

Protecting Earth's Resources

Plant and animal
resources



Teacher Guide

Air quality



Land resources



Protecting wildlife



Protecting Earth's Resources

Teacher Guide



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Protecting Earth's Resources

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Protecting Earth's Resources
Teacher Guide

Core Knowledge Science™ 5

Introduction

ABOUT THIS UNIT

The Big Idea

This unit focuses on human use of natural resources and scientific ideas and technology that can be used to protect Earth's resources over time.

Humans use renewable and nonrenewable resources for many aspects of modern life—for agriculture, transportation, industry, and daily needs. Our use of these resources can have negative effects on the environment, even when the resources are helpful to people across the world. The erosion of land, acid rain, and air and water pollution are just some of the consequences that may result from the use of natural resources by a growing population. We can, however, draw upon scientific principles to monitor and protect the environment. Through scientific practices and technology, we can detect when air, water, land, and ecosystems are changing and when they might be threatened. By applying scientific ideas, we can act to protect Earth's resources and our environment.

Note to Teachers and Curriculum Planners

This unit introduces Grade 5 students to real-world examples and fundamental concepts that will be explored in greater depth in later grades. Students will research efforts that many communities take to reduce the impacts of using natural resources. Using their knowledge of how water, air, and land are used for daily needs, students create a series of action/protection plans, which they will have the option to present to a selected audience of experts. The following are preliminary considerations for planning and instruction relative to this unit:

- The study of renewable and nonrenewable resources is addressed here as a project-based learning (PBL) unit. Read more about project-based and problem-based learning on page 3.
- Each part of this unit engages students to learn of particular natural resources used to meet human needs and how communities work to minimize any negative effects of use.
- This unit has been designed to build on prior knowledge, specifically knowledge gained through CKSci Grade 4 Unit 5, *Using Natural Resources for Energy*. For more information about this, please read pages 5–9.

- Students demonstrate their knowledge of natural resources through certain scientific practices, including the following:
 - determining and combining reliable sources of scientific information as evidence to make a scientific argument
 - describing how communities address human activities that potentially change the environment over time
 - constructing an argument that includes the positive and negative effects of human activity
 - creating and presenting an action/protection plan that outlines certain ways that their community can/should use scientific ideas to protect local natural resources and their local environment

Note to Core Knowledge Teachers

Thanks to ongoing research in the field, our understanding of how children learn continues to evolve. In the subject area of science, in particular, students benefit from not just reading about concepts and ideas, but from hands-on experiences. Following the release of the Next Generation Science Standards (NGSS), the Core Knowledge Foundation used this opportunity to update and enhance the science portion of the *2010 Core Knowledge Sequence*. The result of this effort is the revised *2019 Core Knowledge Science Sequence*.

While there have been some shifts in the grade levels at which certain topics are recommended, the fundamental principles of pedagogy inherent to the Core Knowledge approach, such as the importance of building a sequential, coherent, and cumulative knowledge base, have been retained.

Online Resources



To download the *2019 Core Knowledge Science Sequence*, use the links found in the Online Resources Guide.

www.coreknowledge.org/cksci-online-resources

This science unit, aligned to the *2019 Core Knowledge Science Sequence* and informed by NGSS, embodies Core Knowledge's vision of best practices in science instruction and knowledge-based schooling, such as the following:

- building students' knowledge of core ideas in life, physical, and Earth sciences, as well as engineering design
- developing scientific practices that give students firsthand experience in scientific inquiry, engineering, and technology
- connecting scientific learning to concepts across various disciplines, such as mathematics and literacy

To see how you can continue to use your current Core Knowledge materials with the 2019 CKSci™ curriculum, please see on the next page an example of how this unit compares to the *2010 Core Knowledge Sequence*.

Examples of content retained from the 2010 Core Knowledge Sequence	Examples of Core Knowledge content in this CKSci unit
Ecology (Grade 3) <ul style="list-style-type: none"> Human-made threats to the environment: Pollution: emissions, smog, industrial waste, runoff Measures we can take to protect the environment (for example, conservation, recycling) Energy, Heat, and Energy Transfer (Grade 6) <ul style="list-style-type: none"> Sources of energy: for example, coal, natural gas, solar, atomic, geothermal, falling water, wind Fossil fuels: a finite resource <ul style="list-style-type: none"> Carbon, coal, oil, natural gas Environmental impact of fossil fuels: carbon dioxide, greenhouse effect, acid rain 	Protecting Earth's Water/Air/Land <ul style="list-style-type: none"> Human activities can affect the availability and quality of natural resources: <ul style="list-style-type: none"> Unlimited use of fresh water sources may result in shortages, habitat destruction, etc. Air pollution—human activities discharge matter into the atmosphere (emissions), which change its chemical composition Sources and consequences of land pollution Applying scientific ideas to protect natural resources: environmental impact assessments, conservation, technologies, regulations
For a complete look at how CKSci relates to the 2010 Sequence, please refer to the full Correlation Charts available for download using the Online Resources Guide for this unit: www.coreknowledge.org/cksci-online-resources	

Problem-Based Learning Project

This unit is a **CKSci Problem-Based Learning Unit** (PBL, also known as Project-Based Learning).

In this pedagogical approach, lessons culminate in a capstone project that occurs at the end of the unit. Each lesson includes guidance for teachers to connect individual objectives to the capstone experience.

One key aspect of the CKSci Problem-Based Learning Units is that students engage with their community—that is, the capstone project is presented to an audience beyond the classroom. The audience is often defined by the students themselves. The audience may include other classes at your school, parents/guardians, school principals, and/or scientists and engineers in your area. The goal is for the community to help determine how well students have applied their knowledge as they communicate possible solutions to real-world problems.

Advance preparation is critical to the success of a CKSci Problem-Based Learning Unit. Please refer to the recommendations found throughout the lessons of this Teacher Guide. The goal of this unit is for students to present solutions based on what they learn across multiple lessons, and to interact with their community during and after their culminating presentations.

What are the relevant NGSS Performance Expectations for this unit?*

This unit, *Protecting Earth's Resources*, builds on topics from Grade 4 Unit 5, *Using Natural Resources for Energy*, to meet the broader NGSS Grade 5 Performance Expectation of 5-ESS3-1. Students who demonstrate understanding can

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Online Resources



For detailed information about the NGSS references, follow the links in the Online Resources Guide for this unit. Use the following link to download any of the CKSci Online Resources Guides:

www.coreknowledge.org/cksci-online-resources

*NEXT GENERATION SCIENCE STANDARDS (NGSS) is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of this product, and their endorsement is not implied.

Sources:

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

National Research Council. 2012. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K–12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

What Students Should Already Know

The concept of progressions, articulated in the National Research Council's *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, is very much aligned to the Core Knowledge principle of building new knowledge on prior knowledge. According to the NRC, students build “progressively more sophisticated explanations of natural phenomena” over the course of many years of schooling. “Because learning progressions extend over multiple years, they can prompt educators to consider how topics are presented at each grade level so that they build on prior understanding and can support increasingly sophisticated learning.” In schools following NGSS recommendations, teachers can build on the “prior understandings” captured in the following summaries of NGSS Disciplinary Core Ideas:

PS1.A: Matter and Its Interactions

- Grades K–2**
- Different kinds of matter exist (e.g., wood, metal, water), and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties (e.g., visual, aural, textural), by its uses, and by whether it occurs naturally or is manufactured. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces (e.g., blocks, construction sets). Objects or samples of a substance can be weighed, and their sizes can be described and measured.

PS1.B: Chemical Reactions

- Grades K–2**
- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible (e.g., melting and freezing), and sometimes they are not (e.g., baking a cake, burning fuel).

PS3.A: Definitions of Energy

- Grade 4**
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer

- Grades K–2** • Sunlight warms Earth’s surface.
- Grade 4** • Light also transfers energy from place to place.

LS1.C: Organization for Matter and Energy Flow in Organisms

- Grades K–2** • All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.

LS2.A: Interdependent Relationships in Ecosystems

- Grades K–2** • Animals depend on their surroundings to get what they need, including food, water, shelter, and a favorable temperature. Animals depend on plants or other animals for food. Plants depend on air, water, minerals (in the soil), and light to grow.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Grades K–2** • Organisms obtain the materials they need to grow and survive from the environment. Many of these materials come from organisms and are used again by other organisms.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Grades K–2** • The places where plants and animals live often change, sometimes slowly and sometimes rapidly. When animals and plants get too hot or too cold, they may die. If they cannot find enough food, water, or air, they may die.
- Grade 3** • When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

LS4.C: Adaptation

- Grades K–2** • Living things can survive only where their needs are met. If some places are too hot or too cold or have too little water or food, plants and animals may not be able to live there.

LS4.D: Biodiversity and Humans

- Grades K–2** • There are many different kinds of living things in any area, and they exist in different places on land and in water.
- Grade 3** • Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Grades K–2** • Rocks, soils, and sand are present in most areas where plants and animals live. There may also be rivers, streams, lakes, and ponds. Maps show where things are located. One can map the shapes and kinds of land and water in any area.

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

- Grades K–2** • Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location.

ESS2.E: Biogeology

- Grades K–2** • Plants and animals (including humans) depend on the land, water, and air to live and grow. They in turn can change their environment (e.g., the shape of land, the flow of water).

ESS3.A: Natural Resources

- Grades K–2** • Living things need water, air, and resources from the land, and they try to live in places that have the things they need. Humans use natural resources for everything they do: for example, they use soil and water to grow food, wood to burn to provide heat or to build shelters, and materials such as iron or copper extracted from Earth to make cooking pans.
- Grade 4** • Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

ESS3.C: Human Impacts on Earth Systems

Grades K–2

- Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things—for example, by reducing trash through reuse and recycling.

What Students Need to Learn

For this unit, the *Core Knowledge Science Sequence* specifies the following content and skills. Specific learning objectives are provided in each lesson throughout the unit. NGSS References, including Performance Expectations, Disciplinary Core Ideas, and Crosscutting Concepts, are included at the start of each lesson as appropriate.

A. Problem-Based Learning Introduction

LESSON 1

- Establish a problem-solving mindset as the unifying theme for the unit.

B. Protecting Earth's Water

LESSONS 2–5

- Describe the importance of water to all living things.
- Obtain information from reliable sources to describe evidence of positive and negative relationships between human activity and Earth's water resources.
- List several sources of water pollution and describe how each harms the environment and human health.
- Describe how people have used scientific ideas and technology to protect water resources.
- Develop a plan of suggested actions, based on scientific ideas, to show how your community can protect water resources in your area.

C. Protecting Earth's Air

LESSONS 6–9

- Describe the importance of Earth's air to a living organism.
- Obtain information from reliable sources to describe evidence of positive and negative relationships between human activity and air quality.
- List several sources of air pollution and describe how each harms the environment and human health.
- Describe how people have used scientific ideas and technology to protect Earth's atmosphere.
- Develop a plan of suggested action, based on scientific ideas, to show how your community can protect air resources in your area.

- Describe at least one way that an organism depends on the land around it.
- Obtain information from reliable sources to describe evidence of positive and negative relationships between human activity and Earth's soil, land, and mineral resources.
- List several sources of land pollution and describe how each harms the environment.
- Describe how people have used scientific ideas and technology to protect Earth's land resources.
- Develop a plan of suggested action, based on evidence, to show how your community can protect land resources in your area.

E. Taking Local Action**LESSONS 14–15 AND UNIT CAPSTONE**

- Describe an example of an ecosystem, including ways in which components of the system interact.
- Obtain information from reliable sources to explain positive and negative relationships between human activity and ecosystems, including living and nonliving resources.
- List several sources of ecosystem threats and describe how each may harm the environment.
- Describe how people have used scientific ideas and technology to protect Earth's ecosystems.
- Develop a plan of suggested action, based on evidence, to show how your community can protect an ecosystem in your area.

What Teachers Need to Know

Supportive information on the content standards and the science they address is provided throughout the lessons at points of relevance:

Know the Standards: These sections, found later in this Teacher Guide, explain what to teach and why, with reference to NGSS and Core Knowledge expectations.

Know the Science: These sections provide supporting, adult-level, background information or explanations related to specific examples or Disciplinary Core Ideas.

USING THE STUDENT READER

Student Reader



The *Protecting Earth's Resources* Student Reader has seven chapters and a student Glossary providing definitions to Core Vocabulary words. Engaging text, photographs, and diagrams encourage students to draw upon their own experiences and the world around them to understand scientific concepts. In addition to Core Vocabulary, the Student Readers include a feature called Word to Know, which provides background information to help students understand key terms, and may sometimes include additional informational boxes, such as Think About.

Explore, then read: In the CKSci program, lessons are sequenced to provide active engagement before reading. First, students explore phenomena through hands-on investigations or teacher demonstrations, accompanied by active questioning and analysis; then, students study the informational text provided in the Student Readers. The icon shown at left will signal Core Lesson segments that focus on Student Reader chapters.

CKSci Student Readers extend, clarify, and confirm what students have learned in their investigations. The text helps students develop a sense of the language of science, while images, diagrams, charts, and graphs deepen conceptual understanding. Use of the CKSci Student Readers supports the Science and Engineering Practice “Obtaining, Evaluating, and Communicating Information” as described in *A Framework for K–12 Science Education*.

Independent reading or group read-aloud: While the text in the Student Readers is written for independent reading, we encourage group read-alouds and engagement with the text. The Teacher Guide provides Guided Reading Supports to prompt discussion, clarify misconceptions, and promote understanding in relation to the Big Questions.

USING THE TEACHER GUIDE

Pacing

The *Protecting Earth's Resources* unit is one of five units in the Grade 5 CKSci series. To meet NGSS Performance Expectations we encourage teachers to complete all units during the school year. To be sure all NGSS Performance Expectations are met, each Core Lesson should be completed, and each requires thirty to forty-five minutes of instruction time. The time it takes to complete a lesson depends on class size and individual circumstances.

Within the Teacher Guide, the Core Lessons are divided into numbered segments, generally five or six, with approximate times listed per segment. The final segment is always a Check for Understanding, providing the teacher with an opportunity for formative assessment.

At the end of this Unit Introduction, you will find a Sample Pacing Guide on page 17 and a blank Pacing Guide on pages 18–19, which you may use to plan how you might pace the lessons, as well as when to use the various other resources in this unit. We strongly recommend that you preview this entire unit and create your pacing guide before teaching the first lesson. As a general rule, we recommend that you spend no more than seventeen days teaching the *Protecting Earth's Resources* unit so that you have time to teach the other units in the Grade 5 CKSci series.

The Core Lessons

- Lesson time: Each Core Lesson constitutes one classroom session of up to forty-five minutes. Teachers may choose to conduct all Core Lesson segments, totaling forty-five minutes; may choose to conduct a subset of the lesson segments; or may choose to spend less time per segment.
- Lesson order: The lessons are coherently sequenced to build from one lesson to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

PART	LESSON	BIG QUESTION
A. Problem-Based Learning Introduction	1. Developing Solutions for Ecosystem Problems	What is an environmental protection action plan?
B. Protecting Earth's Water (5-ESS3-1)	2. Water Resources (two class sessions)	What is water quality?
	3. Water Resources, Problems, and Solutions	How can human activities affect the quality of water?
	4. Researching Water Stewardship	How does water pollution spread?
	5. Water Protection Action Plan	How can we protect our local water resources?
C. Protecting Earth's Air (5-ESS3-1)	6. Air Pollution	What is air pollution?
	7. The Need for Clean Air	How can human activity affect the quality of air?
	8. Researching Air Quality Protection	How can we protect air quality?
	9. Air Quality Action Plan	How can we protect our local air quality?
D. Protecting Earth's Land (5-ESS3-1)	10. Land Contamination	What is land contamination?
	11. Living Off the Land	How can human activity contaminate land?
	12. Researching Use of Land Resources	How can we find information about contamination?
	13. Land Resource Action Plan	How can we protect land from contamination?
E. Taking Local Action (5-ESS3-1)	14. Sharing the Environment	How do human activities that affect water, air, and land impact ecosystems?
	15. Researching Environmental Protection	How can we protect land ecosystems from negative consequences of human activities?
	Ecosystem Protection Action Plan	How can we protect an ecosystem from negative consequences of human activities?

Activity Pages

Activity Pages



AP 1.1

AP 1.2

AP 1.3

AP 2.1

AP 2.2

AP 2.3

AP 3.1

AP 3.2

AP 4.1

AP 4.2

AP 4.3

AP 5.1

AP 5.2

AP 6.1

AP 7.1

AP 8.1

AP 8.2

AP 9.1

AP 9.2

AP 10.1

AP 10.2

AP 11.1

AP 11.2

AP 12.1

AP 13.1

AP 13.2

AP 14.1

AP 14.2

AP 15.1

AP 15.2

AP 15.3

AP UC.1

AP UC.2

AP UC.3

Black line reproducible masters for Activity Pages, as well as an Answer Key, are included in Teacher Resources on pages 126–166. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

Students' achievement of the NGSS Performance Expectations is marked by their completion of tasks throughout the unit. A Unit Capstone project is provided as a summative close to the unit.

Lesson 1—Community Information Board (AP 1.1)

Lesson 1—Name the Resource (AP 1.2)

Lesson 1—Lesson 1 Check (AP 1.3)

Lesson 2—Human Activities and Water (AP 2.1)

Lesson 2—Cleaning Water (AP 2.2)

Lesson 2—Lesson 2 Check (AP 2.3)

Lesson 3—Water Pollution Sources (AP 3.1)

Lesson 3—Lesson 3 Check (AP 3.2)

Lesson 4—Z-Chart (AP 4.1)

Lesson 4—How Pollution Spreads (AP 4.2)

Lesson 4—Lesson 4 Check (AP 4.3)

Lesson 5—Water Resources Action Plan (AP 5.1)

Lesson 5—Lesson 5 Check (AP 5.2)

Lesson 6—Testing Air Quality (AP 6.1)

Lesson 7—Air Quality Index (AP 7.1)

Lesson 8—Indoor and Outdoor Pollution (AP 8.1)

Lesson 8—Researching Air Pollution (AP 8.2)

Lesson 9—How Can a Cyclone Clean Air? (AP 9.1)

Lesson 9—Air Quality Action Plan (AP 9.2)

Lesson 10—Making a Waste-Free Lunch (AP 10.1)

Lesson 10—Examining Contaminated Land (AP 10.2)

Lesson 11—Ways Humans Contaminate Land (AP 11.1)

Lesson 11—Modeling Strip Mining (AP 11.2)

Lesson 12—Researching Community Land Use (AP 12.1)

Lesson 13—Community Planning (AP 13.1)

Lesson 13—Land Use Action Plan (AP 13.2)

Lesson 14—Interacting Spheres (AP 14.1)

Lesson 14—Positive and Negative (AP 14.2)

Lesson 15—Positive and Negative Impacts (AP 15.1)

Lesson 15—Researching Environmental Protection (AP 15.2)

Lesson 15—Lesson 15 Check (AP 15.3)

Unit Capstone—Classifying Ecosystem Protection Topics (AP UC.1)

Unit Capstone—Ecosystem Protection Action Plan (AP UC.2)

Unit Capstone—Lesson Reflection (AP UC.3)

Online Resources for Science

Online Resources



For each CKSci unit, the Teacher Guide includes references to online resources (including external websites and downloadable documents) to enhance classroom instruction. Look for the icon on the left.

Use this link to download the CKSci Online Resources for this unit:

www.coreknowledge.org/cksci-online-resources

Teaching Strategies

Start with the familiar.

Lead with an experience. Begin each lesson with a demonstration, activity, or question about a phenomenon to engage students and focus their attention on the topic. Start with the familiar. Every science topic introduced to students relates in some way to their known world and everyday experiences. The purpose of every lesson is to build a bridge between what is familiar to students and broader knowledge about the way the world works.

Ask the Big Question.

At the beginning of each Teacher Guide lesson, you will find a Big Question and Core Lesson segment devoted to encouraging students to think about this question as they are introduced to new science content. Use this opportunity to engage students in conversation, to think about how their own real-world experiences relate to the topic, or to participate in a demonstration that relates to the Big Question.

Encourage scientific thinking.

Approach the lessons with students not as learning about science but as learning about the world with a scientific mind. Science learning models science practice.

Throughout the lessons, encourage students to ask questions about what they observe, do, and read. Record relevant questions in a prominent place in the classroom. Guide students back to these questions as opportunities to answer them emerge from readings, demonstrations, and activities.

Use continuous Core Vocabulary instruction.

As a continuous vocabulary-building strategy, have students develop a deck of vocabulary cards, adding a card for each Core Vocabulary term as it is introduced. Students can add illustrations and examples to the cards as their comprehension of terms expands. During instruction, emphasize Core Vocabulary terms and their meanings in context rather than relying on isolated drill for memorization of definitions. Students will be given the opportunity to preview Core Vocabulary words early in the lessons and to engage in Word Work activities toward the end of the lessons. Encourage students to come up with definitions in their own words and to use the words in their own sentences.

Core Vocabulary words for each lesson, as well as other key terms teachers are encouraged to use in discussing topics with students, are provided at the start of each lesson. You can find Core Vocabulary definitions in the Word Work lesson segments, as well as in the Glossary on pages 167–168.

Emphasize observation and experience.

Lessons employ various ways for students to learn, including watching, listening, reading, doing, discussing, and writing. To meet the NGSS Performance Expectations, which are multidimensional standards, students must not only gain factual knowledge associated with Disciplinary Core Ideas, but also use the content knowledge they acquire.

Use science practices.

Give students opportunities to discover new content knowledge through investigation and to use their new knowledge both in problem-solving exercises and as evidence to support reasoning. Students learn what science and engineering practices are by engaging in those same practices as they learn.

Core Lesson segments are designed to reinforce the idea of science as an active practice, while helping students meet NGSS Performance Expectations. Each lesson segment is introduced by a sentence emphasizing active engagement with an activity.

Make frequent connections.

Use a combination of demonstrations and reading materials, rich with examples, to help students recognize how the science concepts they are learning apply in their everyday lives. Prompt students to relate lesson content to their own experiences, to relate the new and unfamiliar to the familiar, and to connect ideas and examples across disciplines. Refer to the Crosscutting Concepts cited in the lessons, often included in the NGSS References listed at the start of each lesson.

Monitor student progress.

Use verbal questioning, student work, the Check for Understanding assessments at the end of each lesson, and the Unit Capstone to monitor progress during each lesson and to measure understanding at the conclusion of the unit. Many lessons provide tips to help you support students who need further explanations or clarifications.

Effective and Safe Classroom Activities

Conducting safe classroom demonstrations and activities is essential to successful elementary science education. The following resources provide Core Knowledge's recommendations for developing effective science classroom activities.

These resources, included at the back of the Teacher Guide on pages 169–173, consist of the following:

- Classroom Safety for Activities and Demonstrations
- Strategies for Acquiring Materials
- Advance Preparation for Activities and Demonstrations
- What to Do When Activities Don't Give Expected Results

Online Resources



These resources may also be accessed within the CKSci Online Resources Guide for this unit, available at

www.coreknowledge.org/cksci-online-resources

MATERIALS AND EQUIPMENT

The unit requires a variety of materials to support various ways of learning (including doing, discussing, listening, watching, reading, and writing). Prepare in advance by collecting the materials and equipment needed for all the demonstrations and hands-on investigations.

Part A: Problem-Based Learning Introduction

Lesson 1

- piece of fresh fruit (e.g., apple, orange, etc.)
- can of tuna
- bottle of drinking water
- any paper object (paper lunch bag, sheet of paper, etc.)
- any metal object (coin, paper clip, etc.)
- cup or jar of soil
- colored paper (8 different colors)
- sticky notes
- pin board and pins (or whiteboard and tape)
- maps of the local area to use throughout the unit (from any of a variety of websites or library sources)
- index cards for student vocabulary deck (6 per student)
- internet access and the means to project images/video for whole-class viewing

Part B: Protecting Earth's Water

Lesson 2

- pieces of paper (5 different colors)
- yellow sticky notes
- plastic cups
- sand
- dirt
- water
- kitchen sieve
- coffee filters
- index cards for student vocabulary deck (6 per student)
- internet access and the means to project images/video for whole-class viewing

Lesson 3

- images of human activities related to human impacts on water quality, such as the following:
 - farmer spraying fertilizer or pesticide
 - grading roads or land for construction
 - landfill
 - boating
 - logging or clearing trees for construction
 - puddle of oil under a car or in a parking lot
- index cards for student vocabulary deck (6 per student)

Lesson 4

- shallow clear plastic trays (2 to 3 inches deep, 1 per student pair)
- large smooth rocks or pebbles (4 inches high, 1 per student pair)
- food coloring
- ice cubes
- jug
- water source
- paper towels (for cleanup)
- index cards for student vocabulary deck (1 per student)

Lesson 5

- maps of the local area
- images of water pollution (from previous lesson)

Part C: Protecting Earth's Air

Lesson 6

- petroleum jelly
- large index card (1 per student pair)
- cotton ball (1 per student pair)
- clothespin (1 per student pair)
- index cards for student vocabulary deck (2 per student)
- internet access and the means to project images/video for whole-class viewing

Lesson 7

- several magnifying glasses
- index cards for student vocabulary deck (3 per student)

Lesson 8

- wooden matches

Lesson 9

- photocopied detailed satellite map of the community (1 per student pair)
- paper or foam cups with lids (1 per student pair)
- glitter
- pencils (1 per student pair)
- clear glue sticks (1 per student pair)
- internet access and the means to project images/video for whole-class viewing

Part D: Protecting Earth's Land

Lesson 10

- small paper cups with soil (2 per student pair)
- ripe banana
- piece of plastic, such as a straw or juice container, cut into small pieces
- tweezers (1 per student pair)
- magnifying glasses (1 per student pair)
- gloves, such as garden gloves (1 set per student pair)
- paper towels
- index cards for student vocabulary deck (3 per student)
- internet access and the means to project images/video for whole-class viewing

Lesson 11

- 500 mL glass beaker (1 per student pair)
- damp sand
- river stones (1 per student pair)
- paper towels

Lesson 11, continued

- chopsticks rubber-banded together for ease of use (1 per student pair)
- index cards for student vocabulary deck (4 per student)

Lesson 12

- detailed blackline map of the community that includes parks, landfills, farms, highways
- markers or crayons (5 different colors)
- gloves (1 set per student pair)
- paper towels
- magnifying glasses (1 per student pair)
- tweezers (1 per student pair)
- droppers of water (1 per student pair)
- paintbrushes (1 per student pair)

Lesson 13

- internet access for students to conduct research
- scissors
- glue
- green paper

Part E: Taking Local Action

Lesson 14

- index cards for student vocabulary deck (2 per student)

Lesson 15

- images of unspoiled ecosystems
- images of human activities that negatively affect ecosystems
- images of human activities that positively affect ecosystems
- internet access and the means to project images/video for whole-class viewing

Capstone Lesson

- maps of the local area (from any of a variety of websites or library resources)
- images of local land ecosystems
- internet access and the means to project images/video for whole-class viewing

SAMPLE PACING GUIDE

The sample Pacing Guide suggests use of the unit’s resources across a seventeen-day period. However, there are many ways that you may choose to individualize the unit for your students, based on their interests and needs. You may elect to use the blank Pacing Guide on pages 18–19 to reflect alternate activity choices and alternate pacing for your class. If you plan to create a customized pacing guide for your class, we strongly recommend that you preview this entire unit and create your pacing guide before teaching the first lesson.

