect on plant health. Students will create a poster to illustrate the benefits and drawbacks of each tillage system with respect to Soil-Plants-Water.

- **Lab (3) - Land Use Planning Model** - Student groups will make soil/land management decisions based on specific agriculture and land use restrictions on pieces of land such as large urban gardens, range management, forest management, and farmlands. Students will use their knowledge of physical and chemical properties of soil in regards to plants, animals and water to highlight the importance of sustainable agriculture. Getting a land use plan approved and in place with multiple interest groups is complicated and relies on the checks and balances to determine the success of the project. Each student in the group needs to take on a specific role in order to determine their Land Use Plan (such as conservationist, developer, owner, law enforcement, Department of Public Works, Anthropologist, City Planner, etc.). Groups will then prepare a presentation to present their plan. This presentation could be presented to the class and instructor or even community/local industry members.

- **Lab (4) - Agriculture Issue Debate and Policy Proposal** - Students will begin by conducting secondary research using industry journals into the global use of methyl bromide as a chemical soil sterilant. Students will examine the pros and cons of the use of methyl bromide in terms of manipulations to the chemical profile of soil, microbiology, effects on groundwater, runoff challenges and effects on agricultural productivity. Research should highlight chemical reactions as the primary point of focus. Students will then be assigned a perspective related to the methyl bromide investigation (runoff or microbiology, for example) to represent in the debate, using their list of chemistry- and agriculturally-focused pros and cons to inform their contributions. Students will end the debate with a comprehensive analysis of the issue of methyl bromide use in agriculture from multiple angles in order to develop a model policy for their county regarding the possible use of methyl bromide in agricultural applications.

- **Lab (5) - Soil Management Project** - The soil management project, which students began in unit 2, has continued throughout the length of the course. At the end of Unit 6, students will incorporate knowledge gained from all previous labs, and the conclusions drawn from the Phytoremediation and Tillage Protocols: Impact on Soil Structure and Soil Sustainability Labs to test, analyze, treat and/or modify soil structure and fertility for specific usage/in order to achieve desired outcomes. This work will be used as evidence in the Soil Management Capstone Project and will also aid in drawing the final conclusions of the yearlong research and experimentation.

- **Capstone Project - Soil Management Capstone Project** As the final course capstone project, students will be given a scenario and soil sample designed around their local agriculture industry. The given
scenario will provide students with specific information about the topography and climate/rainfall data of the location where the soil sample was collected. Students will use knowledge and skills learned in previous units to physically and chemically analyze the soil sample. Their soil analysis should include the composition and nutrient, pH, and salinity levels. The data collected from their soil sample analysis and the provided land information should be included in the soil management plan that the students create. The student’s Soil Management Plan will recommend soil amendments, proper tillage practices, optimal irrigation methods, crop recommendations, and animal use suggestions. Their recommendations and suggestions should be justified in terms of the 3-pillars of sustainable agriculture.

• **Course Portfolio** - The course portfolio will provide evidence of real-world agriculture application of scientific research done throughout this course. The portfolios will highlight student work from throughout the course to show a progression of learning, experimentation, and application of course content. Items that will be included in the portfolio are student lab reports, the Agriscience Research paper, and their Soil Management Plan.