Online Resources



For a yearlong pacing guide, please use the link found in the Online Resources Guide for this unit. This yearlong view of pacing also includes information about how this CKSci unit relates to the pacing of other programs, such as CKLA and CKHG in the *Core Knowledge Curriculum Series™*.

www.coreknowledge.org/cksci-online-resources

TG–Teacher Guide; SR–Student Reader; AP–Activity Page

Week 1

Day 1	Day 2	Day 3	Day 4	Day 5
<i>Developing Solutions for Ecosystem Problems</i> TG Lesson 1 AP 1.1, 1.2, 1.3	<i>Water Resources DAY 1</i> TG Lesson 2 SR Chapter 1 AP 2.1	<i>Water Resources DAY 2</i> TG Lesson 2 AP 2.2, 2.3	<i>Water Resources, Problems, and Solutions</i> TG Lesson 3 SR Chapter 2 AP 3.1, 3.2	<i>Researching Water Stewardship</i> TG Lesson 4 AP 4.1, 4.2, 4.3

Week 2

Day 6	Day 7	Day 8	Day 9	Day 10
<i>Water Protection Action Plan</i> TG Lesson 5 AP 1.1, 5.1, 5.2	<i>Air Pollution</i> TG Lesson 6 SR Chapter 3 AP 6.1	<i>The Need for Clean Air</i> TG Lesson 7 SR Chapter 4 AP 6.1, 7.1	<i>Researching Air Quality Protection</i> TG Lesson 8 AP 8.1, 8.2	<i>Air Quality Action Plan</i> TG Lesson 9 AP 1.1, 9.1, 9.2

Week 3

Day 11	Day 12	Day 13	Day 14	Day 15
<i>Land Contamination</i> TG Lesson 10 SR Chapter 5 AP 10.1, 10.2	<i>Living Off the Land</i> TG Lesson 11 SR Chapter 6 AP 11.1, 11.2	<i>Researching Use of Land Resources</i> TG Lesson 12 AP 10.2, 12.1	<i>Land Resource Action Plan</i> TG Lesson 13 AP 1.1, 13.1, 13.2	<i>Sharing the Environment</i> TG Lesson 14 SR Chapter 7 AP 14.1, 14.2

Week 4

Day 16	Day 17
<i>Researching Environmental Protection</i> TG Lesson 15 AP 15.1, 15.2, 15.3	<i>Ecosystem Protection Action Plan</i> TG Unit Capstone AP UC.1, UC.2, UC.3

PACING GUIDE

Seventeen days have been allocated to the *Protecting Earth's Resources* unit to complete all Grade 5 science units in the *Core Knowledge Curriculum Series™*. If you cannot complete the unit in seventeen consecutive days of science instruction, use the space that follows to plan lesson delivery on an alternate schedule.

Week 1

Day 1

Day 2

Day 3

Day 4

Day 5

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Week 2

Day 6

Day 7

Day 8

Day 9

Day 10

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Week 3

Day 11

Day 12

Day 13

Day 14

Day 15

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Week 4

Day 16

Day 17

Day 18

Day 19

Day 20

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Week 5

Day 21

Day 22

Day 23

Day 24

Day 25

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Week 6

Day 26

Day 27

Day 28

Day 29

Day 30

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Week 7

Day 31

Day 32

Day 33

Day 34

Day 35

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Week 8

Day 36

Day 37

Day 38

Day 39

Day 40

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PART A

Problem-Based Learning Introduction

OVERVIEW

Lesson	Big Question	Advance Preparation
1. Developing Solutions for Ecosystem Problems	What is an environmental protection action plan?	Gather materials for hands-on investigation. (See Materials and Equipment, page 15.)

Part A: What's the Story?

Scientists and engineers are people who study challenging questions and problems, and what they learn is used to determine a course of action to solve the problem. Students learn more about this process by participating in a **problem-based learning project**, where they obtain and combine information to better understand the impacts of human activities on the environment. Every lesson is designed to help students complete a unit capstone project in which they publish or present their findings to the community.

In this unit, students learn about water, air, and land resources and threats to those resources. Throughout the unit, students identify potential ecosystem threats to their local community and develop action plans to address those threats. Part A provides an introduction to the unit project.

In Lesson 1, we introduce students to the problem-based learning project, in which they will study water, air, and land natural resources and develop an action plan to protect a community resource.

LESSON 1

Developing Solutions for Ecosystem Problems

Big Question: What is an environmental protection action plan?

Problem-Based Learning Project: Investigate the effects of human activities on natural resources, and determine recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives	Lesson Activities
<ul style="list-style-type: none">✓ Define <i>natural resources</i>.✓ Describe a source people can use to find information about water, air, and land.✓ Establish problem-solving mindset as the unifying theme for the unit.	<ul style="list-style-type: none">• student observation• teacher demonstration• discussion and writing• vocabulary instruction

NGSS References

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to the Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning. Students obtain information from authoritative sources. They evaluate this information to determine its credibility and relevance to human impacts on Earth systems. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility. In this lesson, students obtain, evaluate, and communicate information from a reliable source. Students apply this information in the context of local ecosystem problems. Students use the information to explain the causes of the identified problem. They evaluate the merit and accuracy of ideas and methods to explain solutions to the identified problem.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

- action plan
ecosystem
- environmental protection
natural resource
- problem
reliable source information

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above. (**Note:** Lesson 1 is introductory in nature. These terms and others will be taught with additional context in subsequent lessons.)

Instructional Resources

Activity Pages



- AP 1.1
- AP 1.2
- AP 1.3

Activity Pages
Community Information Board (AP 1.1)
Name the Resource (AP 1.2)
Lesson 1 Check (AP 1.3)
Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

- Collect the following items:**
- piece of fresh fruit (e.g., apple, orange, etc.)
 - can of tuna
 - bottle of drinking water
 - any paper object (paper lunch bag, sheet of paper, etc.)
 - any metal object (coin, paper clip, etc.)
 - cup or jar of soil
 - colored paper (8 different colors)
 - sticky notes
 - pin board and pins (or whiteboard and tape)
 - maps of the local area to use throughout the unit (from any of a variety of websites or library sources)
 - index cards for student vocabulary deck (6 per student)
 - internet access and the means to project images/video for whole-class viewing

Advance Preparation

In preparation for the activity, on each of the eight pieces of colored paper, write a type of natural resource. Match the words to the colored paper as follows:

- sunlight: yellow
- water: dark blue
- soil: brown
- air: light blue
- plants: green
- animals: red
- minerals: gray
- fossil fuels: black

(The colors may help students conceptualize each resource.)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

Online Resources



What is an environmental protection action plan? Begin this unit by reviewing the key concepts students explored in Unit 3, *Modeling Earth's Systems*. Ask the following:

- » What are Earth's interacting systems? (*hydrosphere, geosphere, atmosphere, biosphere*)
- » How do Earth's systems interact? (*For example, living things in the biosphere depend on the hydrosphere, atmosphere, and geosphere to survive.*)
- » Give local examples of each of Earth's spheres. (*for example, a local creek [hydrosphere]; local landforms—mountains, rocks [geosphere]; local plants and animals [biosphere]; air [atmosphere]*)

Problem-Based Learning Project: Explain that this lesson is the introduction to the unit's problem-based learning project. In this lesson, students will obtain, evaluate, and communicate information from reliable sources. In the unit, students will apply this information in the context of local ecosystem problems and use the information to explain the causes of the identified problem. Students will evaluate the merit and accuracy of ideas and methods to explain solutions to the identified problem and then present their ideas in a community information board to local community representatives.

Begin by showing the lesson materials to the class. Engage students by asking them what all these items have in common. Explain that all these items come from

natural resources. Use the following questions to discuss how humans use natural resources. (See **Know the Science** for support.) Ask the following:

- » What is a natural resource? (*a stock or supply found in nature*)
- » What are examples of natural resources? (*air, water, soil, oil, minerals, plants, animals*)
- » Why do people use natural resources? (*to get food, water, shelter, transport*)
- » How might human use of natural resources affect local ecosystems? (*For example, cutting trees and tilling soil can cause animals to relocate.*)

SUPPORT—Help students brainstorm answers to the last question. To help students brainstorm, ask them to recall a daily routine. Students may come up with ideas such as eating or drinking. Then ask students to consider other activities. Use prior knowledge to encourage questions about the things that people use and where those things come from. The key here is to connect student thinking about their activities and things around them to how local ecosystems are affected by human use of natural resources.

2. Preview the investigation.

10 MIN

Activity Page



AP 1.1

With students, briefly discuss and visit websites that explore natural resources.

Explain to students that the Environmental Protection Agency (EPA) is responsible for making sure that Americans have clean air, land, and water. It makes recommendations to Congress for laws to protect, preserve, and clean up natural resources. It conducts research and publishes the information on its website to educate people.

Know the Science

How does human use of natural resources affect ecosystems? Since ecosystems provide natural resources, human use of natural resources may reduce available resources for organisms, and removal of natural resources can damage parts of ecosystems. Scientists have found that the human population is growing rapidly. More and more people seek an improved quality of life. The demand on natural resources has an ever-increasing impact on ecosystems. For example, emissions from motor vehicles pollute the air. Discharge from factories pollutes sources of water. Excessive use of pesticides kills beneficial insects. Poor farming practices cause erosion of soil. Mining for minerals causes pollution and destroys habitats. Use of fossil fuels damages habitats as a result of oil spills. Scientists and engineers seek solutions to reduce this impact. By classifying how using natural resources affects ecosystems, scientists can better understand which uses cause the biggest problems and therefore prioritize research for solutions.

You don't need to go into this level of detail with students. However, it may help to engage students if they understand the main ways in which the use of natural resources affects ecosystems.



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Distribute Community Information Board (AP 1.1). Provide an overview of the work in this unit by making the following points:

- Like the EPA, students will be presenting information about resource use.
- Unlike the EPA, students will be presenting their information to their community instead of the entire country.
- Students will present their information via a community information board.
- The board will be a way to communicate ideas that can help the students' community be a better steward of its resources and protect local ecosystems.
- Have students record their ideas for ways to present their information. Be sure students only complete the first question.

Explain that students will be returning to this Activity Page to brainstorm their ideas throughout this unit. Collect and store the Activity Page until needed in Lesson 5.

3. Teach Core Vocabulary.

5 MIN

Prepare Core Vocabulary Cards

Display the following Core Vocabulary terms on the board or chart paper. Have students write each term in the upper left corner of an index card and underline it (one term per card). Explain that these words will be used and Core Vocabulary cards will be developed throughout the unit.

action plan

environmental protection

problem

ecosystem

natural resource

reliable source information

Word Work

Present unit concepts by discussing Core Vocabulary terms, and instruct students to make notes on their cards in their own words.

- **action plan:** (n. a set of steps needed to complete a successful project)
 - » What could the difference between a plan and an action plan be? (*An action plan includes the steps you will act on to achieve the goal.*)
- **ecosystem:** (n. all the living and nonliving things that interact in a given area)
 - » What is the difference between an ecosystem and a community? (*An ecosystem is all the living and nonliving things in a location that interact with each other. A community is just one species.*) Reinforce that an ecosystem includes a group of diverse interacting species as well as their nonliving environment, including water, soil, and air.

- **environmental protection:** (n. the practice of taking care of land, water, air, and living things)
 - » What can people do to protect our environment? (*for example, recycle and reuse materials; conserve energy*)
- **natural resource:** (n. materials that occur in nature that can be used by people)
 - » Name three natural resources. (*for example, water, air, trees*)
- **problem:** (n. a want or a need)
 - » Does every problem have a solution? (*Maybe. Problems must be identified and appropriate solutions explored. Some problems may not have solutions at a given time, or solutions may be too expensive or difficult.*)
- **reliable source information:** (n. authoritative information from competent, knowledgeable people without any conflicts of interest)
 - » Why is it important to use reliable source information when solving problems? (*to make sure your solution is fair, accurate, and well-reasoned*)

Have students safely store their deck of Core Vocabulary cards in alphabetical order. Students will add to the deck in later lessons.

4. Introduce key concepts.

5 MIN

Ask students to work in small groups. Assign each group one of the items you showed earlier. Each group will write the name of their item on a sticky note.

Show the colored pieces of paper you prepared beforehand to students, briefly explaining each natural resource. Pin (or tape) your colored pieces of paper to the board.

Ask students to place their sticky note on the piece of colored paper that represents a natural resource needed to make their item. For example, the group assigned the fresh fruit would write “apple” on their sticky note and might place their note on your brown piece of paper (soil). Continue this activity until all students have placed all their sticky notes on the pin board. Ask the class if they think that the activity is complete. If needed, guide students to conclude that their items might use more than one natural resource. Repeat the activity. For example, the group assigned the fresh fruit would write “apple” on another sticky note and this time would place their note on your dark blue piece of paper (water). Repeat the activity until each group has categorized its item.

5. Support the investigation.

15 MIN

Activity Pages



AP 1.2
AP 1.3

Introduce Name the Resource (AP 1.2). Explain that students will complete the Activity Page based on library research and on what they have learned so far in this lesson. Go over the directions with students, but do not complete the activity for them. Explain that the activity will help students think about how use of natural resources affects local ecosystems, which is covered in more detail throughout the unit.



Have students select one of the resources from the introductory activity. Instruct students to research the impact that using that particular resource has on a local ecosystem. Students should use the EPA website to help with research. Students will write a short passage to summarize their findings.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

SUPPORT—Lead a discussion about the procedure for the Activity Page. Be sure that students are clear on the procedure. If needed, prompt students with questions:

- How will you figure out which natural resources are needed to make your item?
- What do you already know about natural resources needed to make your item?
- How does using those natural resources affect a local ecosystem?

Instruct students to consider multiple effects on local ecosystems. Ensure that students conduct library research on how use of a natural resource affects a local ecosystem.

6. Check for understanding.

5 MIN

Activity Page



AP 1.3 and
Answer Key

Formative Assessment Opportunity

- Distribute Lesson 1 Check (AP 1.3), and ask students to complete it independently. Once they are finished, collect the assessment, and before the start of Lesson 2, check students' answers to identify concepts that need further clarification and to provide the support needed.
- See the Activity Page Answer Key for correct answers and sample student responses.
- Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- developed a basic understanding of the unit project
- explored the EPA website
- identified a natural resource issue in the local community to research
- considered how information they gather might be presented

PART B

Protecting Earth's Water

OVERVIEW

Lesson	Big Question	Advance Preparation
2. Water Resources (2 days)	What is water quality?	Read Chapter 1 in the Student Reader. Gather materials for hands-on investigation. (See Materials and Equipment, page 15.)
3. Water Resources, Problems, and Solutions	How can human activity affect the quality of water?	Read Chapter 2 in the Student Reader.
4. Researching Water Stewardship	How does water pollution spread?	Gather materials for hands-on investigation. (See Materials and Equipment, page 15.)
5. Water Protection Action Plan	How can we protect our local water resources?	Provide research opportunities.

Part B: What's the Story?

In this Problem-Based Learning Project unit, students learn about water, air, and land resources and threats to those resources. Throughout the unit, students identify potential ecosystem threats to their local community and develop action plans to address those threats. Part B focuses on water resources, positive and negative human impacts on water resources, and how to improve water quality.

In Lesson 2, students learn about water resources and the importance of water to life. Students recognize the human impact on water resources and how these resources are protected with water quality testing and water treatment.

In Lesson 3, students explore sources of fresh water and negative impacts of human activity that threatens water resources.

In Lesson 4, students learn how water pollution spreads from point and nonpoint sources.

Lesson 5 focuses on the development of an action plan to address threats to water resources in the local ecosystem.

So, to repeat, students learn about **the importance of freshwater resources, threats to water resources, and ways that water resources can be protected, tested, and treated.**

This set of lessons comprehensively meets the NGSS Performance Expectation 5-ESS3-1.

LESSON 2

Water Resources

Big Question: What is water quality?

Problem-Based Learning Project: Investigate the effects of human activities on water resources to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Identify why water is important for all living things.
- ✓ Explain how humans can affect water in positive and negative ways.
- ✓ Describe the process that people can use to clean wastewater.

Lesson Activities (2 days)

- student observation
- reading, discussion, writing
- hands-on activity
- vocabulary instruction

NGSS References

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning. Students engage in hands-on activities to obtain information about the impacts of human activities on water quality. Students evaluate this information in the context of human impacts on natural systems. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from the Environmental Protection Agency (EPA). Students apply this information in the context of local ecosystem problems. Students use the information to explain the causes of the identified problem. Students evaluate the merit and accuracy of ideas and methods to explain solutions to the identified problem.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

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- algal bloom
bacteria
- disinfection
wastewater
- water quality testing
water treatment plant

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 1

Activity Pages



AP 2.1
AP 2.2
AP 2.3

Student Reader, Chapter 1 “Water Resources”

- Activity Pages**
- Human Activities and Water (AP 2.1) (Day 1)
- Cleaning Water (AP 2.2) (Day 2)
- Lesson 2 Check (AP 2.3) (Day 2)
- Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect the following items:

- pieces of paper (5 different colors)
- yellow sticky notes
- plastic cups
- sand
- dirt
- water
- kitchen sieve
- coffee filters
- index cards for student vocabulary deck (6 per student)
- internet access and the means to project images/video for whole-class viewing

Advance Preparation

In preparation for the activity on Day 1, on the five pieces of colored paper, write the five things that affect water quality. Match the words to the colored paper as follows. (The exact colors do not matter, so long as you use a different color to represent each concept.)

- germs: red
 - other chemicals: gray
 - farm chemicals: green
- dirt and other waste: brown
 - clean water: blue

1. Day 1: Focus student attention on the Big Question.

10 MIN

What is water quality? Remind students that the hydrosphere includes all water on Earth, including the ocean, rivers, glaciers, and sky. Engage students by asking them when they last had a drink of water. Ask students why they need to drink water. If needed, prompt students to explain that they need to drink water to live. Ask students if they can drink water from any source. Use the following questions to brainstorm what kinds of human activities could affect the quality of water:

- » Where does clean water come from? (*faucet, bottled water, filtered water*)
- » What could happen if you drank water from a river? (*You could get sick.*)
- » What happens to water when it is used to clean things such as clothes and dishes? (*It gets dirty.*)
- » What happens to rainwater when it washes across a parking lot? (*It collects oil and grime and goes down drains.*)
- » What happens to water that goes down drains in a street? (*It ends up in streams, lakes, rivers, or the ocean.*)

Problem-Based Learning Project: In the last lesson, students researched a natural resource and began to think about how they might identify a local environmental problem. In this lesson, students go a step further by evaluating and communicating information from the EPA. Students then apply this information in the context of local ecosystem problems. Students use the information to explain the causes of an identified problem.

SUPPORT—To help students brainstorm, ask them to recall how often they drink water. Then ask students to consider the pathway of water after it is used or after rainfall. Use prior knowledge to encourage questions about what human activities could affect the quality of water.

Online Resources



Ask students to write a summary of the discussion. Guide students to use their brainstorming to list various human activities that could affect the quality of water. The USGS website has good information that may help direct student brainstorming.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

2. Encourage discussion.

10 MIN

Online Resources



Have students work with a partner to think about why scientists are concerned about human activities that affect the quality of water. (See **Know the Science 1.**) To focus students' thinking, ask the following questions:

- » What kinds of human activities could affect the quality of water? (*for example, putting garbage into waterways, boating*)
- » In what ways could water be affected by human activities? (*for example, tainting water with fuel, disturbing organisms with boat propeller and noise*)

SUPPORT—Use the online resources as support to help students brainstorm what kinds of human activities could affect the quality of water. Guide students in using a T-chart to compare what they know about clean water and dirty water.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

3. Read and discuss: “Water Resources.”

15 MIN

Student Reader



Ch. 1

Read together, or have students read independently, “Water Resources,” Chapter 1 in the Student Reader. The selection introduces the idea that water is an important resource that can be affected positively or negatively by humans.

Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read:

algal bloom
bacteria

disinfection
wastewater

water quality testing
water treatment plant

Know the Science

1. Why are scientists concerned about human activities that affect the quality of water? All living things need water, and water that contains chemicals or germs can harm humans and other living things. Water is essential for life. Many human activities use water and cause it to become polluted. Changes in water chemistry due to acid rain can kill vegetation. Chemicals used by farmers can pollute waterways, killing fish and other aquatic organisms. Chemicals used by industry may be toxic and interfere with organisms' reproduction or ability to grow.

You don't need to go into this level of detail with students. However, it may help to engage students if they understand that the reason for studying water quality is that polluted water can adversely affect all forms of life.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 1

After students have read the page, ask them if they have ever looked under a sink. Ask the following:

- » How does water get to the faucet? (*pipes under the sink*)
- » How does water leave the sink? (*down the drain*)
- » Where does water go after it goes down the sink? (*through other pipes under the sink*)
- » What do you notice about the structure of the drain pipes compared to the pipes that lead to the faucet? (*Drain pipes are wider and have a U-bend.*)
- » What is the function of the U-bend in the drain pipe? (*to stop drain water from flowing back up, to prevent bad smells from rising through the drain hole*)

SUPPORT—If you have a sink in your class, show the pipes under it to students. Run hot water, and have students feel the faucet pipe so that they understand that clean water flows through those pipes. As the water drains, ask students to listen to or feel the drain pipe so they understand that dirty water flows through that pipe. If you don't have access to a sink in class, use the image in the chapter to explain the functions of the different pipes.

Page 2

After students have read the page, discuss the vocabulary words to ensure understanding. Then discuss various stages of water treatment. Probe for understanding of the key idea that wastewater may contain dirt, germs, or chemicals and that wastewater must be cleaned before it is safe. Ask the following:

- » What are common sources of wastewater from your daily activities? (*kitchen, toilet, shower, bath*)
- » Why must dirt, germs, and chemicals be removed from wastewater? (*These things can harm people, wildlife, and plants.*)

SUPPORT—Ensure that students understand that dirt, germs, and chemicals can come from different sources. Guide students to recognize that wastewater is also produced by human activities other than those in the home.

Page 3

After students have read the page, discuss the vocabulary words to ensure understanding. Then discuss with students the process of water treatment. The key idea is that wastewater is treated in a series of steps. The basic concept is that dirt, germs, and chemicals are removed from wastewater before it is released into water bodies (rivers, lakes, etc.). Ask the following:

- » What is the order of steps in wastewater treatment? (*filtering, spinning to remove grit, bubbling air and bacteria, disinfection and possible further filtration, release back into the environment*)
- » Why is disinfection used as the last step before release? (*It kills all the bacteria.*)

SUPPORT—Ensure students understand that there are “good” and “bad” bacteria. Even the good bacteria used to treat wastewater must be removed before it is safe to release. Probe student understanding of the vocabulary word *disinfection*. If needed, guide students to understand that disinfection is used in many applications (e.g., hand sanitizer, bleaching dirty surfaces, etc.).

Page 4

Explain to students that water treatment plants cannot remove all substances. Focus on the key idea, that surfactants can harm wildlife, by asking students if they have ever cleaned dishes. Then ask the following:

- » What chemicals did you use to clean the dishes? (*soap, detergent*)
- » How can you ensure that soap used for cleaning is safe? (*Check the label to ensure that the ingredients are safe for the environment.*)

Page 5

After students have read the page, review the term *water quality testing* to ensure understanding. Then discuss the necessity of water quality testing. Emphasize that water quality testing is carried out on water in lakes and rivers as well as before treated water is released back into the environment. Show students the image, and explain that water is tested for many other chemicals besides phosphate. Ask the following:

- » How does phosphate enter water? (*soaps and fertilizers*)
- » Why is phosphate bad for the environment? (*It causes algae to grow out of control.*)
- » Why is water quality testing necessary? (*to know whether water is safe to drink, swim in, or discharge from a water treatment plant*)

Page 6

After students have read the page, discuss how an algal bloom arises. Explain to students that chemicals other than phosphate can contribute to algal blooms. (See **Know the Science 2** for additional support.)

SUPPORT—Probe for understanding of the steps by which an algal bloom arises. If needed, address any misconceptions, such as algae “removing” oxygen from water. Like plants, algae produce oxygen—it is the bacteria arising from decomposition of algae and other organisms that reduce oxygen levels.

Know the Science

2. What are algae? Photosynthetic organisms found all over the world that don’t have roots, stems, or leaves as plants do. Through photosynthesis, algae release much of Earth’s oxygen, which organisms in the biosphere need to survive. Some algae are microscopic, such as phytoplankton that photosynthesize at the ocean surface and provide food for ocean organisms. Other algae, such as seaweed, look like plants. Lakes can be smothered by algal growth when there are too many nutrients in the water. These algae layers absorb oxygen and cut off sunlight, which organisms under the water surface need to survive.

4. Check for understanding.

10 MIN

Online Resources



Activity Page



AP 2.1

Formative Assessment Opportunity

Ask students independently to write one human activity on a yellow sticky note. Encourage students to consider human activities other than those mentioned in the lesson. Then follow these steps:

1. Show to students the colored pieces of paper you prepared, briefly reviewing each concept.
2. Tape each paper in a location in the classroom that students can easily access.
3. Ask students to consider the human activity that they wrote and how it would impact water. Ask: Will it add germs (red), farm chemicals (green), dirt and waste (brown), or other chemicals (gray), or will it not affect water (blue)?
4. Tell students to place their yellow sticky notes on the piece of colored paper that most closely describes how their activity would impact the water. For example, if they wrote “washing” on their yellow sticky note, they would place their note on the gray (other chemicals) piece of paper.
5. If the activity does not have a direct impact on water quality (e.g., driving a car), have students put their notes on the blue (clean water) paper and choose another human activity.
6. Ask students to research online to relate their human activity to specific impacts.

After students have placed their sticky notes, distribute Human Activities and Water (AP 2.1) to each student. Read over the questions with the class. Give students time to complete the Activity Page. Circulate throughout the room, answering questions and providing support as needed.

SUPPORT—If needed, direct students back to pages 2–3 in the Student Reader, and review the steps in water treatment to help students identify the step needed to clean water as a result of the human activity they chose. To simplify the activity or save time, you may wish to have human activities already written on the sticky notes and have students work with a partner to place their sticky note on the correct piece of colored paper. Some ideas are washing clothes, brushing teeth, taking a shower, planting a garden, a car with an oil leak, using a rain barrel, and swimming in a lake.

See the Activity Page Answer Key for correct answers and sample student responses.

- Collect the completed Human Activities and Water (AP 2.1).
- Review student questions, and identify any that remain unanswered.

1. Day 2: Refocus student attention on the Big Question.

5 MIN

What is water quality? Refer back to the activity from the previous day's lesson. Ask students to work with a neighbor to create a T-chart with one column labeled "Human Activity" and the other column labeled "Impact." Encourage students to brainstorm human activities and their impacts on ecosystems.

Activity Page



AP 2.1

SUPPORT—Research online to find images related to potential impact of human activities. Present the images to students, and ask them to write one-sentence descriptions to complete the "Impact" column. Discuss any questions that students may have. You can also use this engagement activity to determine gaps in prior knowledge and to address misconceptions that may have arisen.

2. Facilitate the activity.

20 MIN

Activity Page



AP 2.2

Distribute Cleaning Water (AP 2.2). Explain to students that they will complete the Activity Page based on what they have learned so far in this lesson. Go over the directions with students, but do not complete the activity for them. Explain that the activity will help them think about the water resources topic, which is covered in more detail in the next two lessons. Lead a discussion about the procedure for the Activity Page. Be sure that students understand the procedure.

SUPPORT—If needed, encourage students to apply a scientific approach. For example, students could use a timer to record and compare the lengths of time to filter water using the coffee filter versus the kitchen sieve.

3. Teach Core Vocabulary.

10 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words. Have students write each term in the upper left corner of an index card and underline it (one term per card). Explain that these words will be used and Vocabulary Cards will be developed throughout the unit.

algal bloom

disinfection

water quality testing

bacteria

wastewater

water treatment plant

Word Work

Review lesson concepts by engaging students with Core Vocabulary terms.

- **algal bloom:** (n. rapid growth of microscopic algae in a body of water)
 - » What are the consequences of algal blooms? (*Organisms living in water can die from lack of oxygen and sunlight.*)

- **bacteria:** (n. tiny organisms that break down matter)
 - » What are some positive things that bacteria do? (*They decompose dead organisms.*)
 - » What are some negative things that bacteria do? (*They can cause disease, such as strep throat, or decay things we want to preserve.*)
- **disinfection:** (n. the process of cleaning infection from a material)
 - » List words related to disinfection. (*infect, disinfect, infection, disinfectant*)
 - » What is an infection? (*an invasion of bacteria or virus that causes disease*)
 - » What is a disinfectant? (*something that kills disease-causing bacteria or viruses*)
- **wastewater:** (n. water that has been used by people)
 - » How is wastewater different from wasting water? (*If you waste water, you are not conserving it. Wastewater is the water that has been used for washing or sewage.*)
- **water quality testing:** (n. methods to measure the types and amounts of chemicals in water)
 - » Why is water quality testing important? (*People get sick and the environment can be damaged if water is not clean or has bacteria in it.*)
- **water treatment plant:** (n. a facility that cleans wastewater before it is discharged into the environment)
 - » What would happen if water were not treated? (*Bacteria and other organisms could grow in water and spread diseases.*)

4. Check for understanding.

10 MIN

Activity Pages



AP 2.2

AP 2.3

Answer Key

Formative Assessment Opportunity

Collect the completed Cleaning Water (AP 2.2). Review student questions, and identify any that remain unanswered.

Have students summarize what they have learned about how water can be cleaned and used again, asking them to consider the Big Question: **What is water quality?** Ask students to cite information from Cleaning Water (AP 2.2) as evidence.

- Distribute Lesson 2 Check (AP 2.3), and ask students to complete it independently. Once they are finished, collect the assessment, and before the start of Lesson 3, check students' answers to identify concepts that need further clarification and to provide support as needed.
- See the Activity Page Answer Key for correct answers and sample student responses.
- Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- explored potential problems with local water sources
- considered how water can be treated to ensure its cleanliness

LESSON 3

Water Resources, Problems, and Solutions

Big Question: How can human activities affect the quality of water?

Problem-Based Learning Project: Investigate the effects of human activities on water resources to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe the importance of water to all living things.
- ✓ Obtain information from reliable sources to describe evidence of positive and negative relationships between human activity and Earth's water resources.
- ✓ List several sources of water pollution and describe how each harms the environment and human health.
- ✓ Describe how people have used scientific ideas and technology to protect water resources.

Lesson Activities

- student observation
- reading and discussion
- vocabulary instruction
- research and writing

NGSS References

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information
By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning. Students engage in hands-on activities to obtain information about the importance of water to all living things, positive and negative relationships between human activity and Earth's water resources, sources of water pollution, and how people have used scientific ideas and technology to protect water resources.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

conserve
fresh water

groundwater
pathogen

pollutant
surface water

water pollution

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 2

Activity Pages



AP 3.1

AP 3.2

Student Reader, Chapter 2
“Water Resources, Problems,
and Solutions”

Activity Pages
Water Pollution Sources
(AP 3.1)

Lesson 3 Check (AP 3.2)

Make sufficient copies for your
students prior to conducting
the lesson.

Materials and Equipment

Collect the following items:

- images of human activities related to human impacts on water quality, such as the following:
 - farmer spraying fertilizer or pesticide
 - grading roads or land for construction
 - landfill
 - boating
 - logging or clearing trees for construction
 - puddle of oil under a car or in a parking lot
- index cards for student vocabulary deck (6 per student)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can human activities affect the quality of water? Engage students by asking them when they last washed their hands. Ask students why they should wash their hands. If needed, prompt students to explain that they need to wash their hands to clean off dirt and to reduce germs. Use this hook to lead students to consider the possible human activities that could affect the quality of water. Use

the following questions to brainstorm about how human activities could affect the quality of water:

- » What do you use to wash your hands? (*soap and water*)
- » What happens when you wash your hands? (*soap, dirt, and water go down the drain*)
- » What other human activities could affect the quality of water? (*farming, gardening, etc.*)

Challenge students to think about why we need access to safe water and how human activities can affect the quality of water. (See **Know the Science.**) To focus their thinking, ask the following questions:

- » Why is water important? (*Water is essential for life; people use water in many ways; the human body requires water for survival.*)
- » How do humans affect Earth's water resources in positive and negative ways? (*by cleaning it and using it wisely; by polluting it*)
- » What evidence would show that people affect water in a positive way? In a negative way? (*Water would be clean; water would be polluted, and people or animals may get sick.*)
- » How can ecosystems be harmed if people use too much water? (*Water levels in rivers and ponds may drop, and aquatic animals may not have enough water to live in.*)
- » How have people used science and technology to help keep water safe? (*use of water testing, water treatment plants for filtering and disinfection*)

SUPPORT—Indicate to students that they don't need to have the answers to these questions—they will be learning about these topics in the rest of the lesson.

Know the Science

How can human activities affect the quality of water? Human activities may cause pollution, which can include chemicals, germs, and dirt, while some human activities aim to ensure water is clean and safe. Scientists know that three-quarters of Earth's surface is covered in water (hence the "water planet"). However, most of that is in the oceans. Only 1.5 percent of Earth's water is fresh water usable by people. Because of rapid population growth, particularly in developing countries, the available water is increasingly polluted. Water in aquifers is being used faster than it is being replaced. An aquifer is an underground source of water in layers of rock such as gravel, sand, and silt from which water can be extracted using a water well. Therefore, the amount of available water is decreasing. In addition, climate change is causing shifts in weather patterns. Some areas are getting less water (hence fires in California). Other areas are getting too much water (hence flooding due to hurricanes). These factors are the reasons that scientists monitor water flow and pollution. Scientists work with engineers to ensure a steady supply of safe water.

You don't need to go into this level of detail with students. However, students should understand that some human activities have negative effects on water quality while other activities have positive effects.

Problem-Based Learning Project: To build a knowledge base for the capstone lesson, students engage in hands-on activities to recognize the importance of water to all living things and explore positive and negative relationships between human activity and Earth's water resources.

SUPPORT—Ensure that students understand that dirt, germs, and chemicals can come from different sources. Guide students to recognize that wastewater is also produced by human activities other than those in the home. If needed, review sources of pollution introduced in Lesson 2. Emphasize that in this lesson, students will be learning about other kinds of activities that affect water quality.

Ask students to write a summary of the discussion. Guide students to use their brainstorming to list human activities that can affect the quality of water.

2. Read and discuss: “Water Resources, Problems, and Solutions.” 15 MIN

Student Reader



Ch. 2

Read together, or have students read independently, “Water Resources, Problems, and Solutions,” Chapter 2 in the Student Reader. The selection introduces the idea that fresh water is limited and found in certain locations, and the selection reviews types of water pollution.

Preview Core Vocabulary Terms

Before students read the chapter, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read:

**conserve
fresh water**

**groundwater
pollutant**

**surface water
water pollution**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 7

After students have read the page, ask them to compare the images of Earth and Mars. Ask the following:

- » Why are Earth and Mars different colors? (*Earth is covered in mostly water, which we often see as blue. Mars has very little water, and the surface is covered with dust and rocks containing iron, which has a red hue.*)
- » What is the result of there being no water on Mars? (*Mars has no life.*)
- » Why must we protect water resources? (*No living thing can survive without water.*)

Page 8

After students have read the page, discuss the vocabulary words *groundwater* and *surface water* to ensure understanding. Then discuss the fact that we rely on fresh water for drinking, agriculture, and many other uses. Probe for understanding of the key idea that fresh water is found only in certain places. Ask the following:

- » What is a place called that has little water? (*desert*)
- » How is groundwater different from surface water? (*Groundwater is found underground in layers of rock called aquifers. Surface water is found in streams, rivers, and lakes.*)

SUPPORT—Check for possible misconceptions about aquifers. Specifically, most aquifers are underground water in which water is trapped in a permeable rock layer. This permeable layer has impermeable rock layers above and below it. Most aquifers are not underground rivers.

Page 9

After students have read the page, discuss the vocabulary word *conserve* to ensure understanding. Then discuss with students the economics of water use. The key idea is that if water is used faster than it is replenished, it will run out. Ask the following:

- » What are some things that people can do to use less water? (*turn off the water when brushing your teeth, take quicker showers, put water in the sink when washing dishes instead of letting the water run*)
- » How can using less water help local ecosystems? (*Animals and plants that live in water would have more water to live in.*)

SUPPORT—Probe student understanding of the graph. Ensure that students understand that the graph shows use over time and that sometimes people use more water than is replaced by rain. Check for understanding of the vocabulary word *conserve*. If needed, guide students to understand that when a resource is conserved, it is not used too quickly and can be saved for future use.

Page 10

Explain to students that a water pollutant is any substance that makes water unsafe for living things. Review various examples to expand on those mentioned. Emphasize that chemicals may be used for a benefit (e.g., grow crops) but may have undesired effects. Ensure that students understand that there are negative outcomes due to pollution. Then ask the following:

- » Why do farmers apply certain chemicals to their crops? (*to give crops nutrients to grow faster, to stop weeds and insects*)
- » What happens to chemicals used by farmers? (*They can enter surface water and groundwater.*)

Page 11

Discuss with students the trade-off with using oil. Emphasize that using oil has benefits (such as being used for gasoline or to make plastics) but also has negative impacts. Ensure that students understand that oil spills can affect water in many ways. Show students the image, and explain that scientists are working on ways to minimize the effects of oil spills. Ask the following:

- » What happens when oil spills into water? (*It kills wildlife, including algae, fish, and birds.*)
- » How can oil be removed from water? (*It can be soaked up, removed with chemicals or bacteria, skimmed off the surface, or burned off.*)

Page 12

After students have read the page, discuss how garbage patches are caused. Explain to students that most plastic in the ocean comes from people using plastic objects on land.

Also emphasize that plastic has different effects on wildlife. For example, turtles eat plastic bags, thinking they are jellyfish. Tiny plastic particles release chemicals that poison animals. Ask the following:

- » Why is it important not to remove the tiny plants and animals when removing plastic from the water? (*They are an important part of the food chain.*)

Online Resources



SUPPORT—Be sure to check for misconceptions. Garbage patches are not floating mountains of trash. They are areas in the ocean where concentrated amounts of plastic particles have been corralled. If you show students an ocean currents map, you can show them the places where garbage patches occur. Garbage patches cannot be seen from space or even from aircraft. However, the density of plastic is high enough to adversely affect wildlife. Show Boyan Slat's video presentation, but explain that his invention has not yet been proven to be an effective solution.

Page 13

After students have read the page, discuss the purpose of clean-up days. Explain to students that if plastic is not cleaned up, it can end up in waterways and will enter the ocean. Ask the following:

- » Why should cities have clean-up days? (*to periodically remove plastic and other trash*)
- » What can people do locally during clean-up days? (*participate, encourage others to participate*)

Page 14

After students have read the page, review the basic idea of germs, ensuring that students understand the word *pathogen*. Explain that germs in water can cause serious sickness. Ensure that students understand that germs include bacteria, viruses, and microbes. If needed, give examples to distinguish between these (e.g., giardia is a single-celled animal, not a bacteria or virus). Emphasize that water that has not been treated to remove germs is not safe to drink. If needed, ask students to recall water treatment from Chapter 1 in the Student Reader. Ask the following:

- » How can water be treated to remove germs? (*disinfection*)
- » How could hikers make water from streams safe to drink? (*boil water, use a filter, use iodine*)

3. Facilitate the activity.

10 MIN

Activity Page



AP 3.1

Distribute Water Pollution Sources (AP 3.1). Explain to students that they will complete the Activity Page based on library research and on what they have learned so far in this lesson. Go over the directions with students, but do not complete the activity for them. Explain that the activity will help students find out more about the types of pollution and where they come from.

SUPPORT—Have specific websites or books for students to use for their research. Provide links to some suggestions for good resources.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

4. Teach Core Vocabulary.

5 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words. Have students write each term in the upper left corner of an index card and underline it (one term per card). Explain that these words will be used and Vocabulary Cards will be developed throughout the unit.

conserve
fresh water

groundwater
pollutant

surface water
water pollution

Word Work

Review lesson concepts by engaging students with Core Vocabulary terms. Have students add notes to their cards in their own words during the discussion.

- **conserve:** (v. to save or protect)
 - » What are some things you can conserve? (*water, electricity, gasoline*)
- **fresh water:** (n. water that is usable by humans for things such as drinking and cleaning)
 - » What are some local bodies of water that would be considered fresh water? (*the river on the edge of town, the lake we fish in*)
- **groundwater:** (n. water stored in the spaces between materials beneath Earth's surface)
 - » Discuss water wells and digging into the ground to find water. (*Water wells have been used for thousands of years to access groundwater in underground aquifers.*)

- **pollutant:** (n. an artificial or natural substance that contaminates air, water, or soil)
» List common pollutants. (*waste disposal, soap water, agricultural runoff*)
- **surface water:** (n. fresh water found in rivers, streams, and lakes on Earth's surface)
» Identify local sources of surface water. (*Consider local rivers, creeks, and lakes.*)
- **water pollution:** (n. the presence of harmful substances or matter in water)
» Why shouldn't people dump waste in water sources? (*It will pollute the water and make it unsafe.*)

5. Check for understanding.

10 MIN

Activity Pages



AP 3.1

AP 3.2

Answer Key

Formative Assessment Opportunity

Post the images students included with the Water Pollution Sources activity around your learning space. Include additional images such as graphic organizers and maps. Have students complete a T-chart for each image. Title the left-hand column "Connections," and title the right-hand column "Questions."

Invite students to work with a partner and visit a minimum of five images. When visiting each image, students should consider how the image relates to the effects of human activities on water quality. Each pair should add at least one connection and one question to the T-chart for each image. Use student responses to evaluate comprehension of key concepts.

Collect the completed Water Pollution Sources (AP 3.1). Review student questions, and identify any that remain unanswered.

- Distribute Lesson 3 Check (AP 3.2), and ask students to complete it independently. Once students are finished, collect the assessment, and before the start of Lesson 4, check students' answers to identify concepts that need further clarification and to provide the support needed.
- See the Activity Page Answer Key for correct answers and sample student responses.
- Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone activity at the end of the unit:

- identified sources of water pollution
- considered treatments of water pollution

LESSON 4

Researching Water Stewardship

Big Question: How does water pollution spread?

Problem-Based Learning Project: Investigate options for protecting water resources to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Obtain information from reliable sources to describe evidence of positive and negative relationships between human activity and Earth's water resources.
- ✓ List several sources of water pollution and describe how each harms the environment and human health.
- ✓ Describe how people have used scientific ideas and technology to protect water resources.
- ✓ Find a problem with water resource use in your community.

Lesson Activities

- student activity and observation
- teacher demonstration and discussion
- research and writing
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in asking scientific questions and using evidence to evaluate scientific hypotheses. Students then use a variety of tools to communicate their findings. Students engage in research to obtain information about sources of water pollution and how people have used scientific ideas and technology to protect water resources. Students conduct a hands-on activity to demonstrate how a source of water pollution affects the environment. Students examine several sources of information to assess their credibility as evidence for positive and negative relationships between human activity and Earth's water resources.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

stewardship water pollution

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Activity Pages



AP 4.1
AP 4.2
AP 4.3

Activity Pages

Z-Chart (AP 4.1)

How Pollution Spreads (AP 4.2)

Lesson 4 Check (AP 4.3)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect the following items:

- shallow clear plastic trays (2 to 3 inches deep, 1 per student pair)
- large smooth rocks or pebbles (4 inches high, 1 per student pair)
- food coloring
- ice cubes
- jug
- water source
- paper towels (for cleanup)
- index cards for student vocabulary deck (1 per student)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How does water pollution spread? Before class, use the online resources to find several images of water pollution, water treatment, and water pollution cleanup. Use a variety of examples, using the previous lessons as scaffolding to develop students’ ideas about water pollution. Display each of the images in locations around the classroom where students can observe them. Have students work with a partner to answer the following questions about each of the pictures:

- » What is affecting the water resource in the picture? (*Accept plausible student responses.*)
- » How is the ecosystem affected by the use of water in this picture? (*Animals and plants are not thriving.*)

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

SUPPORT—To help students make connections, ask students to consider how water is used in each of the pictures and what effects the use has on animals or plants. Use prior knowledge to encourage questions about the impact of water use on animals and plants. Briefly broaden the discussion to touch on ways that water pollution can be prevented and cleaned up.

Problem-Based Learning Project: To develop a knowledge base for the capstone lesson, students engage in research to obtain information about sources of water pollution and how people have used scientific ideas and technology to protect water resources. Students conduct a hands-on activity to demonstrate how a source of water pollution affects the environment.

2. Encourage discussion.

5 MIN

Challenge students to think about how they could model water pollution. To focus students' thinking, ask the following questions:

- » How does pollution get into the ocean? (*It can wash into it when it rains, or it can be dumped there.*)
- » How does pollution affect plants and animals when it enters the ocean? (*They can eat it or get caught in it and become injured.*)

SUPPORT—Use the materials as a prop for students to brainstorm how they could model water pollution. If needed, review the previous lesson on sources of water pollution.

3. Facilitate the activity.

10 MIN

Activity Page



AP 4.1

Explain that a point source of pollution, such as a discharge pipe into a lake, is a single identifiable source. A nonpoint source of pollution, such as acid rain or car exhaust, is a source of pollution that comes from a variety of locations.

Distribute Z-Chart (AP 4.1), and provide students with an online research challenge to find information related to water resource use in their community. Ask students to develop a Z-chart based on a text they find online. The Z-chart includes (a) two details or key points from the chosen text, (b) an image or visualization of the concept, and (c) a one-sentence summary of the text.

SUPPORT—You may wish to provide students with a few specific websites that focus on water pollution and water resource use in your area or prepare by printing grade-level-appropriate research materials to save time. You may also consider examining Google Maps as a class to look at bodies of water specific to your area and determine any sources of pollution that may affect these locations specifically. Also look for large farms, and consider how fertilizers and pesticides may affect water sources. Guide students in their selection of a problem with water pollution or water use in the community that they will be able to investigate further and develop a plan to inform people of ways that they can help in the unit capstone, the Community Information Board Project that they will be developing.

Collect the completed Z-Chart (AP 4.1). Discuss responses to ensure students have identified an example of point-source pollution.

SUPPORT—If needed, guide students on completing their Z-charts. Ensure that students provide each of the three elements of the chart.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to these resources may be found:

www.coreknowledge.org/cksci-online-resources

4. Demonstrate examples and guide discussion.

15 MIN

Activity Page



AP 4.2

Distribute How Pollution Spreads (AP 4.2).

Explain to students that they will complete the Activity Page based on library research and on what they have learned so far in this lesson. Go over the directions with students, but do not complete the activity for them. Explain that the activity will help students think about the impact of a point source of pollution on the environment.

Ask students to work in small groups. Give each group a set of the materials. Describe the procedure each group should follow:

1. Place the container on a flat surface.
2. If needed, wash the pebble to clean it of any dirt or mud. Place the pebble in the middle of the container.
3. Add enough water to the container to fill it about halfway. The water should not cover the pebble.
4. Put the ice cubes in one corner of the container. (The ice cubes should not move around. If needed, cover the cubes with a paper towel to stop them from moving.)
5. Wait for the water to settle. Do not blow on the water or touch the container.
6. Add several drops of food coloring to the top of the pebble, until some of the food coloring enters the water.
7. Record your observations.
8. Use the paper towels to clean up your workspace or any spills.

Lead a discussion about the procedure for the Activity Page. Be sure that students are clear on the procedure. In particular, check that students understand the purpose of the activity. If needed, prompt students with the following questions:

- » What does the water represent? (*a water body, such as a lake or the ocean*)
- » What does the food coloring represent? (*a point source of pollution*)
- » What does the pebble represent? (*land*)
- » What is the purpose of the ice cubes? (*to create water currents*)
- » What do you observe about the “pollution”? (*The pollution/food coloring spreads away from the land/pebble to all of the water.*)

SUPPORT—Ensure that students relate their model to a real example of point-source pollution. Encourage students to consider which examples from earlier in the lesson could be represented by their model.

5. Teach Core Vocabulary.

5 MIN

Prepare and Revisit Core Vocabulary Cards

Display the following Core Vocabulary terms on the board or chart paper. Have students write *stewardship* in the upper left corner of an index card and underline it. Explain that these words will be used and Core Vocabulary cards will be developed throughout the unit:

stewardship

water pollution

Word Work

Review lesson concepts by engaging students with Core Vocabulary terms. Have students add notes to their cards.

- **stewardship:** (n. the responsibility of taking care of something)
 - » What can good stewards of water do? (*recognize water is a vital resource, test water quality, identify risks to water quality, address threats*)
- **water pollution:** (n. the presence of harmful substances or matter in water)
 - » How does water become polluted in our community? (*for example, agricultural runoff, factory waste, algal blooms*)

6. Check for understanding.

5 MIN

Activity Pages



AP 4.1

AP 4.2

AP 4.3

Answer Key

Formative Assessment Opportunity

After students have completed the activity, do the following:

- Collect the completed Z-Chart (AP 4.1) and How Pollution Spreads (AP 4.2).
- Review student questions, and identify any that remain unanswered.

- Have students summarize what they have learned about point sources of pollution, asking them to consider the Big Question: **How does water pollution spread?** Ensure that students use information from the activity as evidence.

SUPPORT—Be sure that students include information about how water resources can be protected from point sources of pollution. Encourage students to provide specific examples from their online research earlier in the lesson.

- Distribute Lesson 4 Check (AP 4.3), and ask students to complete it independently. Once students are finished, collect the assessment, and before the start of Lesson 5, check students' answers to identify concepts that need further clarification and to provide the support needed.
- See the Activity Page Answer Key for correct answers and sample student responses.
- Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified point and nonpoint sources of water pollution in the community
- recognized how water pollution can spread in the community
- considered how to protect water resources

LESSON 5

Water Protection Action Plan

Big Question: How can we protect our local water resources?

Problem-Based Learning Project: Recommend actions to reduce negative impacts on water resources.

AT A GLANCE

Learning Objective

- ✓ Develop a plan of suggested actions, based on scientific ideas, to show how your community can protect water resources in your area.

Lesson Activities

- class discussion
- research and writing
- student activity
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning. Students engage in hands-on activities to obtain information about local water resources and sources of water pollution. Students evaluate this information to develop an action plan to show to their community ways that they can protect water resources in their area. Students explain their plan on the first part of the community information board.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

action plan water pollution

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Activity Pages



AP 1.1
AP 5.1
AP 5.2

Activity Pages

Community Information Board
(AP 1.1)

Water Resources Action Plan
(AP 5.1)

Lesson 5 Check (AP 5.2)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect the following items:

- maps of the local area
- images of water pollution (from previous lesson)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can we protect our local water resources? Engage students by asking them to recall the images of water pollution from the previous lesson. If needed, show the images again to students, identifying each example of pollution in the images. Ask students if some of the types of pollution they learned about could occur in their community. Challenge students to consider whether some of the solutions they learned about could be applied if water in their community were polluted in these ways. To prompt thinking, ask questions about local water resources and ways to protect them from various types of pollution, such as the following:

- » How could an oil spill in a river be prevented? (*transport oil by land*)
- » How could a farmer prevent pollution from farm chemicals? (*limit use of chemicals to needs, do not apply on windy days, try organic methods*)
- » How could a city prevent pollution from entering the drinking water? (*build water treatment plants*)

- » How could a factory prevent pollution caused by releasing toxic chemicals into water? (*treat water after using it*)
- » How could a city use less water? (*pass laws to restrict water use*)

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to these resources may be found:

www.coreknowledge.org/cksci-online-resources

Problem-Based Learning Project: To wrap up Part B of this unit, students engage in hands-on activities to obtain information about local water resources and sources of water pollution. For the capstone lesson, students evaluate this information to develop an action plan to explain to their community ways to protect water resources in their area. Students explain their plan on the first part of the community information board.

2. Encourage discussion.

10 MIN

Activity Page



AP 1.1

Distribute to each student Community Information Board (AP 1.1), presented in Lesson 1. Explain that students will begin working on the community information board section on **water**. Have students recall that they will be acting like the EPA by providing information for their community about how people can be better stewards of their resources. (See **Know the Science 1.**)

Examine a map of your community to help students identify how their community gets and uses water.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Have students recall all that they have read and learned about water use and pollution. Ask students to answer question 2 by describing a problem with water use in their community.

Know the Science

1. Why protect water resources? All living things need water, and polluted water resources harm the living things and the environment upon which people depend. The first step in protecting water resources is to prevent pollution. Scientists recognize two types of pollution sources: point and nonpoint. A point source is a single identifiable source, such as a discharge pipe. A nonpoint source is a cause of pollution that originates from a variety of locations. For example, when rain falls on a parking lot, it washes away oil that leaked from cars. The water that flows from the lot is called runoff. The runoff collects in drains, eventually entering streams, rivers, and other bodies of water. The direct impact of point-source pollution may be worse than that of nonpoint-source pollution. However, nonpoint-source pollution is typically more difficult to prevent than point-source pollution. The point- and nonpoint-source distinction is a useful starting point for developing students' ideas about pollution. It may help to engage students if you use the images from the first part of the lesson.

SUPPORT—To help students think about local water problems, ask them to recall places where they have seen or used water near their home or neighborhood (e.g., in the home for drinking or washing, watering plants in their gardens or city spaces, community swimming pool, fishing or boating in nearby rivers or lakes, or water treatment plants).

Next, ask students to brainstorm ideas for protecting these local water resources. Students may come up with ideas such as using garbage cans for trash, not washing chemicals or medicines into the sink or bath, using rain barrels, limiting water use, conducting a clean-up day, and limiting use of chemicals for gardening. Have students write a few ideas beside question 3. Collect the Activity Page, and hold it until it is needed again for planning in the upcoming lessons.

Help students to develop their conceptual understanding of their plan for the community information board. Ask students to recall an activity that they have planned in the past. If needed, prompt students with an example of familiar things they may have planned, such as a vacation, birthday party, or hobby project. Use the following questions to brainstorm about essential elements of a plan:

- » What is the basic purpose of a plan? (*achieve a goal*)
- » What kinds of goals should a plan help to accomplish? (*solve a problem, answer a question*)
- » What should a plan begin with? (*statement of a problem, asking a question*)
- » How should a plan address its purpose? (*relate solutions to the problem or question*)
- » How should a plan be organized? (*describe the solution, action items, schedule, budget*)

Explain that their community information board will include a problem and a plan for their community to improve water resource use.

3. Facilitate the activity.

20 MIN

Distribute Water Resources Action Plan (AP 5.1). Explain to students that they will develop a planning page to refer to when putting together the community information board in the capstone lesson. (See **Know the Science 2.**)

Know the Science

2. Why develop a plan to protect local water resources? Access to clean, reliable sources of fresh water is essential to society and human health and necessary for a healthy environment. Given the complexity of supply and demand, hydrologists, city managers, natural resource experts, and legal experts work together to develop water management plans. According to the EPA, such plans focus on “current water uses, water efficiency improvements, conservation activities, and water-reduction goals.” Scientists and engineers conduct studies related to water use, pollution sources, and technological solutions to provide data that inform the planning and decision-making process. Conservation approaches include mapping water resources, eliminating pollution sources, monitoring water usage, and promoting water recycling.

Go over the directions with students, but do not complete the activity for them. Explain that the activity will build on students' learning in the previous lessons in the unit. If needed, review or provide the example plan (or an outline) to guide struggling students.

As students complete the plan, guide them to think about the format that the community information board will take. Options for formats they could choose from include the following:

- poster
- brochure
- web page
- written report
- digital slideshow
- video or animation

Lead a discussion about the procedure for the Activity Page. Be sure that students understand the procedure. If needed, prompt students with the following questions:

- » What water problem did you describe?
- » What are the main challenges to protecting your chosen water resource?
- » What are some possible solutions for protecting your chosen water resource?

SUPPORT—Encourage students to consider several approaches to protecting their chosen water resource. Try to ensure that, as a class, students choose a variety of water resources and protection approaches for their library research. In their plan, students should focus on one water resource but include a variety of approaches for its management. Remind students that the solutions that they develop should be real solutions that people can help with.

4. Teach Core Vocabulary.

5 MIN

Revisit Core Vocabulary Cards

Have students take out the Core Vocabulary cards for **action plan** and **water pollution**. Ask them to add definitions and examples to their vocabulary cards.

Word Work

Review lesson concepts by engaging students with Core Vocabulary terms.

- **action plan:** (n. a set of steps needed to complete a successful project)
 - » What would be on an action plan for stewardship of local water quality? (*identify point and nonpoint water pollution sources, research solutions*)
- **water pollution:** (n. the presence of harmful substances or matter in water)
 - » What is the difference between polluted and clean water? (*For example, clean water is safe to drink; polluted water is not safe to drink.*)

5. Check for understanding.

5 MIN

Activity Pages



AP 5.1

AP 5.2

Answer Key

Formative Assessment Opportunity

After students have completed the activity, do the following:

- Collect the completed Water Resources Action Plan (AP 5.1).
- Review student questions, and identify any that remain unanswered.

Have students summarize what they have learned about protecting local water resources, asking them to consider the Big Question: **How can we protect our local water resources?** Ensure that students use information from the activity as evidence.

- Distribute Lesson 5 Check (AP 5.2), and ask students to complete it independently. Once students are finished, collect the assessment, and before the start of Lesson 6, check students' answers to identify concepts that need further clarification and to provide the support needed.
- See the Activity Page Answer Key for correct answers and sample student responses.
- Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified local water resource problems
- developed a plan for solving local water resource problems

PART C

Protecting Earth's Air

OVERVIEW

Lesson	Big Question	Advance Preparation
6. Air Pollution	What is air pollution?	Read Chapter 3 in the Student Reader.
7. The Need for Clean Air	How can human activity affect the quality of air?	Read Chapter 4 in the Student Reader.
8. Researching Air Quality Protection	How can we protect air quality?	Provide research opportunities.
9. Air Quality Action Plan	How can we protect our local air quality?	Provide research opportunities. Gather materials for hands-on investigation. (See Materials and Equipment, page 16.)

Part C: What's the Story?

In this Problem-Based Learning Project unit, students learn about water, air, and land resources and threats to those resources. Throughout the unit, students identify potential ecosystem threats to their local community and develop action plans to address those threats. Part C focuses on air resources, positive and negative human impacts on air resources, and how to improve air quality.

In Lesson 6, students learn about air resources and the importance of air to life. Students recognize the human impact on air pollution and how air quality can be tested.

In Lesson 7, students identify and communicate the impact of human activities on air quality and learn more about the Air Quality Index and testing the quality of air. Students explore the use of plants to fight indoor and outdoor air pollution.

In Lesson 8, students research to identify the impact of human activities on air in their community.

Lesson 9 focuses on the development of an action plan to address threats to air quality in the local ecosystem.

So, to repeat, students learn about **the importance of air quality, threats to air resources, and ways that air quality can be protected, tested, and treated.**

This set of lessons comprehensively meets the NGSS Performance Expectation 5-ESS3-1.

LESSON 6

Air Pollution

Big Question: What is air pollution?

Problem-Based Learning Project: Investigate the effects of human activities on air quality to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe the importance of air to all living things.
- ✓ Obtain information from reliable sources to describe evidence of positive and negative relationships between human activity and air pollution.
- ✓ Describe how people have used scientific ideas and technology to reverse air pollution.

Lesson Activities

- reading and discussion
- vocabulary instruction
- observations
- student activity and writing

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning. Students engage in a hands-on activity to obtain information about the impacts of human activities on the air we breathe. They evaluate this information in the context of human impacts on natural systems. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from the Student Reader about air pollution. Students will begin to identify sources of air pollution in their communities.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

air pollution

smog

Core Vocabulary Deck As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 3

Activity Page



AP 6.1

Student Reader, Chapter 3
“Air Pollution”

Activity Page
Testing Air Quality (AP 6.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- petroleum jelly
- large index card (1 per student pair)
- cotton ball (1 per student pair)
- clothespin (1 per student pair)
- index cards for student vocabulary deck (2 per student)
- internet access and the means to project images/video for whole-class viewing

Advance Preparation

Beforehand, select a location or several locations where students can collect particles of air pollution by placing index cards overnight. Some ideal locations would be near places where cars or buses drive or other places where pollution may enter the air.

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

What is air pollution? Open the lesson by having students turn to page 15 of Chapter 3 in the Student Reader. Ask students to examine the photo of the people wearing breathing masks.

Use the following questions to prompt discussion:

- » Why do you think the people in the photo are wearing masks? (*The air is bad, but they want to be outdoors.*)
- » What could be in the air that makes it dangerous for people to breathe? (*smoke, dust, smog, or chemicals*)

Tell students to keep the photo in mind as they continue the remainder of the lesson.

Problem-Based Learning Project: To build a knowledge base for the capstone lesson, students engage in a hands-on activity to obtain information about the impacts of human activities on the air we breathe. Students evaluate this information in the context of human impacts on natural systems.

Students will begin to identify sources of air pollution and remedies for air pollution.

2. Teach Core Vocabulary.

5 MIN

Prepare Core Vocabulary Cards

Write each of the following Core Vocabulary terms on the board or chart paper. Have students write each term in the upper left corner of an index card and underline it (one term per card):

air pollution **smog**

Word Work

- **air pollution:** (n. any type of substance that is in air and makes it unsafe to breathe) Ask students to break the term into parts to determine the meaning and write it on the front of the card.
- **smog:** (n. a type of air pollution that results from a mixture of gases from burning fuels, air, and sunlight that makes air look hazy) Ask students to guess what two words are combined to make this word (*smoke* and *fog*). Have students write the words on the front of the card in pencil only. Explain that when students read about this word later in the lesson, they will check to see if they were correct.

3. Read and discuss: “Air Pollution.”

15 MIN

Student Reader



Ch. 3

Read together, or have students read independently, “Air Pollution,” Chapter 3 in the Student Reader. The selection introduces the idea that air is an important resource that can be affected positively or negatively by humans.

Guided Reading Supports

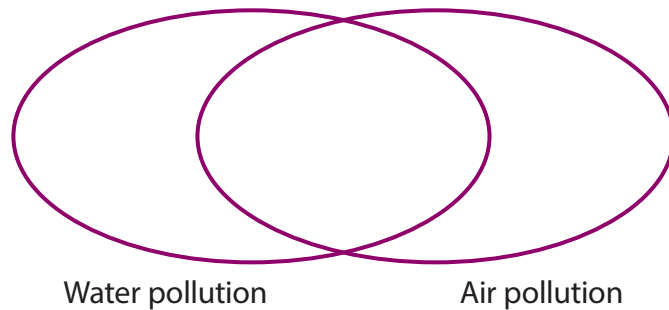
When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 15

After students have read the page, ask them what sort of outdoor activities they enjoy. Then ask students to think about how air pollution could affect their ability to do those activities. Finally, ask students to brainstorm other solutions to the problem of air pollution, besides wearing a mask.

SUPPORT—Have students compare the definition they wrote on the index card to the definition of *air pollution* on page 15. Invite them to make changes if needed.

Make a Venn diagram on the board or chart paper, and quickly discuss some similarities and differences between water pollution and air pollution. You may wish to leave this on display and add to it throughout the lesson. (See **Know the Science**.)



Page 16

After reading this page, have students check to see that the words they wrote on the Core Vocabulary card for *smog* are *smoke* and *fog*. Check for understanding of the word, and correct the misconception that smog is smoke and fog only. Smog is actually a mixture of gases interacting chemically in sunlight. Show a video that describes how smog is formed. Ask the following:

» What are some ways that air can become polluted? (*for example, by people driving cars, by factories, by fires burning*)

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Know the Science

How do water pollution and air pollution compare? Both are hazardous to health. Similarities: Both air and water pollution contaminate essential resources for life. Differences: Air pollution is caused by gases or smoke emitted into the air. Water pollution is caused by liquids or decomposable solids released into the water supply.

Page 17

After students have read the page, discuss some effects of air pollution on human health. Ask the following:

- » What are some effects of air pollution on humans? (*burning eyes, breathing problems, and coughing*)
- » Do you think other living things are affected by pollution in the air? Give an example. (*Other animals that live on land would also be affected by air pollution.*)

Pages 18–20

Before reading, explain that some cities have high amounts of air pollution. Have students look at the photographs on the next three pages. Ask the following:

- » Why might cities have more air pollution than other places? (*because there are more people and more car exhaust and factory emissions*)
- » What do the solutions that these cities have used to help reverse air pollution have in common? (*They all used plants.*)

After students have read the pages, show a video of plant solutions for air pollution. Then probe students for understanding of how plants can eliminate air pollution. Ask the following:

- » What do plants need to live? (*sunlight, air, water*)
- » How do plants “clean” air? (*Plants use carbon dioxide from air and release oxygen.*)
- » How does carbon dioxide get into the air? (*from burning fuels such as wood, oil, gas, and coal*)
- » How could deforestation affect air quality? (*In places where forests are being cut down, there are fewer trees, so air quality will begin to suffer.*)

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

4. Facilitate the activity.

10 MIN

Activity Page



AP 6.1

Distribute Testing Air Quality (AP 6.1) to each student. Read over the directions with students, answer any questions they may have, and check for understanding. Divide the class into pairs, and distribute an index card and a cotton ball dipped in petroleum jelly to each pair of students. After students have applied the petroleum jelly to the card, quickly take students to your preselected outdoor location to place their index cards.

Be sure to choose a location where the cards will not be disturbed or be blown away in the wind. Check that rain is not expected because the cards may not capture any particles if they are wet. Depending on the location selected, students may not be able to use the clothespin to attach the card. In this case, try punching a hole in the cards and hanging them with string or taping them up with duct tape.

5. Check for understanding.

10 MIN

Activity Page



AP 6.1 and
Answer Key

Formative Assessment Opportunity

Review the Venn diagram you created with examples and descriptions of air pollution and water pollution. Have students draw conclusions that compare them.

Collect the completed Testing Air Quality (AP 6.1). Scan over question 3 to see if students correctly explained a location that would have air pollution and that they were able to explain why. Address any misconceptions before beginning the next lesson.

See the Activity Page Answer Key for correct answers and sample student responses.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- explored the definitions of *air pollution* and *smog*
- considered how air can be purified

LESSON 7

The Need for Clean Air

Big Question: How can human activity affect the quality of air?

Problem-Based Learning Project: Investigate the effects of human activities on air quality to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe how human activity affects air quality.
- ✓ Find the Air Quality Index for your location.
- ✓ Measure particles of air pollution at school.

Lesson Activities

- reading
- student activity and discussion
- observation and writing
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information from several sources to evaluate and communicate the air quality at school and in the area where they live. Students will identify and communicate the impact of human activities on the air we breathe. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from the Student Reader about air pollution. Students will measure the air quality in their area and describe sources of air pollution and the effects on living things.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

air quality

Air Quality Index

clean energy

ozone

pollutant

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 4

Activity Pages



AP 6.1

AP 7.1

Student Reader, Chapter 4

“The Need for Clean Air”

Activity Pages

Testing Air Quality (AP 6.1)

Air Quality Index (AP 7.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- several magnifying glasses
- index cards for student vocabulary deck (3 per student)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can human activity affect the quality of air? To build on what students learned in Lesson 6 and activate background knowledge, open this lesson by asking the following questions:

- » What is wind? (*moving air*)
- » What are some materials that can be carried in wind? (*smoke, ash, mist*)
- » How can air pollution produced in one place affect people living in another place? (*Air pollution can be carried by wind.*)

Problem-Based Learning Project: Explain to students that in this lesson, they will build knowledge about air pollution as they work toward the unit’s capstone lesson. Students will learn about how people can affect air quality in different ways. Students will learn about different causes of air pollution and the effects of it. Students will measure the air quality at school and in the area where they live.

2. Facilitate the activity and encourage discussion.

10 MIN

Activity Page



AP 6.1

Take students outside to get the index cards that they placed in the collection locations around the school during the previous lesson and carefully bring them into the classroom. Once students are indoors, distribute several magnifying glasses so that students can observe the index cards for trapped particles. Distribute Testing Air Quality (AP 6.1) from the previous lesson. Allow students time to record their results by making a quick sketch of their card. Let students share their drawings and look for patterns in the data.

Lead a discussion by asking the following questions:

- » Did the cards placed in the same location have similar results?
- » Predict what would happen if the cards were left out for a week.
- » What reasons can you think of for why some cards caught more particles than other cards?
- » If you needed to recommend a place for students in the school to complete outdoor activities, how could you collect data to make your decision?

If you have access to a stereo microscope, students may find it interesting to observe the cards beneath it. Explain that it is easier for smaller particles to become airborne than heavier particles. Have students consider the height at which the cards were placed. After examining the cards, you may choose to continue the experiment for a longer length of time.

3. Read and discuss: “The Need for Clean Air.”

15 MIN

Student Reader



Ch. 4

Read together, or have students read independently, “The Need for Clean Air,” Chapter 4 in the Student Reader. The selection reinforces the idea that human activity affects the quality of air and that air quality can affect living things and their ecosystems.

Preview Core Vocabulary Terms

Before students read, write the following Core Vocabulary terms on the board or chart paper. Encourage students to pay special attention to these terms as they read:

air quality **clean energy** **ozone**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 21

After students have read the page, explain that all living things depend on air. Ask the following:

- » What body organs help living things get oxygen from air? (*lungs, gills*)
- » What system moves oxygen from the lungs to cells and carries carbon dioxide waste out of the body? (*the respiratory system*)
- » What living things do you think would be affected the most by polluted air? (*animals that live on land or in the air, such as birds*) (See **Know the Science.**)

Page 22

After reading the page, review the meaning of the vocabulary word. Ask the following:

- » How does the EPA measure air quality? (*by measuring pollutants in the air*)
- » How does smoke get into the air? (*burning fuels, fireplaces, campfires, and factories*)
- » How can smoke affect air quality? (*It can make the sky hazy and create smog.*)
- » Why don't plants grow as well when it is hazy? (*They cannot get as much sunlight to make food.*)

Page 23

Before reading this page, make a T-chart on the board or chart paper to compare ozone when it is high in the atmosphere to when it is near the ground.

Comparing Ozone

High	Low

Know the Science

Can people always see air pollution? No. Dispel any misconceptions students may have that air pollution is always visible. Sometimes the most dangerous air pollution is from invisible gases in the air. Many years ago, if miners wanted to be sure that there were no dangerous chemicals in a mine, they would take a canary into it. Birds are especially sensitive to air pollution because of their efficient respiratory systems, so if the bird became sick, they would know that the mine was not safe. Today, mines are tested by using technological devices. If air is not safe to breathe, miners are able to use special breathing equipment to stay safe.

After students read the page, complete the T-chart together. Next, discuss how pulling up plants by the roots could have caused something like they see in the photo. Ask the following:

- » How do plants help prevent air pollution? (*They keep dust and dirt down with their roots; they release oxygen into the air.*)
- » What materials do plants need to be able to help with air pollution? (*Plants need water, sunlight, carbon dioxide, and space to grow.*)

Page 24

Activity Page



AP 7.1

After reading this page, review the chart with students. Ask the following questions to probe for understanding:

- » What type of air quality does an orange rating indicate? (*that people should limit outdoor activity*)
- » Should people enjoy outdoor activities if the Air Quality Index is above 200? (*no*)

Go to the website that provides current conditions and air quality forecasts for your area. Key in your zip code, or click on your area of the map. Have students use the chart to determine what the Air Quality Index where they live is today. Distribute Air Quality Index (AP 7.1), and have students record the air quality for where you live today. Explain that you will be examining the website in more depth in the following lesson.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Use the website to reinforce the differences in air quality in populated and less populated areas. For example, key a state name to see the table of air quality results in different sections of the state. Discuss how these results may change throughout the day, during rush hour, or at different times of the year.

Page 25

After reading this page, direct students to the sentence that reads, “The best way to reduce air pollution is to prevent more pollutants from getting into the air.” Ask students to turn to their neighbor and explain what they think this means. If time permits, call on several students to share with the class what they and their partner discussed about the meaning. Ask the following:

- » How does a scrubber prevent air pollution? (*It stops most pollutants from reaching the air.*)

Page 26

After reading this page, discuss how using clean energy can reduce air pollution. Ask the following:

- » Have you ever seen evidence of clean energy being used near where you live?
- » Would the place where you live be a good candidate for using clean energy resources?

4. Teach Core Vocabulary.

5 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed earlier in the lesson). Have students write the terms in the upper left corner of an index card and underline them (one term per card).

air quality **clean energy** **ozone**

Word Work

Give students a few minutes to record the meaning of each term in their own words on the front of each card. Have students add these cards to the rest of the Core Vocabulary deck and store them safely until the next lesson.

- **air quality:** (n. a measure of how clean the air is) Discuss the air quality in your local area.
- **clean energy:** (n. an energy resource that does not release pollutants when it is used) Make a list of different types of clean energy. (*wind, solar, water*)
- **ozone:** (n. a gas found in air) Discuss whether ozone is or is not a pollutant. (*It is not like other pollutants because it is not emitted, but it mixes with pollutants including smog when it is near the ground and can make it hard to breathe.*)

5. Check for understanding.

10 MIN

Activity Page



AP 7.1 and
Answer Key

Formative Assessment Opportunity

Direct student attention back Air Quality Index (AP 7.1). Give students time to complete the rest of the Activity Page. Circulate around the room as students complete the Activity Page. Answer any questions, and address any misconceptions you notice as you check over their answers to the Activity Page.

See the Activity Page Answer Key for correct answers and sample student responses.

- Collect the completed Air Quality Index (AP 7.1). If any contain inaccurate information, engage in further discussion, emphasizing the parts that are missing or incorrect.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- explored the evidence of local air quality and potential problems
- considered how air quality can be improved

LESSON 8

Researching Air Quality Protection

Big Question: How can we protect air quality?

Problem-Based Learning Project: Investigate air quality protection measures to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe causes and solutions for different types of air pollution.
- ✓ Describe effects of air pollution.

Lesson Activities

- research and writing
- teacher demonstration and class discussion
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information from several sources to evaluate and communicate the air quality in their area compared to other areas. Students will research to identify the impact of human activities on air in their community and communicate ideas for how to reduce the impact of human actions on air quality. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from online resources about air pollution. Students will measure the air quality in their area and compare it to other areas. Students will then identify ways that humans impact air quality in their community.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced during this lesson.

Clean Air Act

indoor air pollution

Instructional Resources

Activity Pages



AP 8.1
AP 8.2

Activity Pages

Indoor and Outdoor Pollution
(AP 8.1)

Researching Air Pollution
(AP 8.2)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- wooden matches

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can we protect air quality? Begin by checking the EPA website to see what the AQI (Air Quality Index) is for your location today. Ask the following:

- » How does the AQI today compare to the measurement from yesterday?
- » What could cause the AQI to change? (*a change in weather, increase or decrease in burning, levels of ozone, or levels of pollen in the air*)
- » How could people improve the AQI in their area? (*use less fuels and release less smoke and chemicals into the air*)
- » What sort of daily activities contribute to air pollution? (*driving in cars and buses, using electricity produced from coal or gas, using products made in a factory*)

SUPPORT—Help students think about all of the activities that they do in a day and how using power, driving in cars or buses, the factories that make the products that they use, and many of their daily activities can have an indirect effect on air quality. Now, encourage them to begin thinking about solutions to these problems.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Problem-Based Learning Project: To develop a knowledge base for the capstone lesson, students engage in research to obtain information about sources of air pollution and how people have used scientific ideas and technology to protect air quality. Students will then identify ways that humans impact air quality in their community.

Activity Page



AP 8.1

Distribute Indoor and Outdoor Pollution (AP 8.1). Ask students to name a city that they think will have a poor Air Quality Index. Check the EPA website for the rating for the student suggestions, or allow students to check for themselves. Instruct students to complete the chart on the Activity Page comparing air quality ratings and answer the questions that follow.

2. Demonstrate examples and guide discussion.

15 MIN

Have students close their eyes. Light a match and let it burn. Invite students to raise their hand when they notice a smell. Next, have students open their eyes and carefully observe as you burn another wooden match. Ask the following:

- » Do you think everyone raised their hand at the same time? (*no, because students closer to the teacher smelled the match first, or it depended on which way the smoke was blowing*)
- » What did you see when you observed the match burning? (*black smoke, ash, color change of the match*)

Explain that the Air Quality Index measures pollutants in the air outside. Point out that the indoor air can also contain pollutants. Indoor air quality is often worse than outdoor air quality. Ask the following:

- » What are some pollutants that could be in the indoor air? (*smoke, scents, gases*)
- » How is indoor air monitored? (*with a smoke/radon/carbon monoxide gas detector*)
- » Why are these types of detector devices important? (*Some gases, such as carbon monoxide, are colorless and odorless but very harmful.*)

Encourage students to think about ways that their actions affect the air, either directly or indirectly. Discuss examples that students share, such as wearing perfume, using certain cleaning products or chemicals, burning fuels, or using paints and solvents.

Have students complete Indoor and Outdoor Pollution (AP 8.1), including the Venn diagram to compare indoor and outdoor air pollution. (See **Know the Science 1.**)

SUPPORT—You may wish for students to work with a partner or complete the diagram together as a class. Review how to complete a Venn diagram, if necessary. Encourage students to find several ways that indoor and outdoor air can be different and several things that they have in common.

Ask the following questions to help students compare indoor and outdoor air pollution:

- » How can people protect air quality indoors? (*pass laws, do not smoke, use clean energy*)
- » How can people protect air quality outdoors? (*carpool, walk or bike, use scrubbers on factories*)
- » When you check the EPA website to determine the AQI for your area, what type of air pollution does this measure? (*outdoor*)
- » How can technology help with monitoring indoor air pollution? (*Devices can measure gases in the air and alert people with an alarm system.*)

3. Conduct research.

20 MIN

Activity Page



AP 8.2

Divide the class into small groups. Distribute one copy of Researching Air Pollution (AP 8.2) to each group of students. This research activity can be completed as a jigsaw activity by assigning a different topic to each group to research and then having each group share the information that they find with the class. Read over the sections of the chart, and check for understanding. Answer any questions that students may have. Give each group of students a chance to conduct research and complete the Activity Page. Circulate around the room, and assist students as needed. As students complete their research, call on groups of students to share what they have found with the class. (See **Know the Science 2.**)

Know the Science

1. What are examples of different types of outdoor and indoor air pollution that can be detected? CFCs and radon. In the late 1990s, a type of chemical used in many products, CFCs (chlorofluorocarbons), was banned when scientists noticed the effects that it had on ozone in the atmosphere over time. It had been widely used in aerosol and pressurized products, including hair and paint sprays, since it was developed in the 1930s. Now, people have invented alternative ways to spray materials without the use of CFCs.

Radon is a colorless and odorless radioactive gas produced by decaying uranium. It is present in almost all soils. There are low levels of radon gas in air. Radon becomes indoor air pollution when it seeps into closed buildings through walls and floors and gets trapped inside a well-insulated structure. Long-term exposure can cause lung cancer.

To save time, you may wish to prepare by printing out grade-level-appropriate research material or having a list of possible websites for students to use for their research.

Explain to students that the Clean Air Act (CAA) is a law passed by the federal government designed to control air pollution. Congress first passed the CAA in 1970 to combat a variety of air pollution problems and pollution threats. Major revisions to the act were made in 1977 and 1990. As a result of the CAA, emissions of common pollutants have dropped significantly since 1970.

4. Check for understanding.

5 MIN

Activity Pages



AP 8.1

AP 8.2

Answer Key

Formative Assessment Opportunity

See the Activity Page Answer Key for correct answers and sample student responses.

- Collect Indoor and Outdoor Pollution (AP 8.1) and Researching Air Pollution (8.2), and check to see that students completed the questions. Address any misconceptions or incomplete responses before moving on to the next lesson.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified sources of indoor and outdoor air pollution
- recognized how air pollution can spread in the community
- considered how to improve air quality

Know the Science

2. Why doesn't air pollution drift out into space? *Because of gravity and wind!* Although air may seem weightless, it has mass. Gravity is the force that pulls all objects with mass toward the center of Earth, including air. Gravity keeps Earth's atmosphere in place. When pollution enters the air, it becomes a part of the atmosphere. Therefore, pollutants stay with the planet and do not drift off into space. They can cause effects for years after being expelled into the air. The effects of some types of pollutants may not be observed for many years after they enter the atmosphere. Wind also keeps pollutants in the atmosphere by keeping them aloft in air currents.

LESSON 9

Air Quality Action Plan

Big Question: How can we protect our local air quality?

Problem-Based Learning Project: Recommend actions to reduce negative impacts on air quality.

AT A GLANCE

Learning Objectives

- ✓ Identify sources of air pollution in the community.
- ✓ Create a plan to improve air quality in the community.

Lesson Activities

- research and writing
- teacher-led discussion
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information from several sources to communicate a problem that affects air quality in their area. Students will research to develop a plan to communicate ideas for how to reduce the impact of human actions on air quality in their community. Obtaining information from reliable sources is an important part of the scientific process. Students should use reliable sources when conducting research and gathering information. When students develop their action plan, they should be careful to include facts and keep their plan free of opinions in order to pass on reliable scientific information to their community.

In this lesson, students obtain, evaluate, and communicate information from online resources about problems with air quality in their community and develop solutions for those problems. Students create a plan for ways to include this information in the ongoing project to develop a community information board.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced during this lesson.

air pollution

cyclone

Instructional Resources

Activity Pages



AP 1.1

AP 9.1

AP 9.2

Activity Pages

Community Information Board
(AP 1.1)

How Can a Cyclone Clean Air?
(AP 9.1)

Air Quality Action Plan (AP 9.2)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items :

- photocopied detailed satellite map of the community (1 per student pair)
- paper or foam cups with lids (1 per student pair)
- glitter
- pencils (1 per student pair)
- clear glue sticks (1 per student pair)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can we protect our local air quality? Open this lesson by giving each pair of students a photocopied map of the community. Ask students to work with their partner to mark the areas in the community that contribute to air pollution. Review the vocabulary term *point-source pollution*. Explain that each place they are marking is a cause of point-source air pollution.

Use the following questions to prompt discussion:

- » What kinds of places did you mark on the map? (*factories, power plants*)
- » Are there any places that contribute to air pollution that cannot be marked on the map? (*places with indoor air pollution, places in other cities that release air pollution that blows to this community, nonpoint-source pollution*)
- » Are there any ways that we can prevent air pollution from these places? (*catch pollutants before they enter air, plant trees or other plants*)

Problem-Based Learning Project: To wrap up Part C, students engage in a hands-on activity to obtain information about local sources of air pollution and ways to improve air quality. For the capstone lesson, students evaluate this information to develop an action plan to show their community ways that they can improve air quality in their area. Students explain their plan on the first part of the community information board.

2. Facilitate the activity.

10 MIN

Activity Page



AP 9.1

Have the class continue to work in pairs. Distribute a copy of How Can a Cyclone Clean Air? (AP 9.1) to each pair of students. Read the procedure with students, and model the procedure for the activity.

Discuss the multiple meanings of the word *cyclone*. First ask students to describe a cyclone. Explain that the word has been used to describe a tornado and a hurricane because both involve winds rapidly rotating inward. In this activity, a cyclone refers to a controlled cyclone that uses centrifugal force to separate materials. Show a video to demonstrate if need be.

Check for understanding, and answer any questions that students may have. Distribute the materials to each pair of students: cup with a lid, small amount of glitter, glue stick, and sharp pencil. Circulate around the room, and assist students as they complete the activity. Collect the materials as students finish, and give students time to answer the reflection questions that follow the activity. When students have completed the activity, review the answers to the reflection questions together.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

3. Encourage discussion.

5 MIN

Activity Page



AP 1.1

Distribute to each student Community Information Board (AP 1.1), which they last worked on in Lesson 5. Explain that students will begin working on the community information board section on air quality. Have students recall that they will be acting like the EPA by providing information for their community about how people can be better stewards of their resources.

Have students recall all that they have read and learned about air quality and pollution. Ask students to answer question 4 by describing a problem with air quality in their community.

SUPPORT—To help students think about air problems, ask them to recall places where they have seen pollution in the air near their home or neighborhood (e.g., cars on the highway, dry cleaners, factories). Remind students to think about the map they marked at the beginning of the lesson.

Next, ask students to brainstorm ideas for protecting air. Students may come up with ideas such as riding bikes to school, cleaning air before it is released, and planting trees and gardens. Have students write a few ideas beside question 5. Collect the Activity Page, and hold it until it is needed again for planning in the upcoming lessons.

Remind students of what a plan is and why it is necessary. Explain that the community information board that students will make will include a problem and a plan for their community to improve air quality. (See **Know the Science**.)

4. Support the investigation.

20 MIN

Activity Page



AP 9.2

Distribute Air Quality Action Plan (AP 9.2). Explain to students that they will use the Activity Page as a planning page to refer back to when putting together their community information board.

Go over the directions with students, but do not complete the activity for them. Explain that the activity will build on their learning in the previous lessons in the unit.

SUPPORT—If needed, review or provide an example plan or an outline to guide struggling students. Assist students as they complete the plan.

Lead a discussion about the Activity Page. If needed, prompt students with the following questions:

- » What air problem did you describe?
- » What are the main challenges to protecting air?
- » What are some possible solutions for protecting air in your community?

SUPPORT—Encourage students to consider several approaches to protecting air quality in their community. Try to ensure that, as a class, students choose a variety of problems with the air quality for their library research. In their plan, students should focus on one problem with air quality but include a variety of approaches for its management. Remind students that the solutions that they develop should be real solutions that people can help with.

Know the Science

Why develop a plan to protect local air quality? *Clean air is essential to human health and necessary for a healthy ecosystem.* Although much progress has been made to clean the air in recent years, air pollution continues to harm people's health and the ecosystem. The EPA works with local governments and other agencies to enforce the Clean Air Act and reduce air pollution and its damage. When carbon dioxide builds up in the atmosphere, the effects can be far-reaching. It is most likely the major factor in climate change and ocean acidification. This can result in changes in weather such as more dangerous storms and flooding and more widespread drought, which can lead to wildfires.

5. Check for understanding.

5 MIN

Activity Pages



AP 1.1

AP 9.2

Answer Key

Formative Assessment Opportunity

After students have completed the activity, do the following:

- Collect the completed Air Quality Action Plan (AP 9.2).
- Review student plans, and identify any misconceptions that you notice.

Have students summarize on notebook paper what they have learned about protecting air quality, asking them to consider the Big Question: **How can we protect our local air quality?** Ensure that students use information from the activity as evidence.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified local air pollution problems
- developed a plan for improving air quality

PART D

Protecting Earth's Land

OVERVIEW

Lesson	Big Question	Advance Preparation
10. Land Contamination	What is land contamination?	Read Chapter 5 in the Student Reader.
11. Living Off the Land	How can human activity contaminate land?	Read Chapter 6 in the Student Reader.
12. Researching Use of Land Resources	How can we find information about land contamination?	Gather materials for hands-on investigation. (See Materials and Equipment, page 16.)
13. Land Resource Action Plan	How can we protect land from contamination?	Provide research opportunities.

Part D: What's the Story?

In this Problem-Based Learning Project unit, students learn about water, air, and land resources and threats to those resources. Throughout the unit, students identify potential ecosystem threats to their local community and develop action plans to address those threats. Part D focuses on land resources, positive and negative human impacts on land resources, and how to avoid or limit land contamination.

In Lesson 10, students learn about land resources and the importance of land to life. Students recognize the human impact on land contamination and how solutions such as reusing, recycling, reducing, and constructing landfills control land contamination.

In Lesson 11, students evaluate the negative and positive effects of human activities, such as mining, on land resources. Students learn about methods such as no-till farming, crop rotation, and green spaces that control land contamination.

In Lesson 12, students learn about biodegradable materials and then research to find out how land is used in their community.

Lesson 13 focuses on the development of an action plan to address threats to land resources in the local ecosystem.

So, to repeat, students learn about **the importance of land to living things, threats to land resources, and ways that land resources can be protected, tested, and treated.**

This set of lessons comprehensively meets the NGSS Performance Expectation 5-ESS3-1.

LESSON 10

Land Contamination

Big Question: What is land contamination?

Problem-Based Learning Project: Investigate the human activities that contaminate land to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe the importance of land to all living things.
- ✓ Describe how people have used scientific ideas and technology to help prevent land contamination.

Lesson Activities

- reading and discussion
- vocabulary instruction
- observations
- student activity and writing

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning. Students engage in a hands-on activity to obtain information about the impacts of human activities on land. Students evaluate this information in the context of human impacts on natural systems. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from the Student Reader about land contamination. Students will begin to find ways that they can help decrease the amount of land needed by communities.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

biodegradable contaminated land landfill

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 5

Activity Pages



AP 10.1

AP 10.2

Student Reader, Chapter 5
“Land Contamination”

Activity Pages
Making a Waste-Free Lunch
(AP 10.1)

Examining Contaminated Land
(AP 10.2)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- small paper cups with soil (2 per student pair)
- ripe banana
- piece of plastic, such as a straw or juice container, cut into small pieces
- tweezers (1 per student pair)
- magnifying glasses (1 per student pair)
- gloves, such as garden gloves (1 set per student pair)
- paper towels
- index cards for student vocabulary deck (3 per student)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

What is land contamination? Open the lesson by asking students how people can use land. Give students one minute to brainstorm a list of ways. Give students two minutes to share their ideas with a partner. Call on each pair of students to share their ideas with the class.

Use the following questions to prompt discussion:

- » Why is land important to people? (*to grow food in, to live on, to build roads on*)
- » How is land important to animals? (*Animals need land for shelter.*)
- » How is land important to plants? (*Many plants grow in soil and get the nutrients they need to grow from it.*)

Tell students to keep these questions in mind throughout the rest of the lesson.

Problem-Based Learning Project: To build a knowledge base for the capstone lesson, students engage in a hands-on activity to obtain information about the impacts of human activities on land. Students evaluate this information in the context of human impacts on natural systems.

Students will begin to identify sources of land contamination and remedies for land contamination.

Prepare Core Vocabulary Cards

Write the following Core Vocabulary terms on the board or chart paper:

biodegradable contaminated land landfill

Instruct students to write each of the Core Vocabulary terms in the top left corner of an index card (one term per card). Explain that as students read the chapter, they will write a definition for each of these terms in their own words on the front of each card.

2. Read and discuss: “Land Contamination.”

10 MIN

Student Reader



Ch. 5

Read together, or have students read independently, “Land Contamination,” Chapter 5 in the Student Reader. The selection introduces the idea that land is an important resource that can be affected positively or negatively by humans.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 27

After students have read the page, discuss the meaning of *contaminated land*. Be sure students understand the definition and record it on the Core Vocabulary card that they prepared.

SUPPORT—You may wish to provide some local examples of contaminated land. For example, one of the only remains of a Florida ghost town near the Withlacoochee State Forest, Mannfield, is a cow dip. The cow dip contained a poisonous chemical called arsenic. After being out in the fields, farmers would walk the cows through the dip to kill the ticks and other parasites. Eventually, the cow dips leaked arsenic into the ground. The arsenic did not disappear,

though. It is still in the soil and has seeped into the groundwater. People who live near the area now cannot get their water from wells because the ground and water are contaminated.

Page 28

After reading this page, have students write definitions for the words *landfill* and *biodegradable* on the Core Vocabulary cards they prepared. Check for understanding of the definitions. Ask students to examine the part of the picture showing the items that are placed in a landfill. Ask the following:

- » Are there any ways to reduce the amount of garbage that goes into the landfill? (*use items that can be reused or recycled instead*)
- » What can you use instead of some of these items? (*do not use straws, take reusable bags to the store, use silverware and plates and cups that can be washed*)
- » Even though items can be recycled, such as plastic water bottles, why is it important to use less of these too? (*because it takes energy and money to produce and recycle these items*)

Page 29

After students have read the page, discuss the building of landfills and disposal of garbage. (See **Know the Science** for more information.) Ask the following:

- » What would happen if garbage were not disposed of in a landfill? (*The land would become contaminated.*)
- » Why is a landfill often built nearby a water treatment plant? (*Some water is released as the garbage decomposes and needs to be treated before it is recycled into the environment.*)

Online Resources



SUPPORT—Show a video to further explain how landfills are constructed. Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Page 30

Before reading, ask if students have ever walked on a trail.

Know the Science

Why are landfills lined with clay and plastic? *To isolate the trash from the soil and groundwater.*

A landfill is not a compost pile or a dump. A compost pile is designed to bury organic material to decompose quickly and replenish the soil. A dump is an open hole where trash is buried. The purpose of a landfill is not to create compost, but to store waste and isolate it from the soil and groundwater. Garbage in a landfill does slowly decompose, but it is not used to replenish soil.

After students have read the page, probe students for understanding of what happens to a landfill after it has been filled. Ask the following:

- » How long can it take for a landfill to become full? (*fifty years or more, depending on the size of the landfill*)
- » What happens to a landfill after it is full? (*It is covered with layers of soil and left alone; it can eventually become a park or trail.*)

3. Teach Core Vocabulary.

5 MIN

Word Work

- **biodegradable:** (adj. describing material that decays through the action of bacteria or other living organisms) Break *biodegradable* into its word parts: *bio* means “life,” *de* means “down,” *grad* means “to walk, go, or step,” and *able* is an adjective suffix. *Biodegradable* is to break or step down living things.
- **contaminated land:** (n. land that contains chemicals that are harmful to the environment) Discuss areas of contaminated land, such as Love Canal, New York, where a waste dump site contaminated an entire town and resulted in elevated cancer rates.
- **landfill:** (n. a place where waste is buried underground) Identify local landfills.

4. Facilitate the activity and discussion.

10 MIN

Activity Page



AP 10.1

Distribute Making a Waste-Free Lunch (AP 10.1) to each student. Read over the directions with students, answer any questions they may have, and check for understanding. Give students time to complete the activity.

SUPPORT—Direct students back to the picture on page 28. It may be helpful to have an example of a lunch of things that can be easily swapped out with items that can be reused, for example, a brown paper bag and a reusable lunch box; a single-serving bag of chips with a reusable cloth bag; a sandwich in a reusable box instead of plastic wrap; a reusable water bottle instead of a single-serving juice box. Show online resources for more ideas.

As students finish drawing their lunches on the Activity Page, allow them to share their ideas with the class. Ask the following:

- » What do all of these lunches have in common? (*They have reusable items instead of recyclable or single-use items.*)
- » Do you think it would take more time or more money to pack a waste-free lunch? (*It could. Reusable items cost more than the single-use items, and that it takes time to clean these items between uses.*)

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

5. Support the investigation.

10 MIN

Activity Page



AP 10.2

Assign students a partner, and distribute Examining Contaminated Land (AP 10.2) to each student. Read over the procedure with students, and answer any questions they may have. Distribute two paper cups of soil, gloves, a magnifying glass, tweezers, and a small piece of plastic to each pair of students.

Have students observe the plastic, draw it, and then bury it halfway down in the center of the cup.

Next, peel the banana, and cut a piece of the skin and a piece of banana for each pair of students. Have students repeat the process, burying the banana peel and the piece of banana in the cup of soil.

Explain that students will leave the cups alone for a few days and then will examine the materials to see if they have changed. Have students predict which of the materials they buried in the soil are biodegradable. Discuss how using biodegradable and reusable materials can reduce land contamination.

SUPPORT—For best results, be sure the soil in the cups stays moist.

6. Check for understanding.

5 MIN

Activity Pages



AP 10.1

AP 10.2

Answer Key

Formative Assessment Opportunity

See the Activity Page Answer Key for correct answers and sample student responses.

- Collect the completed Activity Pages. Scan to see if students understand the items that can be used in a waste-free lunch. Address any misconceptions before beginning the next lesson.
- Discuss the Examining Contaminated Land activity and how each item placed in the soil could contaminate it. (*Organic materials such as the banana will break down into soil and change its composition. Some organic materials are composted and improve the soil. Other materials, such as old paint or laundry soap, can have an adverse effect on the soil. Solid waste materials including plastics, glass, and other solid materials may take years to break down and also change the composition of the soil.*)

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- explored the definition of *land contamination*
- considered how waste can be disposed of properly

LESSON 11

Living Off the Land

Big Question: How can human activity contaminate land?

Problem-Based Learning Project: Investigate the human activities that contaminate land to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe ways that living things depend on land.
- ✓ Describe the positive and negative effects of human activity on land.

Lesson Activities

- reading
- student activity and observation
- class discussion and writing
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information as they read to identify positive and negative effects of land use. Students evaluate the effects of mining on land by making a model and communicating what they observed. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from the Student Reader and a student activity about how land is used by people. Students will describe the positive and negative effects of land use, including the effect on living things.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

biodegradable
crop rotation

green space
no-till farming

survey

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 6

Activity Pages



AP 11.1

AP 11.2

Student Reader, Chapter 6
“Living Off the Land”

Activity Pages
Ways Humans Contaminate
Land (AP 11.1)

Modeling Strip Mining
(AP 11.2)

Make sufficient copies for your
students prior to conducting
the lesson.

Materials and Equipment

Collect or prepare the following items:

- 500 mL glass beaker (1 per student pair)
- damp sand
- river stones (1 per student pair)
- paper towels
- chopsticks rubber-banded together for ease of use (1 per student pair)
- index cards for student vocabulary deck (4 per student)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can human activity contaminate land? Explain that in the previous lesson, students learned that putting garbage into the land can cause contamination. Ask students to think of some other ways that land could be contaminated. To build on what students learned in Lesson 10, and activate background knowledge, ask the following:

- » What resources do we get from the land? (*chemicals, gems, rocks, oil, gas, gold, silver, steel*)

- » What types of food do we get from land? (*We get fruits and vegetables from the land. Cattle also need land to graze.*)
- » Is there any way that frozen land can become contaminated? (*Companies dig for oil in frozen land, and if it spills, it can cause land to become contaminated.*)

Problem-Based Learning Project: To build a knowledge base for the capstone lesson, explain to students that in this lesson, they will learn about how people use land in different ways. Students will learn about different causes of land contamination and the effects of it. Students will examine the effects of mining on the land.

2. Teach Core Vocabulary.

5 MIN

Prepare Core Vocabulary Cards

Write the following Core Vocabulary words on the board or chart paper:

crop rotation **green space** **no-till farming** **survey**

Instruct students to write each term in the top left corner of an index card (one term per card).

Word Work

Discuss the individual words in each vocabulary term, and ask students to predict what the compound means. As students complete the reading, have them add definitions to their cards.

- **crop rotation:** (n. the practice of changing the type of crop grown in a field each season)
- **green space:** (n. land that is set aside and left without buildings)
- **no-till farming:** (n. the practice of harvesting only the part of the plant needed for food and leaving the rest in the soil)
- **survey:** (n. a determination of land boundaries)

3. Read and discuss: “Living Off the Land.”

20 MIN

Activity Page



AP 11.1

Student Reader



Ch. 6

Begin by distributing a copy of Ways Humans Contaminate Land (AP 11.1) to each student. Read the directions on the page with students, and explain that as they read, they will complete the chart, taking notes to describe each of the ways that humans use land and describing the effects of each of them.

Next, read together, or have students read independently, “Living Off the Land,” Chapter 6 in the Student Reader. The selection reinforces the idea that human activity affects the land and that contaminated land can affect living things and their ecosystems.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 31

After students have read the page, explain that all living things depend on land. Ask the following:

- » What do people need to do to land to build a home or apartment? (*tear down the trees, pour concrete slab, and build the house*)
- » What other animals build their homes underground? (*moles, prairie dogs, toads, ants, sand crabs*)
- » What happens to an animal if the land where it lives becomes contaminated? (*It would have to find a new home or could die.*)
- » What happens to a plant if the land becomes contaminated? (*It may not be able to grow.*)

Page 32

After reading the page, review the meaning of the word *survey*. Ask students to write the definition on the Core Vocabulary card that they prepared. Ask the following:

- » Why is a land survey important? (*so that people can know if it is OK to build there*)
- » What types of tools help people conduct surveys? (*lasers, radar, cameras*)

Assist students as they work as a whole class to complete the first row of the table on Ways Humans Contaminate Land (AP 11.1). Be sure that students understand that there are positive effects to building on land or people would not do it. By building on land, people have schools to learn in, hospitals to help people, roads to drive from place to place on, and houses to live in as positive effects. The negative effects, though, are that plants and animals living on the land are disturbed.

Page 33

After reading the page, probe for understanding of the vocabulary words. Ask students to write the definition of *crop rotation* and *no-till farming* on the Core Vocabulary cards that they prepared. Ask the following:

- » How can rotating crops help soil? (*It keeps the nutrients from being depleted from the soil.*)
- » How can no-till farming keep soil healthy? (*It keeps it from eroding.*)
- » What can cause soil to erode? (*wind, water*)

Assist students as they work as a whole class or with a partner to complete the second row of the table on Ways Humans Contaminate Land (AP 11.1). Be sure students can name positive and negative effects of using land for farming. Students should describe that without farms, people would not have food to eat, but students should explain some ways that using land for farming can harm it, such as depleting the nutrients and causing soil to erode. (See **Know the Science 1.**)

Page 34

Before reading this page, ask students to name some resources that people get from Earth by mining. Make a list on the board or chart paper. Do research to find if there are any mines in the community and what they mine for. (See **Know the Science 2.**)

After reading this page, ask the following question to probe for understanding:

- » How do strip mines contaminate land? (*They leave behind waste materials that build up over time.*)

Assist students as they work with a partner or individually to complete the third row of the table on Ways Humans Contaminate Land (AP 11.1) to describe the positive and negative effects of using land for mining. Students will build on their understanding of how mining effects land in the activity following the reading, so there is no need to discuss in great detail at this point in the lesson.

Page 35

After reading this page, discuss some reasons that people may clear land. Ask the following:

- » When people clear the land, how does it affect the ecosystem? (*Animals may have to move and plants die; the ecosystem will change.*)
- » How does the soil change when the trees are removed? (*It can become blown or washed away easily.*)

Page 36

After reading this page, discuss the meaning of *green space*. Ask students to write the definition of *green space* on the Core Vocabulary card that they prepared. Ask the following:

- » Are there any green spaces in your community?
- » How does green space help ecosystems? (*It protects them and the plants and animals in them.*)

Know the Science

1. What are the effects of soil erosion? Fertile topsoil is displaced. Erosion by water, wind, or tilling the soil causes topsoil to move, which reduces the productivity of crops and contributes to water pollution if the soil collects in water sources. Farmers have learned how to care for soil by learning from the mistakes made in the past. During the Dust Bowl in the 1930s, for example, millions of acres of land were plowed. Then with lack of rain and windstorms, the soil was eroded. People could no longer productively farm the land and had to move.

2. What resources are mined? Geological materials, including rocks, gemstones, precious metals, coal, salt, clay, and oil. Through mining, people obtain material buried underground that cannot be grown or created in a laboratory. People mine for metals and rocks for building materials; nonrenewable resources like petroleum, natural gas, and water; and precious metals and gemstones such as gold and diamonds.

Assist students as they work with a partner to complete the final row in the table on Ways Humans Contaminate Land (AP 11.1). Students may need prompting to think of a negative effect of green space. Explain that land that is used for green space may not be used by people and that some may view that as a negative effect, especially if that land is desirable for building, mining, fishing, or other uses.

4. Facilitate the activity.

10 MIN

Activity Page



AP 11.2

Distribute a copy of Modeling Strip Mining (AP 11.2) to each pair of students.

Ensure the success of the activity by preparing the materials ahead of time. Place a large river rock in a beaker, and pat down damp sand on top of it. Level the sand so that students can easily measure the volume using the scale on the beaker and so that the surface is flat with no cracks in it. Prepare an identical beaker for each pair of students. Prepare a pair of chopsticks for each pair of students by placing a rubber band around them.

Read the directions on the Activity Page, check for understanding, and answer any questions students may have before they begin. Remind students to draw and write their observations of the beaker before doing anything.

Distribute the beaker, paper towel, chopsticks, and magnifying glass to each pair of students. Circulate as students complete the activity.

Students who complete the activity should begin answering the discussion questions with their partner. Pair partners together to form groups of four to complete the discussion questions.

As all students finish the activity and finish recording their observations, reconvene the class to discuss the answers to the discussion questions together. Call on groups to share their answers to the questions with the class. Be sure that students can explain what each part of the mining model represented.

5. Check for understanding.

5 MIN

Activity Pages



AP 11.1

AP 11.2

Answer Key

Formative Assessment Opportunities

- Collect Ways Humans Contaminate Land (AP 11.1), and scan to see that the table is complete.
- Collect Modeling Strip Mining (AP 11.2), and scan to see that the discussion questions have been correctly completed. Answer any questions, and address any misconceptions you notice as you check over student answers to these questions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified sources of land contamination
- considered how to avoid or limit land contamination

Researching Use of Land Resources

Big Question: How can we find information about contamination?

Problem-Based Learning Project: Investigate best practice uses of land resources to support determination of recommended actions to reduce negative impacts on ecosystems.

AT A GLANCE

Learning Objectives

- ✓ Describe the types of materials that cause damage to land.
- ✓ Research and describe ways land is used in the community.

Lesson Activities

- observation and student activity
- research and writing
- vocabulary instruction

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information from several sources to evaluate and communicate the ways that land is used in their community. Students will research to identify the impact of human activities on land in their community and communicate ideas for how to reduce the impact of land contamination. Communicating information is an essential step in the scientific process, and students must acquire the skills to communicate clearly, effectively, and with credibility.

In this lesson, students obtain, evaluate, and communicate information from online resources about land use in their local community. Students will examine how materials break down over time when buried in soil. Students will then identify ways that humans impact the land in their community.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to this term, which is not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

biodegradable

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary term designated in purple above.

Instructional Resources

Activity Pages



AP 10.2
AP 12.1

Activity Pages

Examining Contaminated Land (AP 10.2)

Researching Community Land Use (AP 12.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- detailed blackline map of the community that includes parks, landfills, farms, highways
- markers or crayons (5 different colors)
- gloves (1 set per student pair)
- paper towels
- magnifying glasses (1 per student pair)
- tweezers (1 per student pair)
- droppers of water (1 per student pair)
- paintbrushes (1 per student pair)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

15 MIN

Activity Page



AP 10.2

How can we find information about contamination? Begin by revisiting the student activity from Lesson 10, Distribute Examining Contaminated Land (AP 10.2), which students began previously.

Have students work with the same partner from Lesson 10 and retrieve their cups of soil in which they buried the piece of plastic, piece of banana, and banana skin. Give each pair of students gloves, a paper towel, a magnifying glass, and tweezers. Instruct students to carefully remove the piece of banana skin and piece of plastic from each of the cups and place them on the paper towel. Give students a dropper with a few drops of water and the paintbrush to brush the dirt from the items so that they can observe them. Tell students to draw each of the items in the space provided on the Activity Page. (See **Know the Science.**) Ask the following:

- » How did each of the items change?
- » Which of the items would contaminate the land and why? (*The plastic would contaminate the land because it would not break down over time.*)
- » How could people protect land from contamination from items such as this? (*Do not use plastic items, but if you do, recycle them, and participate in clean-up activities to remove items such as this from the land.*)
- » Are there any items that can be added to land to help improve it? (*Biodegradable materials, such as banana peels and banana, can add nutrients to soil.*)
- » If there were many little bits of plastic or other contaminants in the soil, how do you think it could be removed? (*sifting*)

Problem-Based Learning Project: To develop a knowledge base for the capstone lesson, students engage in research to obtain information about sources of land contamination and how people have used scientific ideas and technology to avoid or limit land contamination. Students will then identify ways that humans impact land contamination in their community.

2. Encourage discussion.

5 MIN

Encourage students to think about ways that their actions affect the land, either directly or indirectly. Discuss examples that students share.

Know the Science

How can contaminated land be cleaned? When there is too much contamination in the soil to simply pick up, what can people do? Scientists have developed ways to treat contaminated land using technology. One method is heating the soil to high temperatures using a kiln. The soil must be removed from the site to do this, though. Another method is by adding microorganisms, such as bacteria, to the soil to break down the contaminants. Scientists can also use chemicals to produce a reaction in the soil that neutralizes harmful chemicals that may have contaminated the soil. Or scientists can physically remove the contamination from the soil.

3. Teach Core Vocabulary.

5 MIN

Revisit Core Vocabulary Card

Have students retrieve the Core Vocabulary card for **biodegradable**.

Discuss the meaning of the word *biodegradable*. Explain that the banana is an example of a biodegradable item because it began to break down naturally when placed in the soil. Instruct students to write the definition of *biodegradable* in their own words on the front of the card. Have students give several examples of items that are biodegradable on the back of the card. Ask the following:

- » What do biodegradable items have in common? (*They are made of natural materials or are types of food.*)
- » What other words have *bio* in them? (*biology, biography, biome, antibiotic*)
- » What does *bio* mean? (*life*)
- » What does *biodegradable* mean? (*breaking down of living and nonliving materials into natural materials by decomposers*)

4. Conduct research.

15 MIN

Activity Page



AP 12.1

Display the USGS National Map of your location and tell students that they are going to determine how land is used in your community. Distribute the blackline map and five colors of markers or crayons. Have students examine the map with a partner. Instruct students to mark up the map as follows:

- roads and highways: blue
- buildings such as houses, offices, schools: yellow
- farms: orange
- mines: purple
- parks and preserves: green

Distribute Researching Community Land Use (AP 12.1) to each student. Give students time to complete the circle graph to describe how land is used in their community. Circulate around the room, and assist pairs of students as they make the graph and answer the questions that follow. Discuss answers to students' questions as a class.

Online Resources



Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

SUPPORT—You may need to remind students that the parts of a circle graph must add up to 100 percent. All land is 100 percent. Students may need help to estimate what each part of land in the community is used for. Help students decide that if half of the land is colored yellow, then about 50 percent of land in the community is used for housing.

Ask the following questions to help students consider ways to help reduce land contamination in their community:

- » Where do you think most land contamination happens in your community? Explain why.
- » How can your community improve the way that it uses land?

5. Check for understanding.

5 MIN

Activity Page



AP 12.1 and
Answer Key

Formative Assessment Opportunity

See the Activity Page Answer Key for suggested answers and sample student responses.

- Collect the Activity Page, and check to see that students completed the questions and that their graph reflects the map that they colored. Address any misconceptions or incomplete responses before moving on to the next lesson.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified community land use and potential land contamination
- considered how to address land contamination

LESSON 13

Land Resource Action Plan

Big Question: How can we protect land from contamination?

Problem-Based Learning Project: Recommend actions to reduce negative impacts of human activity on land.

AT A GLANCE

Learning Objectives

- ✓ Identify sources of land contamination in the community.
- ✓ Create a plan to improve land use in the community.

Lesson Activities

- research and writing
- teacher-led discussion

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information from several sources to communicate a problem that affects the land in their area. Students will research to develop a plan to communicate ideas for how to reduce the impact of human actions on land and how it is used in their community. Obtaining information from reliable sources is an important part of the scientific process. Students should use reliable sources when conducting research and gathering information. When students develop their action plan, they should be careful to include facts and keep their plan free of opinions in order to pass on reliable scientific information to their community.

In this lesson, students obtain, evaluate, and communicate information from online resources about problems with land contamination and land use in their community and develop solutions for those problems. Students create a plan for ways to include this information in the ongoing project to develop a community information board.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

biodegradable contaminated land green space

Instructional Resources

Activity Pages



AP 1.1
AP 13.1
AP 13.2

Activity Pages
Community Information Board (AP 1.1)

Community Planning (AP 13.1)

Land Use Action Plan (AP 13.2)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items for each pair of students:

- internet access for students to conduct research
- scissors
- glue
- green paper

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How can we protect land from contamination? Open this lesson by reviewing what students have learned about land contamination, land use, and how land is used in their community.

Use the following questions to prompt discussion:

- » What causes land to become contaminated? (*garbage, mines, chemicals*)
- » What things are necessary to use land for? (*houses, schools, hospitals, farms, mines, roads*)
- » Can you think of some things that people can do once land is contaminated? (*remove the contamination by sifting the soil or by adding bacteria or chemicals to the soil*)

Problem-Based Learning Project: To wrap up Part D of this unit, students engage in obtaining information about local land use. For the capstone lesson, students evaluate this information to develop an action plan to explain to their community ways that they can reduce land contamination in their area. Students explain their plan on the first part of the community information board.

2. Facilitate the activity.

15 MIN

Activity Page



AP 13.1

Distribute a copy of Community Planning (AP 13.1), scissors, and glue to each student. Read the directions with students. Check for understanding, and answer any questions that students may have.

Give students time to complete the activity. Collect the materials as students finish. When students have completed the activity, discuss the answers to the following questions together.

Ask the following:

- » Was there any land that was not used for building on? How could this land be used?
- » Did the river and the mountain on the land influence your placement of any of the elements? If so, why?
- » Why is it important to plan how land should be used before people build on it? (*Once an area is designated for a certain type of use, it can take a long time to use it for something else.*)
- » How does land use affect ecosystems? (*It disturbs organisms living on the land.*)
- » Why is green space so important? (*so that the animals that have been displaced can have a place to live*)

SUPPORT—Students can work with a partner to complete the activity if necessary. Point out the landmarks already in the space. Ask students to consider them when placing the elements of their city. If students need assistance determining the value of planning land use, make a scenario where they will need to change an element in their city, and let them see that this would be difficult to do.

3. Encourage discussion.

10 MIN

Activity Page



AP 1.1

Distribute Community Information Board (AP 1.1) from previous lessons to each student. Explain that students will begin working on the community information board section on land use. Have students recall that they will be acting like the EPA by providing information for their community about how people can be better stewards of the land.

Have students recall all that they have read and learned about how land is used and how it can become contaminated. Ask students to answer question 6 by describing a problem with the way that land is used or with land contamination in their community.

SUPPORT—To help students think about problems with land, ask them to recall the places on the community map that contribute to land contamination. Have students think of ways that people in the community contribute to the problem.

Next, ask students to brainstorm ideas for protecting land. Students may come up with ideas such as putting less waste in landfills by reusing and recycling materials, setting aside more green areas, building public transportation so that fewer roads are needed, and using electric cars so that less gasoline is used. Have students write a few ideas beside question 7. Students will use it in the next step.

4. Support the investigation.

10 MIN

Activity Pages



AP 1.1

AP 13.2

Remind students of what a plan is and why it is necessary. Explain that the community information board that students will make will include a problem and a plan for their community to decrease the amount of land that is contaminated or to use land more responsibly. (See **Know the Science.**)

Allow students to refer to the Community Information Board (AP 1.1) as they work through this lesson. Introduce Land Use Action Plan (AP 13.2). Explain to students that they will use the Activity Page as a planning page to refer back to when putting together their community information board.

Go over the directions with students, and explain that the activity will build on their learning in the previous lessons in the unit.

SUPPORT—If needed, review or provide an example plan or an outline to guide struggling students.

Assist students as they complete the plan.

Lead a discussion about the Activity Page. If needed, prompt students with the following questions:

- » What land problem did you describe?
- » What are the main challenges to protecting land?
- » What are some possible solutions for protecting land in your community?

SUPPORT—Encourage students to consider several approaches to protecting land from contamination in their community. Try to ensure that, as a class, students choose a variety of problems with land for their library research. In their plan, students should focus on one problem with land use and include a variety of approaches for its management. Remind students that the solutions that they develop should be real solutions that people in the community can do to help.

Know the Science

Why develop a plan to protect the land? *When land is not conserved, many different ecosystems suffer. The number-one reason that animals become endangered is habitat loss.* Although today, most communities are carefully planned before they are built, this was not always the case. When chemicals, garbage, or other pollution is dumped on land, it is difficult to restore that land to be used in other ways. Green areas must be left so that organisms have a place to live.

5. Check for understanding.

5 MIN

Activity Pages



AP 13.2
AP 1.1
Answer Key

Formative Assessment Opportunity

After students have completed the activity, collect the completed Land Use Action Plan (AP 13.2). Review students' plans, and identify any misconceptions that you notice. Collect Community Information Board (AP 1.1) and hold it until it is needed again for planning in the upcoming lessons.

Have students summarize what they have learned about protecting land from contamination and how to plan the use of land in the community, asking them to consider the Big Question: **How can we protect land from contamination?** Ensure that students use information from the activity as evidence.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- identified local land use problems
- developed a plan for avoiding or limiting land contamination

PART E

Taking Local Action

OVERVIEW

Lesson	Big Question	Advance Preparation
14. Sharing the Environment	How do human activities that affect water, air, and land impact ecosystems?	Read Chapter 7 in the Student Reader.
15. Researching Environmental Protection	How can we protect land ecosystems from negative consequences of human activities?	Provide research opportunities.
Ecosystem Protection Action Plan	How can we protect an ecosystem from negative consequences of human activities?	Provide research opportunities.

Part E: What's the Story?

In this Problem-Based Learning Project unit, students learn about water, air, and land resources and threats to those resources. Throughout the unit, students identify potential ecosystem threats to their local community and develop action plans to address those threats. Part E focuses on developing an action plan to address an environmental threat to the local community.

In Lesson 14, students consider the interaction of Earth's spheres and human impact on them, evaluating the positive and negative relationships between human activity and local ecosystems.

In Lesson 15, students research reliable sources to develop a solution that addresses negative impacts of human activities on the local environment.

In the Unit Capstone, students develop an action plan to address negative impacts of human activities on the local environment.

So, to repeat, students use what they have learned about the importance of natural resources, human impacts on natural resources, and ways to control or limit negative effects to **develop an action plan that addresses a specific environmental issue in their local community**.

This set of lessons comprehensively meets the NGSS Performance Expectation 5-ESS3-1.

LESSON 14

Sharing the Environment

Big Question: How do human activities that affect water, air, and land impact ecosystems?

Problem-Based Learning Project: Investigate effects of human activities on ecosystems to support determination of recommended actions to reduce negative impacts.

AT A GLANCE

Learning Objectives

- ✓ Describe an example of an ecosystem, including ways in which components of the system interact.
- ✓ Obtain information from reliable sources to explain positive and negative relationships between human activity and ecosystems, including living and nonliving resources.

Lesson Activities

- reading and discussion
- vocabulary instruction
- observations
- writing

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students obtain information from the Student Reader about the interaction of Earth's spheres and human impact on them. Students then evaluate the information and identify positive and negative relationships between human activity and ecosystems that they will apply to describing problems in their local community.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 167–168 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

biodiversity

ecosystem

interaction

Core Vocabulary Deck: As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

Instructional Resources

Student Reader



Ch. 7

Activity Pages



AP 14.1

AP 14.2

Student Reader, Chapter 7
“Sharing the Environment”

Activity Pages

Interacting Spheres (AP 14.1)

Positive and Negative (AP 14.2)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- index cards for student vocabulary deck (2 per student)

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

How do human activities that affect water, air, and land impact ecosystems?

Review with students the spheres they studied in the previous unit: biosphere, hydrosphere, atmosphere, and geosphere. Discuss how these spheres interact. Then review the types of water, air, and land resources students have studied and ways in which they can be contaminated.

Use the following questions to prompt discussion:

- » What are the resources we have studied? (*water, air, and land*)
- » What are ways in which each resource can be contaminated? (*Waste materials and erosion pollute water; emissions pollute air; soil deposition and mining can harm land.*)

» How is land important to plants? (*Many plants grow in soil and get the nutrients they need to grow from it.*)

Write *air*, *land*, and *water* on the board or chart paper. Then have students identify which of Earth's spheres is related to each of the resources. (*air—atmosphere, land—geosphere, water—hydrosphere*)

Have students describe the biosphere, which is the living parts of Earth.

Problem-Based Learning Project: To begin work on the capstone activity for this unit, students obtain information from the Student Reader about the interaction of Earth's spheres and human impact on them. Students then identify positive and negative relationships between human activity and ecosystems that they will apply to describing problems in their local community.

2. Read and discuss: "Sharing the Environment."

15 MIN

Preview Core Vocabulary Terms

Write the following Core Vocabulary terms on the board or chart paper. Have students pay special attention to these terms as they read:

biodiversity **ecosystem** **interaction**

Student Reader



Ch. 7

Read together, or have students read independently, "Sharing the Environment," Chapter 7 in the Student Reader. The selection describes how Earth's spheres interact and discusses human impacts on each sphere.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 37

After students have read the page, discuss the definition of each sphere, and have students recall what they learned in Unit 3.

Next help students recall examples of the components of each sphere. (*geosphere: rocks, soil, coal, silver; hydrosphere: rivers, lakes, rain; atmosphere: oxygen, ozone, carbon dioxide, water vapor; biosphere: humans, bees, whales, trees, grass*)

SUPPORT—Emphasize that everything on Earth is part of one of the spheres. For example, every living thing makes up the biosphere, and water in all its forms makes up the hydrosphere.

Page 38

After reading this page, discuss student experiences with the interaction of Earth's spheres. For example, have students identify how the atmosphere changes when a thunderstorm is coming and how rain affects the geosphere and biosphere.

Page 39

After students have read the page, have students write the definitions of the three Core Vocabulary words on the correct vocabulary card.

Then discuss students' experience with plant populations and how they have changed an environment. In some places, for example, trees have died from disease or infestations, and other plants have replaced them. In other places, certain types of plants, such as grasses or trees, have crowded out other types of plants. Discuss what changes to plants have occurred in the local community.

Page 40

After students have read the page, ask students about their personal observations of how animal populations have changed in the community. (See **Know the Science.**)

- » How have birds changed our environment? (*Migrating birds may inhabit an area for a time and leave their waste.*)
- » How do ants affect the geosphere? (*They build hills and change the landscape.*)

Pages 41–42

Before reading, discuss the positive and negative aspects of fire. (*positives: energy and heat; negatives: destruction*)

After reading, discuss some ways in which forest fires start. (*lightning, unattended campfires, and not extinguishing matches or cigarettes in a dry environment*)

Then draw conclusions about positives and negatives of forest fires. (*positives: clear land; negatives: destroy habitats, plants, and property*)

Pages 43–44

Following the reading, discuss ways in which students can affect the environment positively and negatively. (*positive: planting trees, recycling, managing waste; negative: wasteful car emissions, using disposable products, wasting water*)

3. Teach Core Vocabulary.

5 MIN

Prepare Core Vocabulary Cards

Draw students' attention to the Core Vocabulary terms displayed earlier in the lesson.

biodiversity ecosystem interaction

Have students locate the card they prepared for *ecosystem* in Lesson 1 and prepare new cards for the other two terms.

Know the Science

How do earthworms change the environment? *They improve soil nutrients and drainage.*

Earthworms feed on dead roots, grasses, and leaves. Their waste adds to the soil nutrients. Their bodies decompose quickly, which also adds nutrients to soil. In addition, they burrow through soil and loosen and aerate it, which improves soil drainage. Earthworms have a big impact on improving garden and farm productivity. In some areas such as Minnesota, common earthworms are invasive and have caused changes in the soil environment.

Word Work

- **biodiversity:** (n. the variety of species on Earth or in any one environment on Earth) List the different plants and animals students can identify in the schoolyard.
- **ecosystem:** (n. all the living and nonliving things that interact in a given area) Have students list some ways the plants and animals in the schoolyard interact.
- **interaction:** (n. a relationship in a system through which factors affect each other) Ask students to describe personal interactions in which one action is influenced by another action, as in a conversation.

4. Facilitate the activity and encourage discussion.

15 MIN

Activity Pages



AP 14.1
AP 14.2

Distribute Interacting Spheres (AP 14.1) to each student. Read over the directions with students, and answer any questions they may have. Give students five minutes to complete the activity, and then have them discuss and compare their answers.

SUPPORT—Reinforce that students are part of an ecosystem and continually interact with all of Earth’s spheres.

Next distribute Positive and Negative (AP 14.2), and have students work in pairs to complete the activity. Use students’ responses to make a class list of positive and negative relationships humans have with ecosystems.

5. Check for understanding.

5 MIN

Activity Pages



AP 14.1
AP 14.2

Answer Key

Formative Assessment Opportunity

- Collect the completed Activity Pages. Scan to see if students understand that they can interact positively and negatively with all the living and nonliving things in their area. Address any misconceptions before beginning the next lesson.
- See the Activity Page Answer Key for sample student responses.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- explored interactions among spheres in their area
- considered how the local ecosystem is impacted positively and negatively by human interactions

Researching Environmental Protection

Big Question: How can we protect land ecosystems from negative consequences of human activities?

Problem-Based Learning Project: Investigate effects of human activities on ecosystems to support determination of recommended actions to reduce negative impacts.

AT A GLANCE

Learning Objectives

- ✓ List several sources of ecosystem threats and describe how each may harm the environment.
- ✓ Describe how people have used scientific ideas and technology to protect Earth's ecosystems.
- ✓ Prepare a presentation for the community about ecosystem threats and proposed solutions.

Lesson Activities

- research
- discussion
- writing

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning to design a solution that addresses negative consequences of human activities. In this lesson, students research reliable sources, distinguishing from unreliable sources to find evidence related to human activity and ecosystems and how people have used scientific ideas and technology to protect Earth's ecosystems. Students use the evidence to infer whether the human activity has a negative or positive impact on living and nonliving resources.

Students use their research to develop a solution or evaluate an existing solution that addresses negative impacts of human activities on the local environment.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

action plan

environmental protection

Instructional Resources

Activity Pages



AP 15.1
AP 15.2
AP 15.3

Activity Pages

Positive and Negative Impacts (AP 15.1)

Researching Environmental Protection (AP 15.2)

Lesson 15 Check (AP 15.3)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect the following items:

- images of unspoiled ecosystems
- images of human activities that negatively affect ecosystems
- images of human activities that positively affect ecosystems
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

Online Resources



How can we protect land ecosystems from negative consequences of human activities? Engage students by showing images of unspoiled land ecosystems, including forest, desert, grassland, and tundra. Show students images of impacts on each of the ecosystems (such as forest/logging, desert/urbanization, grassland/agriculture, and tundra/pollution). Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to these resources may be found:

www.coreknowledge.org/cksci-online-resources

Ask students why these ecosystems need to be protected. If needed, prompt students to explain that ecosystems together make up the biosphere and support all forms of life, including people. Use the following questions to brainstorm about how land ecosystems are affected by negative consequences of human activities:

- » What happens to forests when people cut down trees? (*Wildlife has less food and space to live.*)
- » What happens to deserts when people build houses and shopping malls? (*Wildlife has less water and space to live.*)

- » What happens to grasslands when the land is used for farming? (*Wildlife has less food and space to live.*)
- » What happens to tundra when those areas are polluted? (*Animals can be poisoned, and plants can die.*)

Problem-Based Learning Project: Students consider what they have learned about threats to water, air, and land in their local communities to develop an action plan to address a specific problem in the local community. Students will present this plan to representatives of the community in the capstone lesson. In developing the action plan, students engage in evidence-based scientific reasoning to design a solution or evaluate an existing solution that addresses negative consequences of human activities. In this lesson, students research reliable sources, distinguishing from unreliable sources to find evidence related to human activity and ecosystems and how people have used scientific ideas and technology to protect Earth's ecosystems. Students use the evidence to infer whether the human activity has a negative or positive impact on living and nonliving resources.

To help students brainstorm, show them the images of human activities that negatively affect ecosystems. Guide students to develop connections between images of unspoiled ecosystems and the images of human activities that negatively affect ecosystems. Discuss the connections with specific examples, where possible using examples from ecosystems in their local area.

Together summarize the discussion. Then list various examples of specific negative consequences of human activities on land ecosystems. Explain to students that they will use library time to research positive and negative relationships between human activity and ecosystems and how people have used scientific ideas and technology to protect Earth's ecosystems.

2. Encourage discussion.

10 MIN

Activity Page



AP 15.1

Challenge students to think about how they could research reliable sources to explain positive and negative relationships between human activity and ecosystems and to find information on how people have used scientific ideas and technology to protect Earth's ecosystems. (See **Know the Science** on the following page.) To focus students' research, ask the following questions:

- » How can we distinguish reliable versus unreliable sources?
- » How can we distinguish positive and negative relationships between human activity and ecosystems?
- » What kinds of scientific ideas and technology could be used to protect Earth's ecosystems?

SUPPORT—Use the images as a prop for students to begin their research. If needed, provide one or two examples to help students connect concepts about human activity and ecosystems with people's use of scientific ideas and technology to protect Earth's ecosystems. Show the images of human activities that positively affect ecosystems as prompts to direct their research on specific examples, preferably using examples from ecosystems in their local area.

You don't need to go into this level of detail with students. However, it may help to engage students if they understand that the purpose of protecting land ecosystems from negative consequences of human activities is to ensure the long-term survival of the natural world that we so admire and depend upon. (See **Know the Science.**)

Introduce Positive and Negative Impacts (AP 15.1). Write the following words in random order on the board or chart paper: *deforestation, global warming, hunting, mining, pollution, recycling, renewable energy, replanting, and wildlife protection.*

Ask students to sort the words into positive and negative impacts of human activities. Then ask students to match the appropriate method of environmental protection to each negative effect that it addresses, writing the correct match in the space on the Activity Page. Discuss students' responses.

3. Support the investigation.

25 MIN

Activity Page



AP 15.2

Distribute and introduce Researching Environmental Protection (AP 15.2) to organize the presentation for the capstone lesson. Engage students by asking them to think about how they can personally have a positive impact on ecosystems. Explain to students that they will complete the Activity Page based on what they have learned so far in this lesson and that they will use the Activity Page as instructions to complete an investigation and as a recording sheet to note their findings.

Know the Science

Why should we protect ecosystems from negative consequences of human activities? All life depends on a healthy worldwide environment. Students may be familiar with images or videos highlighting the beauty and wonder of the natural world. Scientists recognize that this bountiful life we see around us is connected in a myriad of ways. All life on land is dependent on nonliving components of ecosystems. Plants depend on sunlight, water, and nutrients. Organisms are connected by food webs starting with primary producers that create food from the sun's energy, carbon dioxide, water, and nutrients. From them, energy flows (in the form of food) to primary consumers (plant-eating animals). These are food for secondary consumers (predators). The energy from all these organisms in turn moves to decomposers, which facilitate the cycling of energy and nutrients in the ecosystem. Within the food web, additional relationships exist between animals—connected by predator-prey relationships and symbioses, such as parasitism and mutualism. In these complex patterns, the world of the living and nonliving are intricately connected so that disruption of one part of an ecosystem inevitably affects other parts of the ecosystem. Scientists use knowledge of these relationships and connections to inform lawmakers and develop projects and programs that protect ecosystems. For example, if predators are not protected from hunting, herbivore populations can increase, degrading the vegetation and reducing the number of species able to survive. If an area is deforested, less energy is available for primary consumers, decreasing their populations and again reducing the number of species able to survive. These are generalizations, but many specific examples have been documented by scientists.

Go over the directions with students without discussing the objective or outcome. Explain that the activity will help them think about positive and negative relationships between human activity and ecosystems and how people have used scientific ideas and technology to protect Earth's ecosystems.

SUPPORT—If needed, help students by writing words related to the activity on the board or chart paper, but do not place them in any kind of context. These can include *ecosystem*, *positive*, *negative*, and *technology*. Explain to students that they should use these as they conduct the activity.

Ask students to work with a neighbor or in small groups. Describe the procedure each group should follow:

1. Choose a specific negative impact of humans on ecosystems. Preference should be given to a local impact, but impacts with global effects can also be chosen.
2. The group brainstorms to identify prior knowledge about their chosen impact and to develop questions that address remaining gaps in knowledge or understanding.
3. The group conducts library or online research to find reliable sources that address their gaps in knowledge or understanding.
4. The group brainstorms to evaluate an existing solution or to design a new solution to their chosen negative impact.
5. The group creates a visual resource to communicate their solution.

SUPPORT—You can provide more structure to students' research by suggesting that they use a K-W-L chart. This chart helps students organize prior information (what I know), possible questions (what I want to know), and key facts that can support their proposed solution (what I learned).

Lead a discussion about the procedure for the Activity Page. Be sure that students are clear on the procedure. If needed, prompt students with the following questions:

- » What negative impact will you choose?
- » What do you already know about that negative impact?
- » What questions do you have about that negative impact?

SUPPORT—If needed, suggest possible visual resources for groups to communicate their solution. Example resources include a concept map, poster, web page, slide presentation, and brochure.

4. Check for understanding.

5 MIN

Activity Pages



AP 15.1

AP 15.2

AP 15.3

Answer Key

Formative Assessment Opportunity

- Collect the completed Positive and Negative Impacts (AP 15.1) and Researching Environmental Protection (AP 15.2).
- Review students' questions, and identify any that remain unanswered.

Have students summarize what they have learned about environmental protection, asking them to consider the Big Question: **How can we protect land ecosystems from negative consequences of human activities?** Ensure that students use information from the activity as evidence.

SUPPORT—If needed, suggest to struggling students that they use the 5 W's graphic organizer to summarize what they learned about environmental protection. In this approach, students identify answers to five "W" questions:

- Who was involved?
 - What happened?
 - When did it happen?
 - Where did it happen?
 - Why did it happen?
- Distribute Lesson 15 Check (AP 15.3), and ask students to complete it independently. Once students are finished, collect the assessment, and before the start of the unit capstone, check students' answers to identify concepts that need further clarification and to provide the support needed.
 - See the Activity Page Answer Key for correct answers and sample student responses.
 - Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following in preparation for the capstone lesson at the end of the unit:

- researched and developed an action plan to address one water, air, or land environmental threat to the local community

Ecosystem Protection Action Plan

Big Question: How can we protect an ecosystem from negative consequences of human activities?

Problem-Based Learning Project: Recommend actions to reduce negative human impacts on a local ecosystem.

AT A GLANCE

Learning Objective

- ✓ Develop a plan of suggested action, based on evidence, to show how your community can protect an ecosystem in your area.

Lesson Activities

- reading
- discussion
- writing
- research

NGSS References

Performance Expectation 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems

Crosscutting Concepts: Systems and System Models; Connections to Nature of Science: Science Addresses Questions About the Natural and Material World

Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information

By **Obtaining, Evaluating, and Communicating Information**, students engage in evidence-based scientific reasoning to support a plan to protect a local land ecosystem. Students engage in hands-on activities to obtain information about local ecosystems and threats. Students evaluate this information to develop an action plan to show how their community can protect ecosystems in their area. The aim is for students to provide specific and detailed information on one or two key threats to ecosystems in their local community and to develop the most effective approaches to protection from those threats. Students create a resource to communicate their plan.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

action plan

environmental protection

Instructional Resources

Activity Pages



AP UC.1
AP UC.2
AP UC.3

Activity Pages

Classifying Ecosystem
Protection Topics (AP UC.1)

Ecosystem Protection Action
Plan (AP UC.2)

Lesson Reflection (AP UC.3)

Make sufficient copies for your
students prior to conducting
the lesson.

Materials and Equipment

Collect the following items:

- maps of the local area (from any of a variety of websites or library resources)
- images of local land ecosystems
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 45 MIN

1. Focus student attention on the Big Question.

5 MIN

Online Resources



How can we protect an ecosystem from negative consequences of human activities?

Engage students by asking them to recall the images of land ecosystems from the previous lesson. If needed, show the images again to students. Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to these resources may be found:

www.coreknowledge.org/cksci-online-resources

For each image, ask students to identify positive and negative impacts of human activities. Ask students if some of the threats to ecosystems they learned about could occur in their community. Challenge students to consider whether some of the solutions they learned about could be applied if ecosystems in their local area could be threatened or harmed in these ways. To prompt thinking, ask questions about local ecosystems and ways to protect them from various threats, such as the following:

- » How could people prevent declines in wildlife? (*create wildlife protection laws, preserve habitat*)
- » How could people prevent pollution from plastic trash? (*use reusable shopping bags and food storage containers, recycle, donate used items instead of throwing them away*)

- » How could people prevent air pollution? (*use low-emission vehicles, convert to electric heating*)
- » How could people prevent pollution from toxic chemicals (*treat water after use, dispose of chemicals properly, use rechargeable batteries*)
- » How could people be encouraged to help protect land ecosystems? (*promote education*)

Emphasize that these questions address only a limited set of threats to land ecosystems. In practice, ecosystems face a wide range of threats, requiring a wide range of solutions. (See **Know the Science** on the following page.) Explain to students that in this lesson, they will identify threats to local land ecosystems and develop a plan to address those threats.

Ask students to write on notebook paper a summary of the discussion. Guide students to use their brainstorming to list potential threats to ecosystems and ways to protect land ecosystems.

Problem-Based Learning Project: Students develop their action plans to address a threat to local water, air, or land resources, which they will prepare to present to representatives of the community.

2. Preview planning.

10 MIN

Help students to develop their conceptual understanding of a plan. Guide students by asking them to work with a neighbor to recall an activity that they have planned in the past. If needed, prompt students with an example of familiar things they may have planned, such as a vacation, birthday party, or hobby project. Use the following questions to brainstorm about essential elements of a plan:

- » What is the basic purpose of a plan? (*achieve a goal*)
- » What kinds of goals should a plan help to accomplish? (*solve a problem, answer a question*)
- » What should a plan begin with? (*statement of a problem, asking a question*)
- » How should a plan address its purpose? (*relate solutions to the problem or question*)
- » How should a plan be organized? (*problem statement, action items, schedule, budget*)

SUPPORT—Display each element of a plan to the class. If needed, review the purpose of each element and the approaches to (a) obtaining information for each element, (b) evaluating the information sources, and (c) communicating the plan. Ensure that students can relate the elements of a plan to the learning objective to develop a plan of suggested action, based on evidence, to protect a local ecosystem. The diverse facets of land ecosystem protection will challenge students to create a comprehensive plan. Students will need to focus on a specific problem that they identify during their research and then develop a plan around solutions for that problem. Consider providing students an example plan or an outline of a plan that is appropriate to their learning level.



Distribute Classifying Ecosystem Protection Topics (AP UC.1). Ask students to complete the T-chart. Students identify topics related to ecosystem threats in the left column. In the right column, students relate strategies or approaches related to the specific problem identified in the left column. Students are not expected to list all ecosystem threats and protection approaches. Encourage students to be as specific and detailed as they can on one or two key threats and the most effective approaches to protection from those threats. The aim is to check for students' conceptualization of various topics related to ecosystem threats and protection so that they can evaluate approaches to include in their action plans. Discuss the completed Classifying Ecosystem Protection Topics (AP UC.1).

3. Facilitate the activity.

20 MIN



Distribute Ecosystem Protection Action Plan (AP UC.2).

Explain to students that they will work with a neighbor to complete the Activity Page based on library research and on what they have learned in this lesson and in previous lessons in this unit. Go over the directions with students, but do not complete the activity for them. Explain that the activity will build on their learning in the previous lessons in the unit. If needed, review or provide the example plan (or an outline) to guide struggling students. Emphasize that the plan should be structured with the following elements:

- a title
- a summary: one paragraph including the problem and recommended solutions
- background or introduction: problem statement in context (i.e., why the problem affects the community and why a plan is needed to prevent or resolve the problem) and a desired goal or outcome
- recommendations: steps and approaches that address the specific problem, including diagrams (such as concept maps) or flowcharts, showing how the goal will be accomplished
- budget and schedule
- references: credible, reliable information sources

Know the Science

How do scientists inform the community about protecting local land ecosystems? Citizens and local politicians rely on credible scientific information to make decisions about community resources. They can then evaluate a range of priorities to balance the needs of people with those of ecosystems. When developing plans to protect ecosystems, a team of planners works together to use data and models to forecast expected impacts of a specific threat. An environmental impact statement (EIS) is one tool that scientists can use to protect ecosystems. For example, when a road is to be constructed, a local government (e.g., city council) will request an EIS. The EIS includes a forecast of how the options for proposed routes of the road will affect habitats, water resources, and wildlife populations. In addition, planners will hold public hearings to include statements from local citizens in the EIS. The final planning decision must balance the needs of the environment with other considerations, including cost and efficiency.

As students complete their research, guide them to think about how they will present their action plan. Options for formats they could choose from include the following:

- poster
- web page
- written report
- digital slideshow
- video or animation

Lead a discussion about the procedure for the Activity Page. Be sure that students are clear on the procedure. If needed, prompt students with the following questions:

- » What local land ecosystem did you choose?
- » What do you already know about that local land ecosystem?
- » What are the specific threats faced by that ecosystem?
- » What are the main challenges to protecting your chosen land ecosystem?
- » What are the main solutions for protecting your chosen land ecosystem?

SUPPORT—Encourage students to consider several approaches to protecting their chosen land ecosystem. Try to ensure that, as a class, students choose a variety of land ecosystems and protection approaches for their library research. In their plan, each pair of students should focus on one land ecosystem but include a variety of approaches for addressing threats. If students are challenged to provide a budget or schedule, explain that they need only give guesstimates since such information would need more time and information than could be obtained during their research. The aim is for students to relate the concepts of time and money to the planning process.

After students have completed the activity, do the following:

- Collect the completed Ecosystem Protection Action Plan (AP UC.2).
- Review students' questions, and identify any that remain unanswered.

Have students summarize what they have learned about protecting a local chosen land ecosystem, asking them to consider the Big Question: **How can we protect an ecosystem from negative consequences of human activities?** Ensure that students use information from the activity as evidence. Students should be ready to present their plans.

3. Check for understanding.

10 MIN

Activity Page



AP UC.3 and
Answer Key

Formative Assessment Opportunity

- Distribute Lesson Reflection (AP 16.3), and ask students to complete it independently. Once students are finished, collect the assessment, and check students' answers to identify concepts that need further clarification and to provide the support needed.

- See the Activity Page Answer Key for correct answers and sample student responses.
- Prompt students to ask any new questions they may have, and hold a class discussion to further clarify any misunderstandings or misconceptions.

Problem-Based Learning Progress

In this lesson, students should have accomplished the following:

- refined an action plan to address one water, air, or land environmental threat to the local community
- prepared to present the action plan to community representatives

Example Land Ecosystem Protection Action Plan

Review the example Land Ecosystem Protection Action Plan below as a guide to student assessment. Depending on students' learning level, you may wish to provide them with a copy of the plan. Alternatively, you may use it as a scaffold to guide students on the assessment expectations for their own plans.

Title: An Unused Golf Course—Making Good Choices

Summary: A disused golf course is available for sale. Developers want to use the land to build a shopping mall or new subdivisions. The neighborhood already has a large strip mall nearby, and the golf course is surrounded by mid- to upper-income subdivisions. Our action plan explores possibilities for this land, including a green space.

Background: The map of the local area shows the golf course that is for sale (see Figure 1). The map shows that the golf course is surrounded by subdivisions. The 143-acre golf course includes several wooded areas and a natural creek (see Figure 2). The proposed park includes an environmental interpretation center, observation tower, and natural playground as well as areas and facilities for birding, fishing, picnics, forest walks, and wildflower plantings. Natural and paved trails are provided, as well as facilities for a variety of outdoor sports. None of the proposed new structures will be built on existing natural areas. Existing areas of the golf course will be converted to provide wildlife habitat enhancement. Advocates emphasize that the benefits of the park far outweigh any drawbacks. Numerous scientific studies have shown that natural areas are beneficial to people's physical and mental health. Children in particular have been shown to benefit from experiences of nature. A plan to organize citizens around the purchase of the course for use by citizens as a nature park could prevent or limit pressure from developers to sell the land for building the shopping mall or additional subdivisions. Our plan provides approaches that the local environmental group can implement quickly and inexpensively to increase the chances that the county approves the purchase of the golf course as a nature park.



Figure 1. Map of Forgotten Golf Course and surrounding area. The light gray shapes represent existing subdivisions. The darker, irregular shapes represent the golf course fairways that would be the basis for the repurposing of the area to a nature park.



Figure 2. Forgotten Golf Course has numerous natural areas that will remain untouched during the repurposing of the course to create a nature park.

Recommendations: Our recommendations include the following steps that the local environmental group can take:

- Form an organization specifically dedicated to supporting the park: The organization can serve as the focal point to rally local support and to lobby local politicians.

- **Create a website:** The website can serve as the foundation for providing information, raising funds, and promoting the value of the park as a way to protect the local ecosystem.
- **Conduct scientific survey of flora and fauna:** If the natural areas support any threatened species, developers would have to present an environmental impact statement, reducing their potential profits and incentive to compete for the sale of the land.
- **Network with national environmental groups:** National environmental groups have high visibility and wide reach and would be better positioned to pressure local officials to approve the purchase of the land for a nature park.
- **Create a social media campaign:** Developing a presence on social media will enable the group to reach out to local citizens and keep them informed of the effort to pressure the county to approve the purchase of the land for a nature park.
- **Conduct survey of local residents:** A survey of local residents can determine support for the purchase of the land for a nature park. The survey would also help to raise awareness and would likely show support for the park since local residents would expect the value of their homes to increase.

Budget and Schedule: The cost of implementing this plan need not be expensive. The group could ask students from the local university to conduct the scientific survey of flora and fauna. Alternatively, the group could try to pay for the survey via online crowdfunding. For reaching out to citizens, the group could rely on volunteers, since supporters of the purchase of the land for a nature park are very enthusiastic. In terms of the schedule, the group wants to promote the nature park concept to as many people as possible before the county public hearing. We recommend an editorial calendar with itemized content to push out to the group's existing and potential supporters. The calendar organizes and prioritizes content so that the group can ensure the maximum impact of its messaging. For example, the calendar will want to include timing and content of email and social media posts to maximize awareness just before the public hearing. The aim would be to maximize citizens' attendance at the public hearing so that the county commissioners (who are elected) understand the extent of public support for the nature park proposal.

References: Students' project artifacts should include lists of references they used in their research, such as the following:

Interview with Dr. William MacDougal, August 10, 2020

Interview with Carl Spackler, August 10, 2020

The Trust for Public Land, "Golf Course to Public Parks Conversions: Millbrook Park and other 2018 additions," <https://www.parkology.org/ParkKnowledgeBaseArticleDetail?article=a1946000001OrWHAA0> (accessed August 13, 2020)

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Name _____

Date _____

Activity Page 1.1

Use with Lesson 1.

Community Information Board

Throughout this unit, you will be gathering information about the effects of resource use on ecosystems in your community. You will brainstorm your ideas on this Activity Page and then create a community information board to tell people where you live ways that they can help local ecosystems.

1. How can you present information about resource use to people in your community?

2. Describe a problem with water use in an ecosystem in your community.

3. How can people make better use of water resources in your community?

4. Describe a problem with air quality in an ecosystem in your community.

5. What can people do to improve air quality in your community?

6. Describe a problem with land use in an ecosystem in your community.

7. How can people make better use of land resources in your community?

Name _____

Date _____

Activity Page 1.2

Use with Lesson 1.

Name the Resource

1. Based on the class discussion, make a list of the basic natural resources used by people.

2. What item did you use for your library research?

3. What resources are used in making your item? Make a list based on the class discussion.

4. Choose one of the resources to research. Write that resource here.

5. How does using this resource affect plants and animals in a local ecosystem? Write a short passage to summarize your findings. Include how you used the Environmental Protection Agency website in your research.

Name _____

Date _____

Activity Page 1.3

Use with Lesson 1.

Lesson 1 Check

Consider how local ecosystems are affected by human use of natural resources. Then answer the questions that follow.

1. What is a natural resource?

2. You wake up, have breakfast, and then take the school bus to go to school. Explain how your activities needed use of three or more natural resources. (Underline each resource.)

3. Why does human use of natural resources affect ecosystems?

4. You're working for the government. You have been asked to make one law to protect natural resources. Choose a natural resource, and explain why it should be protected and how your law would protect it.

Name _____

Date _____

Activity Page 2.1

Use with Lesson 2.

Human Activities and Water

1. Based on the class discussion, make a list of human activities that impact water quality.

2. What human activity did you write on your sticky note?

3. How does this activity impact water quality? Try to include as many different things as possible.

4. Identify the water treatment step that would be needed to clean the water as a result of this activity. Explain how this step would clean the water.

Name _____

Date _____

Activity Page 2.2

Use with Lesson 2.

Cleaning Water

Work with a partner to use the provided materials to model the way a water treatment plant cleans water.

STEP 1: Place two cups on a flat surface.

STEP 2: Add some sand to a third cup, and fill that cup with water.

STEP 3: Place the kitchen sieve over one of the empty cups. Pour some of the sandy water into that cup, through the sieve.

STEP 4: Place a coffee filter in the remaining empty cup. Pour some of the sandy water into that cup, through the coffee filter.

STEP 5: Repeat steps 1 through 4 using soil in a cup instead of sand.

STEP 6: Record your observations, and answer the questions.

1. Describe the difference between using the coffee filter and the sieve to filter the water with **sand**.

2. Describe the difference between using the coffee filter and the sieve to filter the water with **soil**.

3. What can you conclude about the difference between using the coffee filter and the sieve to filter water?

4. Which method would be better to use for water treatment?

Name _____

Date _____

Activity Page 2.3

Use with Lesson 2.

Lesson 2 Check

Consider the impact of human activities on the quality of water. Then answer the questions that follow.

1. Why should we be concerned with how human activities affect the quality of water?

2. Wastewater needs to be treated to be safe to drink. What is the purpose of filtering wastewater?

3. What is the purpose of disinfection in the treatment of wastewater?

4. Why can surfactants be a problem for fish?

5. How do scientists find out how much phosphate is in water?

6. How can farmers reduce the chance that farming activities will cause an algal bloom?

7. How does phosphate cause an algal bloom?

8. Why is an algal bloom harmful?

Name _____

Date _____

Activity Page 3.1

Use with Lesson 3.

Water Pollution Sources

1. Based on the class discussion, make a list of water pollution sources.

2. From the T-chart activity, what connections do you observe between different water pollution sources?

3. Choose one source of water pollution to investigate further. Print out and include an image of this source to include with this Activity Page. Which source did you select?

4. What is the impact of this water pollution source? Make a list of impacts based on the class discussion and library research. Try to include as many different things as possible.

5. What can people do to ensure that water quality is not affected by this pollution source? If necessary, include activities that could prevent the pollution as well as clean it up.

Name _____

Date _____

Activity Page 3.2

Use with Lesson 3.

Lesson 3 Check

Consider how human activities affect the quality of water. Then answer the questions that follow.

1. Why must people protect water resources?

2. Where is fresh water found?

3. Why do government and state agencies monitor freshwater levels?

4. You're at a garden center buying some plants for the garden. Dave says that chemicals used in the garden are all bad and should be banned. Cite evidence to support an argument on whether Dave is right or wrong.

5. How does an oil spill impact water resources?

6. Describe two ways that an oil spill can be cleaned up.

7. What is a garbage patch?

Name _____

Date _____

Activity Page 4.1

Use with Lesson 4.

Z-Chart

Create a Z-chart based on your online research to find information related to the use of water resources in your community.

1. What source of information did you choose to find information about water use in your community?

2. How does the use of water in your community affect local ecosystems? Remember that people can affect water in both negative and positive ways!

3. Create your Z-chart in the space below.

Two points from the text:

1.

2.

Use an image or drawing of an effect of water use in your community.

Summarize the text in one sentence.

Name _____

Date _____

Activity Page 4.2

Use with Lesson 4.

How Pollution Spreads

1. Based on the activity, describe how the different parts of your model represent features of point-source pollution.

2. What effect did the ice cubes have?

3. Based on the activity, describe one example of how point-source pollution spreads.

4. Use your example from the previous question to explain how the spread of pollution from a point source can harm the environment and human health.

5. Use your example from the previous question to describe two specific ways in which water resources can be protected from that point source of pollution.

Name _____

Date _____

Activity Page 4.3 (page 1 of 2)

Use with Lesson 4.

Lesson 4 Check

Consider how we can protect our water resources. Then answer the questions that follow.

1. Based on the activity, place the following steps of a chemical spill in the correct order by writing the letters in the provided spaces.

- A. Chemical spreads in water.
- B. Pipe breaks.
- C. Cleanup begins.
- D. Chemical company is fined.
- E. Chemical is released into water.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

2. Explain one difference between a point source of pollution and a nonpoint source.

3. Imagine that you are a researcher studying the effects of chemicals on the growth of frogs in fresh water. Which of the following resources would you consider to be a reliable source of information? (Circle all that apply.)

- A. Journal of Freshwater Ecology
- B. Chemical Industry Magazine
- C. American Institute of Chemical Research
- D. Everybody Loves Frogs
- E. Journal of Saltwater Zoology

4. Describe one example of evidence of a positive relationship between human activity and Earth's water resources.

5. Describe one example of how people have used scientific ideas and technology to protect water resources.

Water Resources Action Plan

1.

Based on the class discussion and the research that you completed, describe one problem with water resources in your community.
2.

Complete the chart to make a plan for solving the problem that you described above. You will use this chart when you make your community information board at the end of the unit.

Cause of the problem	Plan for solving the problem
	Describe the solution.
	Describe actions needed.
	Describe time/budget and other details.

Name _____

Date _____

Activity Page 5.2

Use with Lesson 5.

Lesson 5 Check

Consider how we can protect our local water resources. Then answer the questions that follow.

1. Why do we need to protect our local water resources?

2. What is the purpose of a water resources protection plan?

3. What are the essential components of a protection plan?

4. You're a scientist working for a local water authority. What scientific methods would you use to write a report on local water resources?

Name _____

Date _____

Activity Page 6.1

Use with Lesson 6.

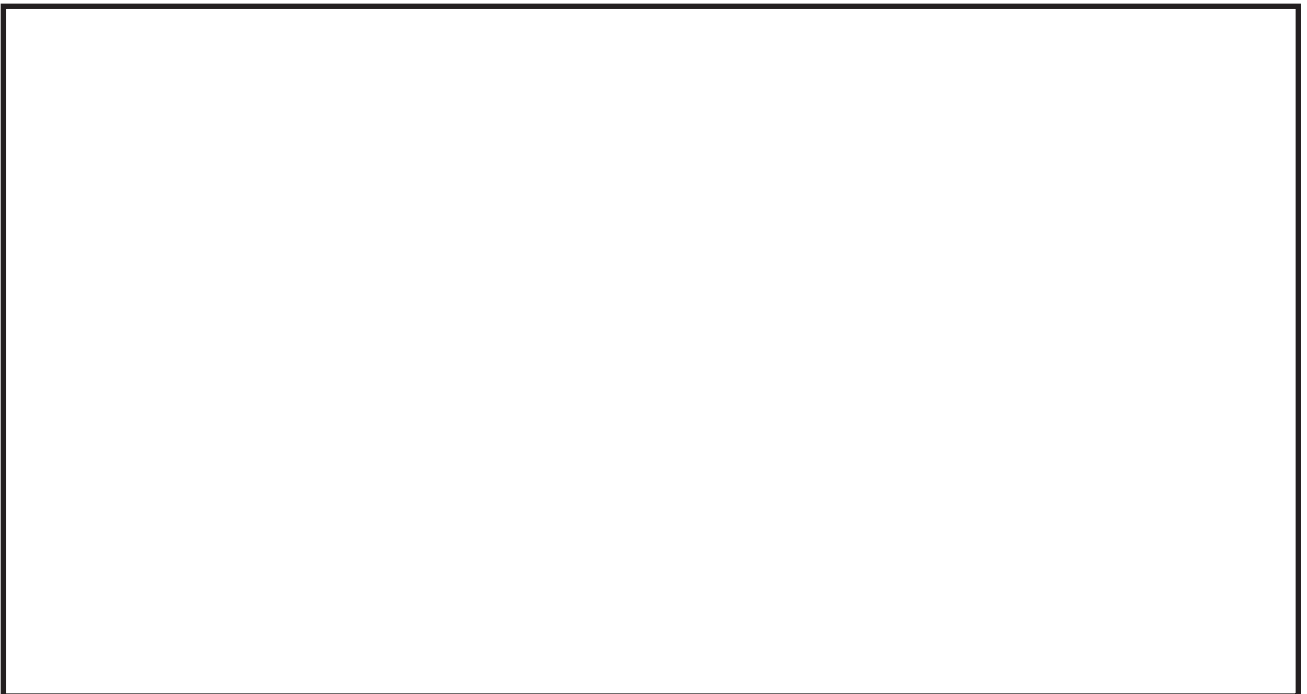
Testing Air Quality

1. Dip the cotton ball in petroleum jelly.
2. Use the cotton ball to apply a thick layer of petroleum jelly on the bottom half of the index card.
3. Find a place to attach your card outdoors so it will capture air pollution.

What location(s) would be a good place to put the card to try to capture air pollution? Why?

4. Clip the dry part of the card to the selected location so that the part with the petroleum jelly is exposed to the air. Leave the card until tomorrow.

After waiting one day, collect your card, and examine it with a magnifying glass. Draw what you see in the space below.



Name _____

Date _____

Activity Page 7.1

Use with Lesson 7.

Air Quality Index

1. What is the color of the Air Quality Index where you live for today?

2. What is the number of the Air Quality Index where you live for today?

3. What do these measurements indicate about air pollution where you live?

4. What are some effects of being outdoors when the air pollution levels are above 100?

5. How can people help improve air quality?

6. Is it possible for a city that does not release pollutants into the air to still have a high amount of pollutants found in the air? Explain your answer.

Name _____

Date _____

Activity Page 8.1

Use with Lesson 8.

Indoor and Outdoor Pollution

Comparing AQI

1. Complete the chart by filling in the Air Quality Index from your city and two other cities.

City	Air Quality Index	
	Color	Rating

2. How does the air in your city compare to the air in other cities?

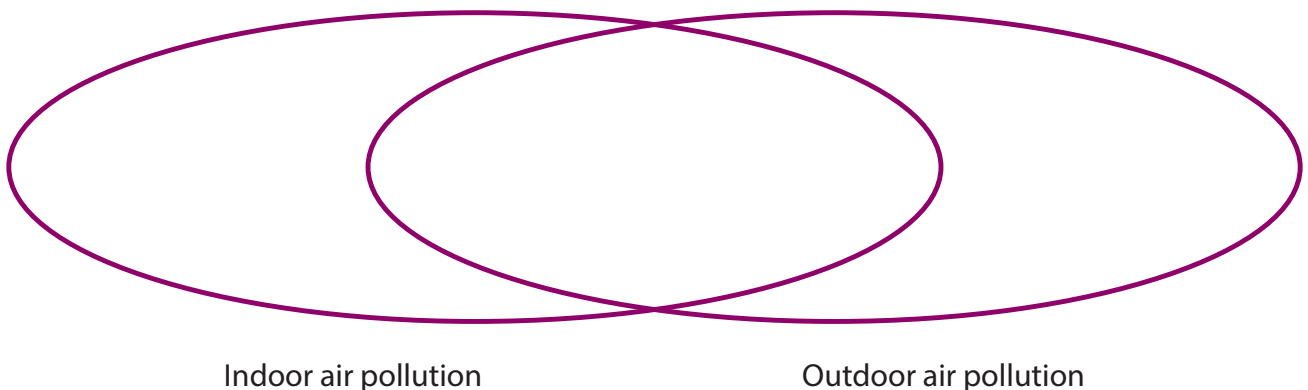
3. Explain why the Air Quality Index differs from place to place.

A Closer Look at Air Pollution

After the teacher demonstration, complete the rest of the questions.

4. Explain why all students did not smell the smoke from the burning match at the same time.

5. Compare indoor and outdoor air pollution. Remember to write shared characteristics in the overlapping part of the diagram.



Name _____

Date _____

Activity Page 8.2

Use with Lesson 8.

Researching Air Pollution

<u>Type of Pollutant</u>	<u>Does it affect indoor air or outdoor air?</u>	<u>Is it caused by humans or natural?</u>	<u>Is there any way to reduce it?</u>
Volcanic eruption			
Smoking/vaping			
Emissions from vehicles			
Forest fire			
Smoke/chemicals from factories or power plants			
Smoke from cooking food			
Smog			

Name _____

Date _____

Activity Page 9.1

Use with Lesson 9.

How Can a Cyclone Clean Air?

In this activity, you will learn about a way that scientists have found to remove pollutants from air before it is released from factories. They can create a cyclone. A cyclone is spinning air. Let's investigate!

Procedure:

1. Sprinkle some glitter in the bottom of the cup.
2. Smear glue on the sides of the upper part of the cup.
3. Place the lid on the cup.
4. Push the sharpened pencil about halfway through the bottom of the cup, making the hole a little larger than the pencil.
5. Twirl the pencil around so the cup rotates on the end of the pencil.
6. Open the lid, and observe the inside of the cup.

Discussion Questions:

1. What happened to the glitter when the cup was spun around?

2. Where would this be a good method to control air pollution?

Air Quality Action Plan

1. Based on the class discussion and the research that you completed, describe one problem with air quality in your community.
- _____
- _____
- _____
2. Complete the chart to make a plan for solving the problem that you described above. You will use this chart when you make your community information board at the end of the unit.

Cause of the problem	Plan for solving the problem
	Describe the solution.
	Describe actions needed.
	Describe time/budget and other details.

Name _____

Date _____

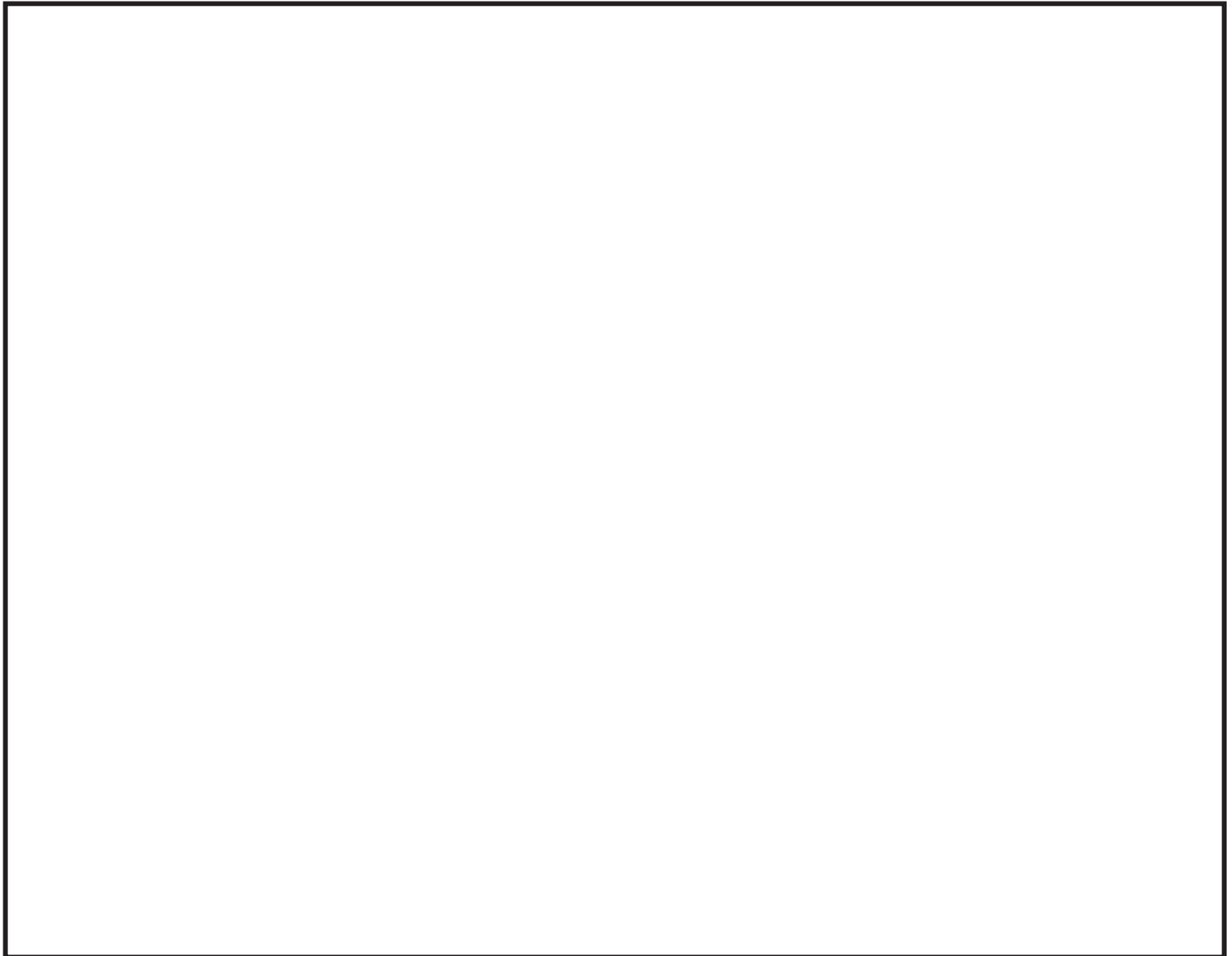
Activity Page 10.1

Use with Lesson 10.

Making a Waste-Free Lunch

Think about what you eat for lunch every day. If you have a sandwich wrapped in plastic, a juice box, and a bag of chips, you are putting three things in the garbage can daily. This may not seem like very much, but if you do this every day for the school year, that is 540 pieces of garbage. If you multiply that by the number of students in your class or school, that is a lot of waste!

In the space below, draw a school lunch that would be waste-free, having no items that need to be recycled or thrown in the garbage can when you are finished eating.



Explain the advantages and disadvantages of packing waste-free lunches.

Name _____

Date _____

Activity Page 10.2

Use with Lesson 10.

Examining Contaminated Land

Part 1:

Examine each of the items given to you by your teacher, and draw them in the space below.

--	--	--

Use the tweezers to bury each item halfway down in the cup of soil. The soil in the cups should be kept moist. You will check the items in a few days to see how they have changed.

1. Explain how you think that each item will change, and explain why.

Part 2:

Use the tweezers to extract each item from the cup, and place them carefully on the paper towel. Observe the items, and draw each of them in the space below.

--	--	--

2. Explain how each of the items changed, and explain why.

3. Explain how using biodegradable materials affects land contamination.

Ways Humans Contaminate Land

Ways That Humans Use Land	Positive Effects	Negative Effects
Building on land		
Farming		
Mining		
Green space		

Name _____

Date _____

Activity Page 11.2

Use with Lesson 11.

Modeling Strip Mining

Follow the directions in the procedure, and dispose of materials as directed by your teacher.

Procedure:

1. Examine the beaker of sand and draw it in the space below labeled "Before." Be sure to note the amount of sand and the appearance of the sand on the surface of the beaker.
2. Lay the paper towel down, and place the beaker in the middle of it.
3. Using the chopsticks, carefully remove the river rock from the beaker, and place it on the paper towel.
4. Examine the beaker of sand again and draw it in the space labeled "After." Be sure to note the amount of sand and the appearance of the sand on the surface of the beaker.

Before	After

Discussion Questions:

1. What did each of the following represent in the model?
 - Sand _____
 - Stone _____
 - Chopsticks _____
2. Explain how the sand changed after removing the rock.

3. Explain how mining can change land.

4. How does mining affect animals and plants on the land?

Name _____

Date _____

Activity Page 12.1

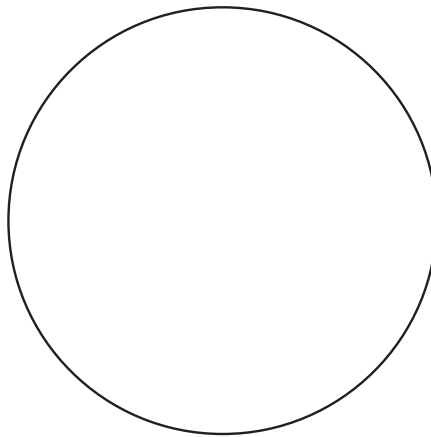
Use with Lesson 12.

Researching Community Land Use

1. Color each of the following areas of land use on your map:

- roads and highways: blue
- buildings such as houses, offices, or schools: yellow
- farms: orange
- mines: purple
- parks or preserves: green

Make a circle graph to show how land is used in your community.



2. What is most land used for in your community?

3. What recommendations can you make for your community to improve their use of land?

4. Where do you think the most contaminated land is located in your community? Why? Mark these areas with a large red X.

Name _____

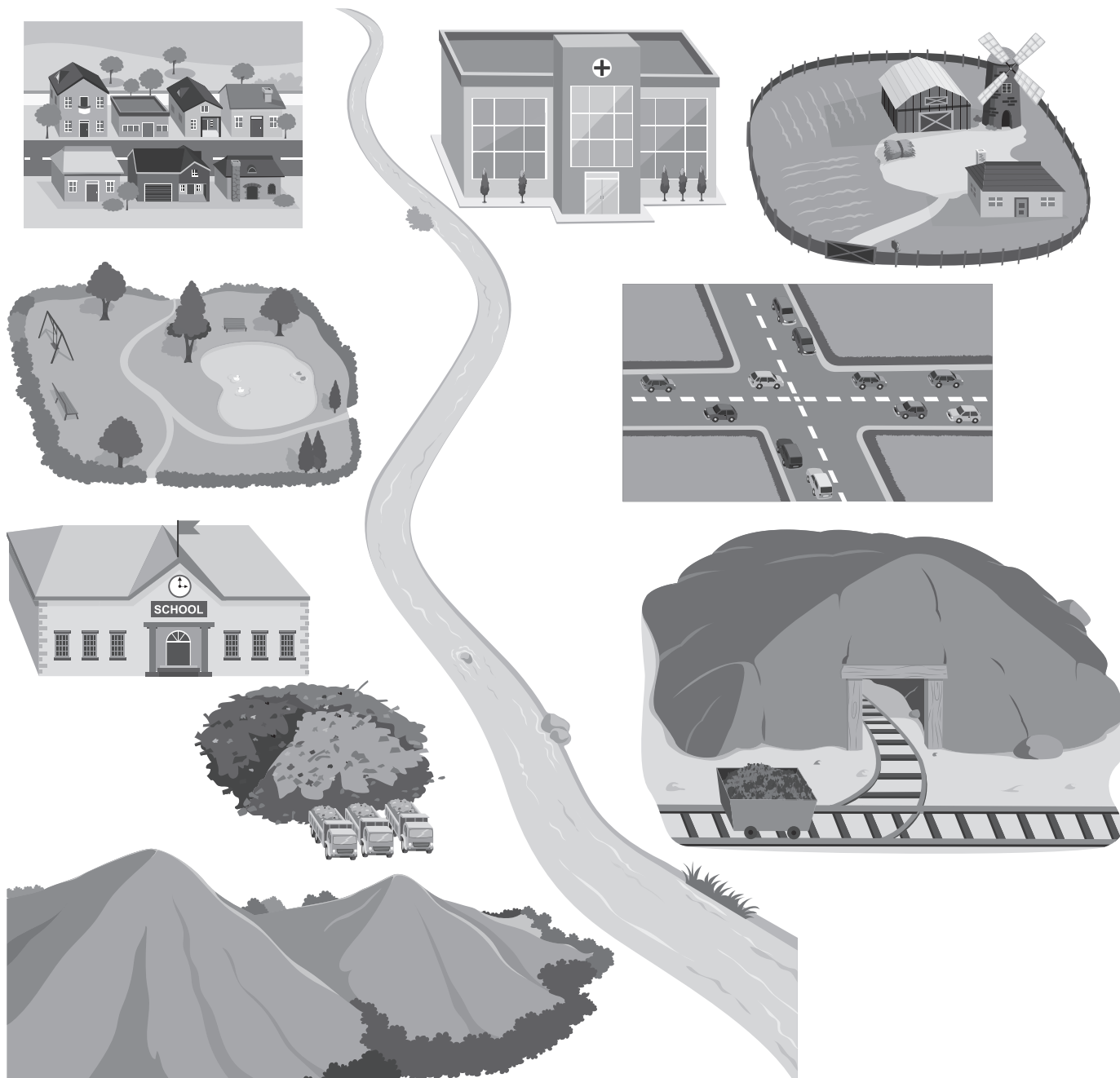
Date _____

Activity Page 13.1

Use with Lesson 13.

Community Planning

In this activity, you will plan how an ideal community will use their land. Begin with a sheet of green paper to represent tree-covered land. You will plan the community there by deciding where to place each part. Cut out each part of the ideal community, and include it somewhere in your plan.



Name _____

Date _____

Activity Page 13.2

Use with Lesson 13.

Land Use Action Plan

1. Based on the class discussion and the research that you completed, describe one problem with land contamination or the way that land is used in your community.

2. Complete the chart to make a plan for solving the problem that you described above. You will use this chart when you make your community information board at the end of the unit.

Cause of the problem	Plan for solving the problem
	Describe the solution.
	Describe actions needed.
	Describe time/budget and other details.

Name _____

Date _____

Activity Page 14.1

Use with Lesson 14.

Interacting Spheres

Think about the ecosystem you live in.

Describe how you interacted with each sphere in the last twenty-four hours.

Atmosphere	
Biosphere	
Geosphere	
Hydrosphere	

Positive and Negative

Think about how you interact with your ecosystem. Review the Student Reader. List five ways humans have a positive impact on ecosystems. Then list five ways humans have a negative impact.

Positive Relationships	Negative Relationships

Positive and Negative Impacts

Complete the following questions based on the list of words provided in the class discussion.

1.

What are the examples of negative activity impacts?
2.

What are the examples of positive activities?
3.

Complete the table to match each negative activity impact with the positive activity best suited to address it.

Negative Activity Impact	Is Addressed By (Positive Activity)

Name _____

Date _____

Activity Page 15.2

Use with Lesson 15.

Researching Environmental Protection

Complete the following questions based on your library and online research.

1. What negative impact did you choose?

2. What do you already know about that negative impact? List sources of ecosystem threats, and describe how each may harm the environment.

3. What questions do you have about that negative impact?

4. Describe existing solutions to the negative impact.

5. Summarize your own solution or evaluation of existing solutions to the negative impact. How does this solution use scientific ideas and technology to protect Earth's ecosystems?

6. What sources did you use for your research?

Name _____

Date _____

Activity Page 15.3 (page 1 of 2)

Use with Lesson 15.

Lesson 15 Check

Consider how we can protect local ecosystems from negative consequences of human activities. Then answer the questions that follow.

1. How do you distinguish a reliable source of information from an unreliable source?

2. Describe one example of a positive relationship between human activity and living resources in a land ecosystem in your community.

3. Describe one example of a positive relationship between human activity and nonliving resources in a land ecosystem in your community.

4. Describe one example of a negative relationship between human activity and living resources in a land ecosystem in your community.

- 5.** Describe one example of a negative relationship between human activity and nonliving resources in a land ecosystem in your community.

- 6.** List one ecosystem threat in your community, and describe how it may harm the environment.

- 7.** Describe one example of how people have used scientific ideas and technology to protect Earth's ecosystems.

Name _____

Date _____

Activity Page UC.1

Use with Capstone Lesson.

Classifying Ecosystem Protection Topics

Based on the class discussion, complete the T-chart related to land ecosystem threats and related approaches to protect the ecosystem.

Ecosystem Threat(s)	Ways to Protect Ecosystem

Name _____

Date _____

Activity Page UC.2

Use with Capstone Lesson.

Ecosystem Protection Action Plan

Use the questions below to help you organize the class action plan.

1. What is the title of your plan?

2. Which local area did you choose for your ecosystem protection plan?

3. What ecosystem threat is your plan addressing?

4. What are the main challenges to protecting your chosen ecosystem?

5. What are the main solutions for protecting your chosen ecosystem?

6. What presentation method are you using to communicate your ecosystem protection action plan?

Name _____

Date _____

Activity Page UC.3

Use with Capstone Lesson.

Lesson Reflection

Consider how we can protect our local ecosystems. Then answer the questions that follow.

1. Why do we need to protect our local ecosystems?

2. What is the purpose of an ecosystem protection plan?

3. What are the essential components of a protection plan?

4. You're a scientist working for a local conservation organization. What scientific methods would you use to write a report on the health of local ecosystems?

Activity Pages Answer Key: *Protecting Earth's Resources*

This answer key offers guidance to help you assess your students' learning progress. Here you will find descriptions of the expectations and correct answers for each Activity Page of this unit.

Name the Resource (AP 1.2) **(page 127)**

1. Answers should include the following: sunlight, water, soil, air, plants, animals, minerals, fossil fuels.
- 2–5. Responses based on student choices of resources will vary.

Lesson 1 Check (AP 1.3) **(page 128)**

1. Answers will vary. Accept the following: a stock or supply of a substance, material, or objects found in nature and of use to people
2. Answers will vary. Accept any reasonable answer, such as: For breakfast I had cereal. Cereal is made from plants, which need soil, water and sunlight to grow. The bus uses gasoline. Gasoline comes from oil. The whole time I was breathing air.
3. Answers will vary. Accept the following: Since ecosystems provide natural resources, human use of natural resources reduces available resources for organisms, and removal of natural resources can damage parts of ecosystems.
4. Answers will vary. Accept any reasonable answer, such as: I choose water as my natural resource. It should be protected since all living things need water. I would make a law to stop people from putting chemicals in the water.

Human Activities and Water (AP 2.1) **(page 129)**

1. Answers may include various activities such as washing clothes, taking a shower, brushing teeth, fishing, swimming, and cooking.
- 2–4. Answers will vary based on student choices.

Cleaning Water (AP 2.2) **(page 130)**

1. Answers should note that the coffee filter trapped all the sand and that the water was less colored compared with the sieve. However, water took longer to pass through the filter.
2. Answers should note that the coffee filter trapped all the soil and that the water was less colored

AP 2.2, continued

- compared with the sieve but that the sieve also trapped some material. Water took longer to pass through the filter.
3. Answers should note that the coffee filter is better at filtering water but is slower than the sieve.
 4. Answers will vary. Students should include the concept of a balance between the time taken to filter the water and the effectiveness of the filter.

Lesson 2 Check (AP 2.3) **(page 131)**

1. Answers will vary. Accept the following: When germs, waste, chemicals, or other substances enter water, they can harm people and wildlife.
2. Answers will vary. Accept the following: to remove large objects from the wastewater
3. Answers will vary. Accept the following: to kill bacteria or other bugs or germs in the water that could make people sick
4. The chemicals stick to the gills of fish. The fish are less able to get oxygen from water.
5. water quality testing
6. use less phosphate
7. Phosphate causes the algae to grow out of control.
8. As the algae grow out of control, they decompose. The bacteria that decompose the algae use up oxygen in the water. Fish and other animals need oxygen. As their oxygen is used up, they cannot survive.

Water Pollution Sources (AP 3.1) **(page 132)**

1. Answers may include one or more of the following: farming, gardening, road or building construction, landfill, trash, boating, fishing, logging, runoff from parking lots
2. Answers will vary. Students should observe that some pollution sources have common origins. For example, plastics from a landfill may pollute rivers and end up as a garbage patch in the ocean.
- 3–5. Answers will vary based on student choices.

Lesson 3 Check (AP 3.2) **(page 133)**

1. Answers will vary. Accept the following: Every living thing needs water to survive. Plants and animals live in water, drink water, and use water to make food. No living thing can survive without water.
2. Answers will vary. Accept the following: on Earth's surface in lakes and rivers and underground in aquifers
3. Answers will vary. Accept the following: to ensure that fresh water is not used faster than it is replaced
4. Answers will vary. Accept any reasonable answer, such as: Dave is wrong because people use chemicals that benefit plants. The chemicals can keep weeds from growing among crops. Other chemicals stop insects from damaging crops. However, these chemicals can be harmful if they enter lakes and rivers.
5. Answers will vary. Accept the following: Oil is difficult to remove from water, and it kills plankton, fish, birds, and other sea life.
6. Answers will vary. Accept two or more of the following: soaked up, use chemicals or bacteria, skim off the surface, burned off
7. Answers will vary. Accept the following: an area of ocean where pieces of plastic collect or an area of ocean where the density of plastic is high

Z-Chart (AP 4.1) **(page 134)**

1. Answers will vary based on student choices. Look for sources appropriately related to the task.
2. Answers will vary based on region and available source information.
3. Answers will vary based on student choices. Look for grade-appropriate organization of information from the source.

How Pollution Spreads (AP 4.2) **(page 135)**

1. Answers will vary. However, answers should include the following elements: The water represents a water body, such as a lake or ocean. The food coloring represents a point source of pollution. The pebble represents land.

AP 4.2, continued

2. Answers will vary. However, answers should include that the ice cubes created water currents that caused the food coloring to move.
3. Answers will vary. Accept any reasonable answer, such as: An oil spill is an example of point-source pollution. When the oil is spilled, water currents can move the oil to other places in the water.
4. Answers will vary. Accept any reasonable answer, such as: An oil spill first harms wildlife in the water near the spill. When the oil spreads to other areas, it will harm even more wildlife. If people eat fish affected by the oil spill, they could become sick.
5. Answers will vary. Accept any reasonable answer, such as: Preventing oil spills is one way to protect water resources. Oil spills can be prevented by ensuring that oil companies transport oil safely. Cleaning up quickly after an oil spill is another way to protect water resources. One way to clean up oil spills is to use bacteria that eat oil.

Lesson 4 Check (AP 4.3) **(pages 136–137)**

1. Correct order: B, E, A, C, D
2. Answers will vary. Accept the following: A point source of pollution may cause worse initial damage than a nonpoint source. A point source of pollution may be quicker to clean up than a nonpoint source.
3. Correct selection: A, C
4. Answers will vary. Accept any reasonable answer, such as: When people clean up an oil spill from water, the cleaner water resource benefits wildlife and people.
5. Answers will vary. Accept any reasonable answer, such as: A water treatment plant uses technology to filter and disinfect water so that the water is safe for people and the environment.

Water Resources Action Plan (AP 5.1) **(page 138)**

1. Answers will vary by classroom and community.
2. Evaluate students based on reasonable grade-appropriate use of topical information.

Lesson 5 Check (AP 5.2) **(page 139)**

1. Answers will vary. Accept any reasonable answer, such as the following: We need to protect our local water resources because access to clean, reliable sources of fresh water is essential to society and human health and necessary for a healthy environment.
2. Answers will vary. Accept any reasonable answer, such as the following: to address a specific water resources problem with solutions and recommendations to achieve a specific goal or desired outcome
3. Answers will vary. Accept any reasonable answer that includes five or more of the following: title, summary, background or introduction, problem statement or question, recommendations, evidence such as maps or diagrams, specific goals to be accomplished, budget and schedule, references
4. Answers will vary. Accept any reasonable answer, such as the following: Use observations and surveys to collect data. Make predictions about potential issues or concerns. Test solutions and methods to address water resources problems.

Testing Air Quality (AP 6.1) **(page 140)**

3. Answers will vary based on location of school, but students may mention putting the card near where cars or buses drive since air pollution is produced when fuel is burned.
4. Results should prompt students to draw a representation of tiny collected particles.

Air Quality Index (AP 7.1) **(page 141)**

- 1–3. Answers will vary based on location. Check for accurate interpretation of available data.
4. breathing problems, itchy eyes
5. planting trees and plants, reducing use of fuel, using clean energy, putting scrubbers on smokestacks
6. Yes, wind can move air pollution from one place to another, so it is possible for a place to suffer from poor air quality even though it did not contribute to the problem.

Indoor and Outdoor Pollution (AP 8.1) **(page 142)**

- 1–2. Answers will vary based on location. Check for accurate interpretation of available data.
3. If a city is more crowded with cars or has more factories, it can have a higher AQI.
4. The smoke blew toward some students but not others.
5. Evaluate responses based on grade-appropriate use of information. Sample answers:

Indoor air pollution:

comes mostly from textiles and cleaning supplies

Both:

presents health hazards

Outdoor air pollution:

comes mostly from vehicles and industry

Researching Air Pollution (AP 8.2) **(page 143)**

Volcanic eruption:

outdoor air; natural; no

Smoking/vaping:

indoor air; human-caused; yes

Emissions from vehicles:

outdoor air; human-caused; yes

Forest fire:

outdoor air; both; yes

Smoke/chemicals from factories or power plants:

both; human-caused; yes

Smoke from cooking food:

indoor air; human-caused; yes

Smog:

outdoor air; human-caused; yes

How Can a Cyclone Clean Air? (AP 9.1) **(page 144)**

1. It stuck to the sides of the cup.
2. in a factory before the smoke is released, in an exhaust chimney, or on the tailpipe of a car or truck to keep pollutants from entering air

Air Quality Action Plan (AP 9.2) **(page 145)**

1. Answers will vary by classroom and community.
2. Evaluate students based on reasonable grade-appropriate use of topical information.

Making a Waste-Free Lunch (AP 10.1) **(page 146)**

- Drawings will vary but should show only items that are 100% consumable or reusable.
- Some disadvantages are that it takes more time to plan and may cost money to buy the reusable items and take time to wash them every day. Some advantages are that there is less waste that needs to be recycled or put in landfills. This keeps land from being contaminated and saves energy and cost from transporting and recycling the materials.

Examining Contaminated Land (AP 10.2) **(page 147)**

1. Accept all reasonable responses.
2. Students should note deterioration in biodegradable material and no change in nonbiodegradable material.
3. It reduces land contamination because the material eventually is broken down completely.

Ways Humans Contaminate Land (AP 11.1) **(page 148)**

Building on Land:

positive effects: can stabilize areas, provides living environments for humans

negative effects: destabilizes ecosystems, takes away living environments for existing organisms

Farming:

positive effects: can replenish soil, adds ecosystems to an area

negative effects: introduces chemicals to the environment that can be harmful, reduces living areas for wildlife

Mining:

positive effects: provides resources for humans, provides jobs

negative effects: can damage ecosystems, long-term effects due to chemicals used

AP 11.1, continued

Green Space:

positive effects: provides living areas for wildlife, helps return oxygen to the air

negative effects: reduces land available for human uses, destination green spaces can increase traffic in an area

Modeling Strip Mining (AP 11.2) **(page 149)**

1. **Sand:** land/soil; **Stone:** materials removed during mining; **Chopsticks:** bulldozer/drill
2. It moved.
3. It removes material and makes it sink.
4. It is not able to be used for animals to live in or plants to grow in.

Researching Community Land Use (AP 12.1) **(page 150)**

Answers will vary based on location. Evaluate for grade-appropriate use of relevant information.

Land Use Action Plan (AP 13.2) **(page 152)**

1. Answers will vary by classroom and community.
2. Evaluate students based on reasonable grade-appropriate use of topical information.

Interacting Spheres (AP 14.1) **(page 153)**

Sample answers:

Atmosphere: I breathed the air. I saw through the atmosphere to find things.

Biosphere: I ate plants. I played with my dog. I listened to the birds. I wore cotton socks.

Geosphere: I walked on the ground. I put salt on my potato. I drank from a glass.

Hydrosphere: I drank water. I ran through the rain. I used water to brush my teeth.

Positive and Negative (AP 14.2) **(page 154)**

Positive Relationships:

monitor changes and well-being of plants and animals

recycle and reuse resources

efficiently use resources such as water or energy in heating, lighting, or traveling

AP 14.2, continued

make rules to protect endangered animals and plants
find ways to dispose of waste materials safely

Negative Relationships:

litter

use disposable cups, bottles, dishes

waste resources by leaving on lights, leaving windows open when heating a building, letting the water run

use chemicals that harm wildlife

destroy animal habitats

Positive and Negative Impacts (AP 15.1) (page 155)

1. deforestation, global warming, hunting, mining, pollution
2. recycling, renewable energy, replanting, wildlife protection
3. **Negative Impact:** deforestation, global warming, hunting, mining, pollution
4. **Is Addressed By (Positive Activity):** replanting, renewable energy, wildlife protection, recycling, recycling

Researching Environmental Protection (AP 15.2) (page 156)

Answers will vary based on location. Evaluate for grade-appropriate use of relevant information.

Lesson 15 Check (AP 15.3) (pages 157–158)

1. Answers will vary. Accept any reasonable answer, such as: A reliable source is from a well-known news website that is not biased. A scientific article or paper is a reliable source. An unreliable source does not use evidence or scientific reasoning.
2. Answers will vary. Accept an answer that cites an example of a positive relationship with living resources, such as: Replanting forests is a human activity with a positive impact on the ecosystem's trees.
3. Answers will vary. Accept an answer that cites an example of a positive relationship with nonliving resources, such as: Limiting use of fossil fuels for transport is a human activity with a positive impact on the ecosystem's air.

AP 15.3, continued

4. Answers will vary. Accept an answer that cites an example of a negative relationship with living resources, such as: Hunting animals is a human activity with a negative impact on the ecosystem's wildlife.
5. Answers will vary. Accept an answer that cites an example of a negative relationship with nonliving resources, such as: Mining is a human activity that generates waste with a negative impact on the ecosystem's soil.
6. Answers will vary. Accept any reasonable answer that cites an example of an ecosystem threat and describes how it harms the environment, such as: Deforestation causes trees to be removed, loss of soil, and loss of habitat for wildlife. The ecosystem is harmed because these impacts reduce its capacity to support life.
7. Answers will vary. Accept any reasonable answer that cites an example of how people have used scientific ideas and technology to protect Earth's ecosystems, such as: Scientists use satellite images to monitor deforestation and replanting.

Lesson Reflection (AP UC.3) (page 161)

1. Answers will vary. Accept any reasonable answer, such as the following: We need to protect our local ecosystems because healthy ecosystems are essential for society, human health, and maintaining the food supply. Healthy ecosystems provide food, clothing, medicines, energy, and clean air and water.
2. Answers will vary. Accept any reasonable answer, such as the following: to address a specific ecosystem's problem with solutions and recommendations to achieve a specific goal or desired outcome
3. Answers will vary. Accept any reasonable answer that includes five or more of the following: title, summary, background or introduction, problem statement or question, recommendations, evidence such as maps or diagrams, specific goals to be accomplished, budget and schedule, references
4. Answers will vary. Accept any reasonable answer, such as the following: Use observations and surveys to collect data. Make predictions about potential threats, issues, or concerns. Test solutions and methods to address ecosystem problems.

Glossary

Purple words and phrases are Core Vocabulary terms for the unit. **Bold-faced words and phrases** are additional vocabulary terms related to the unit that you should model for students during instruction and that are often used within the Student Reader, and these latter terms do not have specific page numbers listed. Vocabulary words are not intended for use in isolated drill or memorization.

A

action plan, n. a set of steps needed to complete a successful project

air pollution, n. any type of substance that is in air and makes it unsafe to breathe (15)

air quality, n. a measure of how clean the air is (22)

Air Quality Index, n. a tool government agencies use to communicate air quality information to the public

algal bloom, n. rapid growth of microscopic algae in a body of water (6)

atmosphere, n. the layer of gas that surrounds Earth

B

bacteria, n. tiny organisms that break down matter (3)

biodegradable, adj. describing material that decays through the action of bacteria or other living organisms (28)

biodiversity, n. the variety of species on Earth or in any one environment on Earth (39)

biosphere, n. all life on Earth

C

Clean Air Act, n. a United States federal law enacted in 1970 to protect people and the environment from the effects of air pollution

clean energy, n. an energy resource that does not release pollutants when it is used (26)

conserve, v. to save or protect (9)

contaminated land, n. land that contains chemicals that are harmful to the environment (27)

crop rotation, n. the practice of changing the type of crop grown in a field each season (33)

cyclone, n. a rotating wind

D

disinfection, n. the process of cleaning infection from a material (3)

TEACHER RESOURCES

E

ecosystem, n. all the living and nonliving things that interact in a given area (39)

environmental protection, n. the practice of taking care of land, water, air, and living things

F

fresh water, n. water that is usable by humans for things such as drinking and cleaning (8)

G

geosphere, n. all of the solid, rocky material that makes up Earth

green space, n. land that is set aside and left without buildings (36)

groundwater, n. water stored in the spaces between materials beneath Earth's surface (8)

H

hydrosphere, n. all of Earth's water

I

indoor air pollution, n. impurities in indoor air

interaction, n. a relationship in a system through which factors affect each other (39)

L

landfill, n. a place where waste is buried underground (28)

N

natural resource, n. materials that occur in nature that can be used by people (11)

no-till farming, n. the practice of harvesting only the part of the plant needed for food and leaving the rest in the soil (33)

O

ozone, n. a gas found in air (23)

P

pathogen, n. a microorganism that can cause disease

pollutant, n. an artificial or natural substance that contaminates air, water, or soil (10)

problem, n. a want or a need (4)

R

reliable source information, n. authoritative information from competent, knowledgeable people without any conflicts of interest

S

smog, n. a type of air pollution that results from a mixture of gases from burning fuels, air, and sunlight that makes air look hazy (16)

stewardship, n. the responsibility of taking care of something

surface water, n. fresh water found in rivers, streams, and lakes on Earth's surface (8)

survey, n. a determination of land boundaries (32)

W

wastewater, n. water that has been used by people (2)

water pollution, n. the presence of harmful substances or matter in water (10)

water quality testing, n. methods to measure the types and amounts of chemicals in water (5)

water treatment plant, n. a facility that cleans wastewater before it is discharged into the environment (2)

Classroom Safety for Activities and Demonstrations

In the Core Knowledge Science program (CKSci), activities and demonstrations are a vital part of the curriculum and provide students with active engagement related to the lesson content. The activities and demonstrations in this unit have been selected and designed to engage students in a safe manner. The activities and demonstrations make use of materials and equipment that are typically deemed classroom safe and readily available.

Safety should be a priority when engaged in science activities. With that in mind, observe the following safety procedures when the class is engaged in activities and demonstrations:

- Report and treat any injuries immediately.
- Check equipment prior to usage, and make sure everything is clean and ready for use.
- Clean up spills or broken equipment immediately using the appropriate tools.
- Monitor student behavior to ensure they are following proper classroom and activity procedures.
- Do not touch your eyes, ears, face, or mouth while engaging in an activity or demonstration.
- Review each step of the lesson to determine if there are any safety measures or materials necessary in advance.
- Wear personal protective equipment (e.g., safety goggles, aprons, etc.) as appropriate.
- Check for allergies to latex and other materials that students may have, and take appropriate measures.
- Secure loose clothing, hair, or jewelry.
- Establish storage and disposal procedures for chemicals as per their Safety Data Sheet (SDS), including household substances, such as vinegar and baking soda.

Copy and distribute the Student Safety Contract, found on the next page, for students to read and agree to prior to the start of the first unit so students are aware of the expectations when engaged in science activities.

Online Resources



For additional support for safety in the science classroom, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Student Safety Contract

When doing science activities, I will do the following:

- Report spills, breakages, or injuries to the teacher right away.
- Listen to the teacher for special instructions and safety directions. If I have questions, I will ask the teacher.
- Avoid eating or drinking anything during the activity unless told to by my teacher.
- Review the steps of the activity before I begin. If I have questions I will ask the teacher.
- Wear safety goggles when working with liquids or things that can fly into my eyes.
- Be careful around electric appliances, and unplug them, just by pulling on the plug, when a teacher is supervising.
- Keep my hands dry when using tools and devices that use electricity.
- Be careful to use safety equipment like gloves or tongs when handling materials that may be hot.
- Know when a hot plate is on or off and let it cool before touching it.
- Roll or push up long sleeves, keep my hair tied back, and secure any jewelry I am wearing.
- Return unused materials to the teacher.
- Clean up my area after the activity and wash my hands.
- Treat all living things and the environment with respect.

I have read and agree to the safety rules in this contract.

_____ / ____ / ____ / ____

Student signature and date

Print name

Dear Parent or Guardian,

During science class, we want to create and maintain a safe classroom. With this in mind, we are making sure students are aware of the expectations for their behavior while engaged in science activities. We are asking you to review the safety rules with your daughter or son and sign this contract. If you have any questions, please feel free to contact me.

_____ / ____ / ____ / ____

Parent or guardian signature and date

Strategies for Acquiring Materials

The materials used in the Core Knowledge Science program (CKSci) are readily available and can be acquired through both retail and online stores. Some of the materials will be reusable and are meant to be used repeatedly. This includes equipment such as scales, beakers, and safety goggles, but also items such as plastic cups that can be safely used again. Often these materials are durable, can be cleaned, and will last for more than one activity or even one school year. Other materials are classified as consumable and are not able to be used more than once, such as glue, baking soda, and aluminum foil.

Online Resources



The Material Supply List for this unit's activities can be found online. Follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Ways to Engage with Your Community

The total cost of materials can add up for an entire unit, even when the materials required for activities and demonstrations have been selected to be individually affordable. And the time needed to acquire the materials adds up too. Reaching out to your community to help support STEM education is a great way to engage parents, guardians, and others with the teaching of science, as well as to reduce the cost and time of collecting the materials. With that in mind, the materials list can be distributed or used as a reference for the materials teachers will need to acquire to teach the unit.

Consider some of the following as methods for acquiring the science materials:

- **School Supply Drive**—If your school has a supply drive at any point in the year, consider distributing materials lists as wish lists for the science department.
- **Open Houses**—Have materials lists available during open houses. Consider having teams of volunteers perform an activity to show attendees how the materials will be used throughout the year.
- **Parent Teacher Organizations**—Reach out to the local PTO for assistance with acquiring materials.
- **Science Fair Drive**—Consider adding a table to your science fair as part of a science materials drive for future units.
- **College or University Service Project**—Ask service organizations affiliated with your local higher education institutions to sponsor your program by providing materials.
- **Local Businesses**—Some businesses have discounts for teachers to purchase school supplies. Others may want to advertise as sponsors for your school/programs. Usually you will be asked for verifiable proof that you are a teacher and/or for examples of how their sponsorship will benefit students.

Remember: if your school is public it will be tax exempt, so make sure to have a Tax Identification Number (TIN) when purchasing materials. If your school is private, you may need proof of 501(c)(3) status to gain tax exemption. Check with your school for any required documentation.

Advance Preparation for Activities and Demonstrations

Being properly prepared for classroom activities and demonstrations is the first step to having a successful and enriching science program. Advance preparation is critical to effectively support student learning and understanding of the content in a lesson.

Before doing demonstrations and activities with the class:

- Familiarize yourself with the activity by performing the activity yourself or with a team, and identify any issues or talking points that could be brought up.
- Gather the necessary materials for class usage. Consider if students will gather their materials at stations or if you will preassemble the materials to be distributed to the students and/or groups.
- Identify safety issues that could occur during an activity or demonstration, and plan and prepare how to address them.
- Review the Teacher Guide before teaching, and identify opportunities for instructional support during activities and demonstrations. Consider other Support and/or Challenge opportunities that may arise as you work to keep students engaged with the content.
- Prepare a plan for postactivity collection and disposal of materials/equipment.

While engaged in the activity or demonstration:

- Address any emergencies immediately.
- Check that students are observing proper science safety practices as well as wearing any necessary safety gear, such as goggles, aprons, or gloves.
- When possible, circulate around the room, and provide support for the activity. Return to the Teacher Guide as students work, to utilize any Support and Challenge opportunities that will make the learning experience most meaningful for your students.

After the activity or demonstration:

- Use your plan for students to set aside or dispose of their materials as necessary.
- Have students wash their hands after any activity in which they could come in contact with any potentially harmful substances.

When engaging students in activities and demonstrations, model good science practices, such as wearing proper safety equipment, never eating during an investigation, etc. Good science practices at a young age will lead to students observing good science practices themselves and being better prepared as they move into upper-level science classes.

What to Do When Activities Don't Give Expected Results

Science activities and experiments do not always go according to plan. Microwave ovens, super glue, and X-rays are just some of the discoveries made when people were practicing science and something did NOT go according to plan. In your classroom, however, you should be prepared for what to do when activities don't give the expected results or when an activity doesn't work.

When going over an activity with an unexpected result, consider these points in discussion with your students:

- Was there an error in following the steps in order? You or the student may have skipped a step. To help control for this, have students review the steps to an investigation in advance and make a check mark next to each step as they complete it.
- Did students design their own investigation? Perhaps their steps are out of sequence, or they missed a step when performing the activity. Review and provide feedback on students' investigation plan to ensure the work is done in proper sequence and that it supports the lesson's Big Question.
- When measurements were taken, were they done correctly? It is possible a number was written down incorrectly, a measurement was made in error, such as a wrong unit of measure or quantity, or the starting or ending point of a measurement was not accurate.
- Did the equipment or materials contribute to the situation? For example, chemicals that have lost their potency or a scale that is not measuring accurately can contribute to the success or failure of an activity.

One of the greatest gifts a student can learn when engaged in science is to develop a curiosity for *why something happened*. Students may find it challenging or frustrating to work through a problem during an activity, but guiding them through the problem and figuring out *why* something happened will help them to develop a better sense of how to do science.



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Core Knowledge **SCIENCE™**

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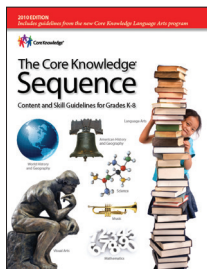
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